Secondary school mathematics teachers' perspectives of Continuing Professional Development (CPD): The case of a selected district in Central Zambia

Kabwe Maureen Kanchebele Sinyangwe

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Declaration

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

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Abstract

Without acknowledging teachers' perspectives on Continuing Professional Development (CPD) and without accommodating their CPD needs, CPD initiatives can be poorly directed or inadequate for the teachers whom they are intended to serve. This research study questions the extent and quality of the continuous professional development (CPD) available to secondary school mathematics teachers in Zambia. Designed as a case study, the principal focus is on the views of the teachers themselves on whether and how current CPD meets their CPD needs. The teachers' views were ascertained by means of multiple data collection tools: questionnaire, face-to-face interviews, focus group discussions and analysis of documents.

Teachers' perceived CPD needs were categorised under six headings: mathematics content knowledge; pedagogical content knowledge and skills; professional practices and relationships; knowledge of and skills to meet learners' needs; affective needs; and school development needs. Of these, teachers' responses show that they had the highest need in the category of knowledge of learners and lowest needs in the school development needs category. Their responses also show that they have wide range of varying needs across all the categories of CPD needs and in various combinations depending on several factors that include their academic background, work experiences and personal circumstances. Teachers' responses show that even though their needs differ from one another, differentiated CPD approaches designed to meet such different needs have not been sufficiently considered. Analysis of background information about Zambia, teachers' responses and relevant literature has led to the conclusion that CPD in Zambia, a low income and developing country, should aim at empowering teachers with the knowledge, skills, competencies values and personal qualities that would enable them not only to improve their teaching practice, but also to continually cope with the demands, pressures, challenges and expectations within a disadvantaged educational system and broad socio-economic environment such as is obtaining in Zambia.

Teachers' consideration of whether CPD was effective in meeting their needs depended on whether they were able to identify their needs or not. A needs analysis model is suggested to guide teachers in identifying their CPD needs and how these might be met. It is hoped that the findings of this research will contribute to informing not only present but also future improvements in CPD provision.

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List of abbreviations and acronyms

ACME	Advisory Committee on Mathematics Education
ACTEQ	Advisory Committee on Teacher Education and Qualifications
ALT	Adult Learning Theory
AIDS	Acquired Immune Deficiency Syndrome
AN	Affective Needs
CDC	Curriculum Development Centre
CK	Content Knowledge
CPD	Continuing Professional Development
CSO	Central Statistical Office
EOF	Educating Our Future
EU	European Union
ECZ	Examination Council of Zambia
FNDP	Fifth National Development Plan (2008-2010)
FOL	Focus On Learning
GRZ	Government of the Republic of Zambia
HIV	Human Immunodeficiency Virus
HOD	Head of Department
JICA	Japanese International Cooperation Agency
LS	Lesson Study
HEIs	Higher Education Institutions
KLC	Knowledge of learners and their characteristics
KLCN	Knowledge of learners and characteristics and needs

MA	Master of Arts
MSc	Master of Science
MOE	Ministry of Education
PCK	Pedagogical Content Knowledge
PD	Professional Development
PCKP	Pedagogical Content Knowledge and Practices
PhD	Doctor of Philosophy
PPR	Professional Practices and Relationships
SBCPD	School-Based Continuing Professional Development
SD	School Development
SNDP	Sixth National Development Plan (2011-2015)
SPSS	Statistical Package for the Social Sciences
TDA	Training and Development Agency for schools
UNESCO	United Nations Educational Scientific and Cultural Organisation
ZAME	Zambia Association of Mathematics Education
ZECF	Zambia Education Curriculum Framework

Chapter 1: Context of the study

This chapter presents the introduction to the study on secondary school mathematics teachers' perceptions of CPD in the Zambian context. It is divided into six sections. Section 1.1 presents the general background information about Zambia, while section 1.2 presents information about the Zambian education system and structure. Information pertaining to mathematics education in Zambia is discussed under Section 1.3. The focus of section 1.4 is the background information regarding teachers' CPD in Zambia while that of section 1.5 is the focus of the study presenting the statement of the problem, the research aim and the questions guiding the research. Section 1.6 presents the significance of the study, 1.7 the theoretical framework for the study followed by an overview of the thesis chapters under section 1.8. Section 1.9 summarises the chapter.

1.1 General Background information about Zambia

Zambia is a landlocked country located in the southern part of Africa. It shares its borders with eight countries namely: Tanzania, Malawi, Zimbabwe, Botswana, Namibia, Angola, Mozambique, and Democratic Republic of Congo. The country has ten (10) provinces divided into a total of 105 districts.

Figure 1 Map of Zambia

Source: Maps of world: http://www.mapsofworld.com/zambia/zambia-political-map.html

Figure 1 above is the map of Zambia showing nine of the ten provinces, 23 of the 105 districts and all the eight neighbouring countries.

According to Zambia's 2010 census, the total population is 'approximately 13.1 million (13,046,508) with a growth rate of 2.8% between 2000 and 2010' (CSO, 2010, pp. 152-3). Of the total population, 50.7% (6 638 019) are female and 49.3% (6 454 647) male. Overall, Zambia has a young population as 45.4% are aged below 15 years. In terms of regional distribution, 60.5% (7 923 289) of the people in Zambia are in rural areas and 39.5% (5 169 377) in urban areas. The average life expectancy is 49 years for males and 53 years for females (CSO, 2012).

Zambia has a lower income level status (United Nations Development Programme [UNDP], 2016). Poverty remains a weighty problem in Zambia, which is worsened by a high birth rate and relatively high HIV/AIDS burden among other issues. HIV/AIDS is a leading cause of death in Zambia (Centre for Disease Control [CDC], 2013). According to the latest Demographic Health Survey, the 2013-2014 Zambia Demographic Health Survey, the HIV prevalence rate, is at 13%, with 14.3% among women and 12.5% among men, which indicates a decrease overtime compared to the 2001-2002's 16% (CSO, 2012). However, even with comparatively lower prevalence rates, the HIV/AIDS pandemic is still considered a threat to the wellbeing and productivity of Zambians and has a negative impact on all sectors of the Zambian society (Tembo, 2012). The poverty levels in the country are high. The country's reported economic growth has not translated to significant poverty reduction(UNDP, 2016; WorldBank, 2014). The absolute number of poor people in Zambia has continued to increase from 6 million in 1991 to 7.9 million in 2010. Sixty point five per cent (60.5%) live below the poverty line and 42% considered to be living in extreme poverty(WFP, 2016).

Zambia's economic challenges have not only reflected in the high poverty levels, but have affected the education system as well as education provision and quality maintenance. According to UNESCO (2015), the educational challenges that Zambia has been facing are tied to the educational challenges faced in the 1980s and 1990s and include:

…decline in enrolment rates and exclusion of the most vulnerable groups, low level of learning achievements, inadequate educational infrastructure at all levels, a shortage of teaching and learning materials and appropriately qualified teachers and general absence of investment in the education sector. These challenges made it difficult for the government to deliver educational services effectively (p.4).

Even though the situation has changed considerably, with the increase in enrolment especially at primary school level and increase in school infrastructure projects, the challenges highlighted above still remain. In fact, with the attention that has been given to primary education, it can be deduced that there would be sufficient or higher numbers of pupils[1] moving on to secondary school level, which would subsequently demand further financial investment to be made.

Further, while budget allocation to the education sector has increased from 4.2% of Gross Domestic Product (GDP) in 2002 to 5.2% of GDP in 2014, a significantly big portion of this increase in the budget has gone toward improving school infrastructure for the purpose of increasing access to education and improving conditions of service for educational personnel. Even though it is envisaged that with current achievements in increasing access, as mentioned above, focus for the sector could also be on improving quality of education and education delivery (DeKemp, Elbers, & Gunning, 2008) this has not been so much the case in reality. UNESCO (2015) argues that school construction and renovations have continued to take centre stage. According to UNESCO (2015), this '…entails that the argument for increasing funding for quality concerns may seem abstract'(p. 36). Zambia needs to increase and move financial resources to address quality issues especially on teaching and learning (UNESCO, 2015). For instance, the recently revised national curriculum equally requires instructional resources to support its implementation process. There are, therefore, competing priorities for the limited funds available for the delivery of educational services in the country.

An additional challenge is that associated with the use of Output-Based Budget (OBB) system in Zambia (GRZ, 2014). Zambia has moved from using the Activity Based Budget (ABB) to OBB in what is said to be a move toward enhancing performance orientation of the budget. The OBB system requires indicating 'the actual outputs (deliverables) that will be produced as a result of spending the allocated funds' (UNESCO, 2012a, p. 14). In the education sector like other sectors, this budget system is likely to shift attention from less tangible outcomes such as collaboration or change of attitude toward work which add value, but are difficult to identify, measure and may not be formalised (UNESCO, 2015).

[1] 'Pupils', 'learners', and 'students' are used interchangeably to refer to the 'taught'.

The country's development agenda has been defined through the Five-year National Development Plans with the latest being the SNDP which, like the FNDP, embraces the 'Vision 2030'. Vision 2030 is a long-term national development plan with an overall vision of Zambia becoming a 'Prosperous middle-income nation'. The specific development goals include: fostering a competitive and outward-orientated economy, significantly reducing hunger and poverty and reaching middle-income status. Education is seen as a pillar to be used to attain the prosperous middle-income status. Since Vision 2030 has spelt out the kind of citizenry the country desires to have, the new curriculum has embraced the issues therein to define a learner: the kind of learner the education system should produce so that it fits in with the vision expressed in Vision 2030 (MOE, 2013b).

1.2 Zambian education system and structure

1.2.1 Education policies

The Zambian education system and education provision is governed by principles and guidelines indicated in the education policy documents. Since Zambia's independence from British colonial rule in 1964, three major education policy documents have been put in place: 1977 Education Reforms; 1992 FOL; and the 1996 EOF which is still in use at present. Among the principles being upheld in the EOF policy document is that every individual has a right to educational opportunities. The implication of this for the government is that it must provide access at all levels of education together with an appropriate curriculum and, more to the point, highly trained and competent teachers to deliver it. The MOE[2] in Zambia will then meet its responsibility to ensure that education provision and delivery conforms to the principles raised in the national policy document and the global declarations to which Zambia is a signatory (MOE, 2005).

1.2.2 Approach to teaching and learning

MOE documents such as FOL and EOF policy document together with the 2013 ZECF, have made references to the point that learning should be focussed on learners and that teaching should be conducted using learner-centred teaching approaches. For instance, the FOL

[2] In 2011 Ministry of Education (MOE) became known as Ministry of Education, Science, Vocational Training and Early Education (MESVTEE). MESVTEE was split in 2015 into the Ministry of General Education and the Ministry of Higher Education. This study uses MOE to represent MESVTEE or the two 'split' ministries for the purpose of consistency.

national document states that ‘The curriculum should be centred on the student rather than on the material to be covered’(MOE, 1992, p. 7). The EOF policy document states that the education system should ‘produce a learner capable of developing an analytical, innovative, creative and constructive mind’(MOE, 1996, p. 5). It also states that secondary school education should provide ‘educational experiences that will nurture skills that will enable pupils to take charge of their own learning’ (MOE, 1996, p. 51). This is consistent with Borko & Putnam’s (1995) argument that current education reforms endorse a shift toward learner-centred teaching approaches in the teaching and learning process. This reform, current then and now, suggests a change from the traditional knowledge transmission from teachers to learners to a cognitive and social construction of knowledge (Mansour, Alshmrani, Aldahmash, & Alqudah, 2013). The ideas of learner-centred learning/teaching can be said to be linked to constructivist theory (Bada, 2015). Constructivist theory has been discussed in detail under section 1.7.1.

Despite calls for use of learner-centred teaching approaches, most, if not all, of the lessons in Zambian schools cannot be considered learner-centred. Hambokoma et al.’s (2002) national baseline study using questionnaires, interview, lesson observations and reviewing documents involving secondary school pupils and science and mathematics teachers in Zambia shows that teachers have continued using teacher-centred approaches. A similar finding was made by MOE (2009) that school lessons ‘…are conducted in a traditional way of “chalk and talk” as well as teacher-centred method’(p. viii). More specifically in the case of mathematics teaching, teachers largely transmit mathematical knowledge to learners and learner engagement in the lessons is kept to the minimum. Ishii (2015) reveals that mathematics teachers in Zambia focus on external activities such as written answers to given mathematical tasks rather than the process of thinking behind the learners’ written work and answers to given tasks. This observation is similar to that made by ECZ (2015) with reference to the way teachers give feedback to learners based on learners’ work. They state that teachers focus only on the answer without critically analysing the reasoning behind a pupil’s work (ECZ, 2015). Generally, assessment of pupils’ work does not go beyond whether the answer is correct or not. Possible reason for this is teachers’ lack of understanding of the notion of learner-centred teaching and of a lack of common understanding and training of what is required to implement such teaching/learning approaches. According to Ishii (2015) ‘the intention and detail of the term [learner-centred] have not been clarified’(p. 275). This is confirmed in MOE teachers’ document called the ‘Teaching Skills Book’, which states that:

In the long run followed by a series of Lesson Study and implementation in class, it is hoped that teachers will come up with proper strategies of learner-centred teaching and learning, as there is no clear position on this matter in Zambia. Also worth noting is the fact that the learner-centred learning varies from country to country and culture to culture. It is envisaged that, in the long run, Zambia will be in a position to define its own learner-centred teaching and learning through our effort for developing better lessons for the pupils (MOE, 2009, p. viii).

Therefore, even though there are intentions and calls for use of learner-centred approaches to be practised in Zambia, there are no clear core principles and there is no clear strategy in place for its implementation.

1.2.3 Revised Zambian curriculum

The recently revised school curriculum is intended to be a tool to assist teachers and teacher educators in the implementation of the national policy principles and guidelines on education for Zambians (MOE, 2013b). This curriculum, which was last reviewed and revised comprehensively in early 1970, has stipulated the essential knowledge and skills to be obtained through the regular school subject areas and other important competencies, skills, values and attitudes which school children need to achieve as they pass through the school system as a whole.

With respect to mathematics in particular, the new and revised curriculum has also called for some changes in the mathematics content and generally in the way that mathematics is to be taught. There are topics such as 'Computers' that have been included in the curriculum and topics such as 'Matrices' which were initially taught at senior secondary school level which are now being taught at junior secondary school level. There is also a focus not only on acquisition of mathematical knowledge and development of relevant accompanying skills for solving mathematics problems but also on the development of important values such as 'teamwork', 'creativity' and 'perseverance'. In addition, the new and revised curriculum stresses a focus on development of 'life skills'. Life skills are not a subject or subjects per se, but an integral part of each school subject, including mathematics, and are the implicit intended outcomes of the entire teaching and learning process within the school system.

Further, there are some areas, which do not appear as regular school subject areas but remain linked to all subjects and are important components of school-life crosscutting issues, which have been emphasised in the new curriculum. Examples of such crosscutting issues are: health, the environment, guidance and counselling among others. The argument is that these crosscutting issues help to bridge the gap between school subjects and real life outside school.

Furthermore, according to the new curriculum, there is an emphasis on the point that the target area of teaching is not only acquisition of the academic skills, but also the development of the entire personality of the learner: where teaching has an influence on the learners' attitudes, affect changes in learner behaviour and contribute to the development of the emotional, spiritual and physical aspects of the learners. MOE expects teachers to pay attention to the process of enabling the development of desired knowledge, skills, competencies (such as communication skills, analytic creative and innovative skills), values and attitude in learners (MOE, 2013b) for their holistic development. With respect to the holistic development of a learner, UNESCO (2011) observes that each teacher, irrespective of the subject specialisation, is supposed '…to see to the development of the entire personality of the learner, with all its cognitive, emotional, affective, moral and physical facets' (p. 7). This point has been developed further in Chapter 2. At this point however, it can still be stated that even though the MOE has not prescribed how teachers are to produce such effects on learners, there is no doubt that well-designed teachers' CPD can play a significant role in raising awareness on, or reminding the teachers of this responsibility and equip them with relevant knowledge and skills to help them fulfil this role.

The changes in the way that mathematics is to be taught is first of all reflected in the shift from behavioural objective based education to an outcome-based education. According to MOE (2013b):

Outcome-Based Education (OBE) is an approach to learning that the Ministry of Education, …has adopted, moving away from Behavioural Approach. The approach seeks to link education to real life experiences as it gives learners skills to access, criticise, analyse and practically apply knowledge. Learners are given practical experiences during the teaching and learning processes that help them gain life skills.(p. 16)

This approach is applicable in terms of mathematics teaching and learning. The literature (CORD, 1999; Gutstein & Peterson, 2006; Aydın-Güç , Hacısalihoğlu-Karadeniz, Aksu, & Güç, 2014) states that most learners learn best when they can connect mathematical concepts being learnt to the real world through their personal experience or the experiences that their teachers provide. This could be a challenge in the context where teachers 'teach to the book' and where mathematics is disconnected from the real world. However, when done, it would imply that mathematics teaching will respond to needs of learners and the needs of society.

The expected changes in the way that mathematics is to be taught is also reflected in an emphasis on use of learner-centred approaches in the teaching and learning process. It is

stated in the ZECF that '…teachers and teacher-educators are strongly advised to use the Learner-Centred Approach in the teaching and learning process'(MOE, 2013b, p. 57).

Embracing the changes that have come with the new and revised curriculum for successful curriculum implementation demands that secondary school mathematics teachers' view of a *'teacher'*, view of *'teaching'* and view of the '*nature of mathematics and mathematics content'* are equally adjusted. This is discussed in the next two sections below.

1.2.3.1 Implications of curriculum changes on teachers' view of *'teacher'* and of *'teaching'*

To start with, teachers' traditional conception of a *'teacher'* and of *'teaching'* needs to change and be aligned with the views and practices expressed in the curriculum. The view that teachers are transmitters of knowledge, as is commonly upheld in the Zambian context, will have to change to accommodate and embrace the view of a teacher who facilitates learning and in-depth understanding of mathematical concepts that require to be learnt. As a facilitator, a teacher will have to be flexible enough to provide opportunities and incentives to allow for exploration and investigation for the purpose of knowledge creation, knowledge construction and understanding (Gergen, 1995; Von Glasersfeld, 1996) and problem-solving (Thompson, 1992). This allows for going beyond shallow knowledge and understanding of mathematical concepts to in-depth content understanding, which learners cannot easily forget. Thus the idea that teachers' views of teaching and ways of teaching will equally have to change. This is consistent with the literature (Loucks-Horsley, Harding, Arbuckle, Murray, Dubea, & Williams, 1987; Putnam & Borko, 2000) which argues that encouraging learners to learn based on the constructivist lines and learner-centred teaching and learning require that teachers adjust their ways of teaching too. For instance, traditional mathematics teaching characterised by rote learning would have to change. Additionally, teachers would have to stress higher order thinking as stipulated in Bloom's taxonomy (Anderson & Krathwohl, 2001) in relation to mathematics work compared to remaining stagnant at promoting lower-order thinking. It also calls for allowing pupils to communicate their ideas or reasoning clearly and precisely to generally acceptable correct or incorrect responses to mathematical problems. Teacher-pupil interaction will similarly have to change. The traditional power relations have to be reconstructed (Bishop & Glynn, 2003; Gergen, 1995; Weimer, 2002) and this requires, among other things, a deep knowledge of learners and ability to appropriately apply this knowledge to enrich the teacher/pupil and/or pupil/pupil interaction and experiences.

The need to produce autonomous learners, who can take responsibility for learning and construct knowledge with and from the learning activities they engage in, is crucial for the success of the implementation of changes that have been defined in the new curriculum. A teacher's role therefore would be one where s/he is to provide an enabling environment for creating such autonomous learners, even though for them to be able to do so also depends on whether they have and can exercise autonomy in their personal learning. It is possible that teachers may have been taught in a transmissive style themselves, and/or may not know what autonomous learning looks like and thus unable to teach following constructivism principles. They might demonstrate inability or simply need guidance in efforts to make changes and incorporate instructional practices, which are attached to constructivism approaches in teaching as highlighted in this section. The needed support and guidance can come through relevant and meaningful CPD.

A discussion on teachers' view of *'teacher'* and of *'teaching'* cannot be complete without referring to a view of *'learning'*. The ZECF states that learning should involve gaining 'knowledge, skills, values and positive attitudes that enable them to function in any given environment'(MOE, 2013b, p. 18). This suggests that teachers' focus on learners' learning will encompass not only learners' gaining mathematics content knowledge and skills, but also the accompanying values and positive attitudes as stated in ZECF.

It is expected that the current changes, in the content and teaching procedures, coming with the new curriculum will improve current mathematics classroom practices and experiences. However, note should be taken that without accompanying changes in teachers' views, and attitudes as illustrated above improving classroom practice will remain complicated and almost unattainable.

1.2.3.2 Implications of curriculum changes on teachers' view of the *'nature of mathematics'*

Broadly stated, Mathematics has a complex and technical nature to it with obvious and not so obvious links within it (ACME, 2002; Smith, 2012). Mathematics is made up of subject matter such as definitions, facts, proofs and theorems, and computational skills as well as conceptual skills which are necessary in the construction of mathematical objects and facts (Harel, 2008). It encompasses complex reasoning, problem solving from different perspectives, analysing and communicating patterns and relationships (Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010). It is possible to argue that teaching mathematics is

not affected by a teacher's view of mathematics or the nature of mathematics. However, the argument here is that teaching mathematics can affect or be affected by a teacher's view of mathematics and its nature. A teacher's view of mathematics has an impact on how s/he teaches mathematics (Harel, 2008). Among the views of the nature of mathematics are two main ones: the Absolutist view and the Fallabilist view. Absolutists' view of the nature of mathematics is that mathematics is'…a body of infallible, objective knowledge…' (Ernest, 1991, p. xii). It consists of truths, collection of facts and rules that are fixed. With this understanding, the perception of mathematics is that of being right or wrong and '…to be learned from outside human consciousness…'(Ernest, 1991, p. xii). This view is reinforced in mathematics textbooks, for instance, which influence teachers who use them as an authority of the mathematics they teach in the classroom. The view they present is that mathematics is '… pre-given and unchanging…' (Jaworski, 2010, p. 13). With this view, teachers are generally content with simply knowing the facts related to the mathematics they teach.

The Fallibilist view of mathematics is that 'mathematical truth is fallible and corrigible, and can never be regarded as beyond revision and correction' (Ernest, 1991, p. 18). To use Ernest's (1996) simple example, 1 + 1 = 2 is not absolutely true. It is true under the normal arithmetic interpretation and not true under other background systems such as that of base 2 arithmetic where 1 + 1 = 10. Therefore, illustrating that truth in mathematics is not absolute, as absolutists argue, but is to be understood or interpreted with respect to a background system. In this case, what is known about mathematical concepts and rules cannot necessarily be considered as complete. This perspective appears to provide some flexibility and creativity in dealing with mathematical truths (Jaworski, 2010). With this view, mathematics is a practical subject and through practice one is able to reconstruct mathematical knowledge. It can thus be deduced that this perspective is more accommodating of the principles of learner-centred teaching/learning and constructivism approach to teaching.

The choice of the view of mathematics is a crucial basis for the teaching of mathematics, use of teaching/learning resources and materials as well as the choice of teachers' personal way(s) of learning for the purpose of improving their mathematics teaching practices. Teachers' view of the nature of mathematics can facilitate or hinder implementation of the changes in the new curriculum. As Loucks-Horsley et al (2010) noted, if teachers' abilities to teach mathematics in ways consistent with national curriculum standards are to be increased then it is important that the nature of mathematics is kept in mind.

As stated above, Fallibilists can be said to be more accommodating of the principles of learner-centred teaching/learning and constructivism approach to teaching than would Absolutists. While Absolutist and Fallibilist views are the two main opposing views of the nature of mathematics, it should be stated here that there is also a view of the nature of mathematics that acknowledges and combines both views (Ernest, 1998). By deduction, teachers who subscribe to both views are equally more readily to accommodate the principles of learner-centred teaching/learning and constructivism approach to teaching than those that exclusively uphold the Absolutist view.

1.2.4 Structure of the education system in Zambia

The formal schooling system in Zambia starts with Pre-school and is followed by a 7-5-4 system denoting seven years of primary school, five years of secondary education and four years of university education. Even though four years of university education have been stated as above, the numbers of years covered after secondary education vary depending on the course that an individual decides to pursue after completing secondary education. The structure of the education system in Zambia together with the number of years learners spend in school from the time they enter pre-school to doctorate degree level schooling is shown as Appendix A.

The official primary school entrance age in Zambia is 7 years, but there are variations in age because some children enrol when they are older than 7. One of the reasons for enrolling at an older age is high poverty levels. Since primary school continues for seven years it can be reasoned that the official secondary school entrance age is 14-15 years and completion of secondary school education being around 18 years of age for those 'on-time pupils' or much order for late entrants. Table 1 below shows the age-grade match, which applies to the given educational level starting with 7 years old which is the official age for entry into primary school. The secondary school section is divided up into two: Junior Secondary School covering two years (Grade 8 -9) and Senior Secondary School covering Grades 10-12**.**

Table 1 Expected age and grade levels for pupils in the Zambian school system

Level	Duration	Ages for on-time pupils
Primary	7 years	7-13
Junior Secondary School level (Grades 8-9)	2 years	14-15
Senior Secondary school level (10-12)	3 years	16-18
Higher Education level	Varies depending on programme	18 years and above

Adapted from (FHI360, 2014; UNESCO, 2011)

There are national public examinations conducted at the end of primary school level (Grade 7), junior secondary school (Grade 9) and at the end of senior secondary school level (Grade 12) for the main purpose of selection and certification. These are referred to as the Grade 7 composite examinations, Grade 9 Junior Secondary School Leaving Examinations (JSSLE), and Grade 12 examinations for School Certificate (SC) and General Certificate of Education Ordinary levels (GCE O-Levels). Learners have to sit for the national examinations to proceed to Grade 8 or to proceed to Grade 10 after 2 years of junior secondary school education and sit for the Grade 12 final examination to enable them to proceed to tertiary education and then employment (ECZ, 2013). In Zambia, the GCE Advanced-level in Mathematics (i.e. Additional mathematics) in particular is optional and offered to learners whose performance is generally above average (ECZ, 2015).

Secondary education is followed by college or university education. For the purpose of this study only teacher training and secondary school mathematics teachers' training in particular are considered.

1.2.4.1Teacher training

Initial teacher training is designed to supply trained teachers for the school system. The minimum entry qualification for initial teacher training is a secondary school leaving certificate with credit (which is equivalent to 50%)or better in at least 5 subjects including Mathematics and English. The background is that there are three categories of secondary school mathematics teachers in Zambia. There are those with a primary school teaching certificate, those with a diploma in secondary education and the ones with a degree in secondary education. The minimum qualification for secondary school teachers is first degree in secondary education. However, due to critical shortages of mathematics teachers, teachers with diploma in secondary education, and sometimes in extreme cases those with primary school teaching certificate, are seconded to teach Mathematics at secondary school. Teachers with primary school teaching certificate used to undergo an initial two-year teacher-training course[3] at any one of the colleges of education in the country. During their training, they

[3] This has currently been phased out for the three-year primary school Diploma programme following changes in the minimum qualifications to teach at primary school. Trainee teachers for this programme are still not expected to specialise in any teaching subject as they would have to teach all the primary school subjects after completion.

were not expected to specialise in any teaching subject as they were being trained to teach all subjects offered at primary school.

Teachers with a diploma in secondary education are trained to teach at junior secondary school level (Grades 8-9). During their initial teacher training they follow a two-year residential programme specialising in one or two teaching subjects. Following changes in minimum qualifications for teachers teaching at secondary school, secondary school teachers have to possess a degree in secondary education. Teachers possessing secondary school degree are expected to teach at senior secondary level (Grades 10-12). The general trend is for teachers to specialise in two teaching subjects during their initial training and at the same time take some professional courses in education, but there are also cases where some have a single major subject area of specialisation. Despite there being more opportunities and modes for training with mathematics as an area of specialisation, the number of individuals specialising in mathematics at the different universities in the country remains small to a point of concern. This has contributed to further shortages of mathematics teachers in schools as discussed in detail in the next section.

Generally, the initial teacher training curriculum includes academic and professional components and first school experience or school teaching practice. The academic component for secondary school teacher training is aligned with the subject of specialisation and focussed on improving the content knowledge, but not limited to topics actually taught to secondary school-going pupils. It is also composed of pedagogy component with a focus on the methods of teaching the teaching subjects including micro, macro and peer teaching sessions during training. The education and professional component concentrates on providing trainee teachers with foundation knowledge on the guiding principles in education provision and management. It presents trainee teachers with opportunities to explore some of the historical, philosophical and theoretical underpinnings of the field of education and examine various aspects of education practice, policy including child psychology and crosscutting issues affecting the learners and Zambian community. 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 lasts for 6-12 weeks depending on the training institution.

1.3 Mathematics teaching and learning in Zambia

1.3.1 Mathematics as a school subject

Mathematics is a compulsory subject throughout all the grade levels from primary through to secondary school. It is one of the core subjects in both the academic as well as the vocational career pathways at secondary school. The secondary school mathematics syllabus has a total of 52 topics with 24 covered at junior secondary school level and 28 at senior secondary school level spread out with the main content domains being: Algebra, Numbers and Calculations, Geometry, Relations, Probability and Statistics, Measures and Computers. Accordingly, secondary school going pupils are expected to learn mathematics content as contained in the main content domains presented above and acquire the knowledge, skills and values as prescribed in the new and revised curriculum (CDC, 2013a, 2013b; MOE, 2013b).

The importance of mathematics and Mathematics as a school subject to individual learners, community and nation at large cannot be over emphasised. According to the Zambian Curriculum Development Centre (CDC) documentation (CDC, 2013a, 2013b) which is in line with the new curriculum, among the objectives of learning Mathematics are that Mathematics: fosters the development and improvement of learners' intellectual competence in logical reasoning, spatial visualisation, analysis and abstract thought; is a significant tool for learning other subjects; enlarges learners' ability to understand the world around them; and helps learners to prepare for further education. It is further stated that through learning mathematics, learners; develop life skills such as problem solving skills, which are critical for everyday day life; are equipped to live in the Artistic, Scientific and Technology-orientated age and enabled to contribute to the social, economic development of the country. It is expected that through learning mathematics, learners gain an understanding and appreciation of mathematical concepts and computational skills and also develop ethical values necessary for accountability such as would be needed in financial matters through interpreting financial information among other areas (CDC, 2013a, 2013b). It is because of the significance of mathematics and the value of the experience through the learning of mathematics that all learners are required to study mathematics. Further, it is a requirement that learners pass mathematics among other subjects that are considered to enable them proceed to Grade 10 and obtain a credit or better in Mathematics if they are to progress to HEI (ECZ, 2015). However, despite the well-presented objectives and outcomes of teaching and learning mathematics, poor performance in mathematics is recorded. Whether it is a question of the

nature of assessment or the way mathematics is taught or learnt or learners' attitude towards mathematics, this poor performance is a concern not only to teachers but also to learners, parents, teacher educators, political leaders and other stakeholders. Section 1.3.3 and 1.3.4 further illustrates and discusses the issue of poor performance in mathematics.

1.3.2 Teachers of mathematics in Zambia

Mathematics teaching in Zambia is largely a male-dominated field. This is confirmed by the available national published research (Hambokoma et al., 2002) involving in-service mathematics teachers in Zambia and showing gender inequality in a detailed manner at this level. The data provided by this study in particular (4.1.1.1) shows that similar trends are prevailing.

As evidenced by the high pupil: teacher ratios (1.3.3 below), there is no adequate number of teachers in schools in Zambia. The situation is particularly critical for mathematics teachers. As earlier stated, despite there currently being more opportunities and modes of training with mathematics as an area of specialisation, the number of individuals enrolling and taking Mathematics at the different universities in the country remains small to a appoint of concern. This is clearly evident as students progress through the programme (4.2.2 has provided findings to this effect). It is common at university level for students specialising in mathematics to drop out, change the subject of specialisation to non-mathematics subjects, repeat courses or be excluded from the course because of poor performance. Some of the reasons for this could be that: some university mathematics students, do not have solid mathematical background to enable them handle university mathematics courses and thus an increase in the failure or dropout rates (Rylands & Coady, 2009); or that there are differences between pre-university and university learning and study environment which student are unable to cope with or adjust to (Chilufya & Ndhlovu, 2013). There is every possibility that there are other factors at play, but this cannot be provided as is beyond the scope of this study. However, the concern remains that if teachers experience difficulties in their personal mathematics education, then this is likely to contribute to their having a negative image and attitude toward Mathematics Education (UNESCO, 2012a) and can also contribute to their inability to encourage pupils to take on mathematics at a higher level. Further, it can be stated here that the higher the failure or dropout rates among those taking mathematics at university the fewer students specialising in mathematics are graduating from universities to take on mathematics teaching positions hence the increased shortage of secondary school mathematics teachers. Among the few that graduate are some who do not take on teaching

jobs but non-teaching jobs, which are considered more lucrative. Even so, there remains a critical need for mathematics teachers in secondary schools.

The situation of low staffing levels in the Mathematics Departments in secondary schools is compounded by high attrition rate of teachers (UNESCO, 2011). Some teachers move from secondary school teaching and take up non-teaching jobs in other ministries within the country and in neighbouring countries offering favourable conditions of service and hence more rewarding. It is argued that MOE fails to retain its teachers because the conditions of service in the Zambian Teaching Service do not compare favourably with those obtaining in other ministries within the country and in the neighbouring countries (UNESCO, 2011). Other reasons for leaving apply too. For instance, available statistics show that in 2013, 8, 803 teachers out of a total teaching force of 93, 164 compared to 6,450 in 2012 left their respective positions due to retirement, promotion, death, illness and other reasons (UNESCO, 2015). There is no doubt that there are teachers of mathematics among the teachers leaving their teaching positions. According to Mulkeen's (2010) study which was conducted in Zambia and 7 other Anglophone countries in Sub-Saharan Africa, the attrition of mathematics teachers is higher with attrition at secondary school higher than at primary school levels. Even though the MOE aspires to manage the attrition by employing 5000 teachers annually, at all levels of school education, the number leaving exceeds the number being replaced. Additionally, since 20% of the deployed teachers annually is allocated to the Early Child Education subsector, teacher shortages in secondary schools will continue (UNESCO, 2015). This has a negative impact on education provision in general and the teaching/learning of mathematics in particular and will continue if not adequately addressed.

1.3.3 Practicalities of mathematics teaching in Zambia

There are challenges associated with quality teaching and learning of mathematics in secondary schools in Zambia. One such challenge is linked to heavy workload, which is also associated with teaching large overcrowded class sizes and the increased shortages of mathematics teachers. The latest documented data shows that the average class sizes in Grades 1 to 9 is 37.3 and 50.7 for Grades 10-12 (UNESCO, 2015) with variations depending on schools. Class sizes can vary from as small as 35 pupils to as large as 100 pupils. Pupil: teacher ratios have remained high in Zambia. According to UNESCO (2015) the average pupil: teacher ratio in 2013 was 37:1 with variations ranging from 45 to 92: 1. Similar trends currently exist. With such class sizes and high pupil: teacher ratio it can be challenging to engage learners more in the teaching/learning process and address individual learning needs

or to give constructive feedback to individual learners based on their work. In addition, learner participation, even if it were stimulated, is generally hampered in an overcrowded classroom setting.

The other challenge is related to the shortage of qualified teachers. While diploma holding teachers are not expected to teach senior secondary school mathematics, there are still more diploma holders than degree holders teaching mathematics in senior secondary schools and in some schools there are no degree-holder teachers. In some circumstances of critical mathematics teacher shortages, teachers qualified to teach at primary school with a primary school certificate have been seconded to secondary school mathematics teaching positions. While there could be exceptions, a considerable number of teachers with diploma or primary school teaching certificate lack extensive knowledge and skills for teaching mathematics especially at senior secondary school level (Grade 10-12). There is a possibility that they do not teach well some of the topics in mathematics, especially those they regard as difficult topics, and that quality teaching of mathematics is generally compromised. The ability of the few qualified teachers to teach effectively is also hampered by frustrations such as those associated with unavailability or short supply of the needed teaching/learning resources. The shortage of teachers means that available teachers have heavy workloads, which can lead to being overstretched and overworked and hence hampering the capacity to teach effectively. Muhammed (2015) has made a similar observation, even though with reference to teachers with heavy workloads in Nigeria.

Instructional materials such as textbooks are in short supply or unavailable in most schools in the country. This has a negative effect on teacher effectiveness. Implementation of the curriculum is hampered in the face of unavailable teaching/learning resources. It is expected that the release of the revised curriculum (1.2.3) for implementation, would be accompanied by the release of relevant teaching and learning resources such as textbooks. However, this has not been the case in Zambia. Teachers have continued using the textbooks used with the now ‘out-dated’ curriculum. This could be considered as an alternative solution if all teachers were in a position to easily adapt content to suit the revised curriculum, but this might not always be the case. As UNESCO (2012a) reports, teachers, who even though dependent on text books, find it challenging to adapt the content of previously used textbooks to suit the content of the new curriculum. Banda & Baba’s (2013) study reveals that the problem also extends to the quality of the content of the few and inadequate textbooks available. One of

the findings of the study is that even though the textbooks have the basic and correct content of mathematics, the order of sequencing of the content 'does not flow in a way that enhances the desired teaching and learning of the concerned subject' (Banda & Baba, 2013, p. 149)

There is also lack of technology-related instructional resources to facilitate the teaching of technology related topics in mathematics and for the general integration of technology in mathematics classrooms for the purpose of enhancing learning. For instance, based on the new curriculum, there is a topic called 'Computers' in the both the Grade 8-9 and Grades10-12 mathematics syllabus and yet there are schools with no computers, some with computers which are not functional and the teachers themselves lack the content knowledge and skills to handle the topic. More generally, teachers are struggling to keep up with the advancement in the use of technology in mathematics teaching and learning. Other associated challenges are no internet connectivity and incessant intermittent power (electricity) supplies.

1.3.4 Performance in mathematics

Despite its potential value, mathematics is deemed to be a difficult subject to learn. A survey study by Mulendema (2012) on pupils' attitude towards mathematics involving 100 secondary school pupils in selected schools in Zambia shows that pupils regard mathematics as the most difficult subject to learn. Performance in the subject is also generally poor as evidenced by the national examination results. Performance in mathematics examinations at all levels has been poor and below satisfactory levels over the years (ECZ, 2015). This is illustrated in Table 2 below based on available data from the Examination Council of Zambia (ECZ).

Table 2 Overall pass and fail percentage rates in mathematics national exams 2013-2015 at Grade 9 and Grade 12 levels

Year	Grade 9		Grade 12	
	Pass %	**Fail %**	**Pass %**	**Fail %**
2013	23.7	76.3	26.5	73.5
2014	28.6	71.4	17.4	82.6
2015	25.9	74..1	17.4	82.6

Source: ECZ (2015, 2016)

Table 2 above shows that a significantly higher percentage (more than 70%) of candidates, at both Grade 9 and 12 level failed the mathematics examinations in the years under consideration compared to those who passed. In terms of subject grading, majority of the learners are in the low and poor performing category of below 40 percent (ECZ, 2014, 2015).

Further, significantly large number of candidates obtain zero in both Mathematics papers 1 and 2 at both Grade 9 and 12 levels and overall. For instance, out of 181, 779 candidates 12, 076 candidates at Grade 12 obtained zero in mathematics paper one and 8, 633(out of 181 779) in paper 2 in the 2014 national examination. The numbers of those obtaining zero increased to 13, 282 (out of 124 743) for the 2015 national examination. A similar situation applies for the Grade 9 results. Overall, poor performance in mathematics is attributed to learners' lack of mastery of concepts and skills taught which is partly attributed to the way mathematics is taught (ECZ, 2015). This is could be as a result of teachers being under pressure to cover certain amounts of work from what is considered a bulky syllabus in a given teaching session:- a situation which UNESCO (2012a) states that generally leads to sacrificing mastery of content for wide coverage. It is also considered as resulting from exam pressure where teachers are under pressure to have their learners perform well in exams and in the process lose sight of the objectives of teaching and learning mathematics and/or resulting from the nature of the exam or assessment structure. The fact that learners continue to face challenges and demonstrate lack of mastery of concepts and abilities to handle mathematics examinations questions show that serious interventions may need to be put in place if the performance in the subject is to improve. Since teachers have a contributory role to play in improving pupil performance then they may need to be helped and supported in their efforts. This could be accomplished through what would be considered as relevant CPD activities. Additionally, with changes in the content and teaching procedures, coming with the new curriculum (1.2.3) it is expected that there would equally be changes in the current examination system and overall assessment structure. However, at the moment there is no evidence of such changes.

1.4 Teachers' CPD in Zambia

Zambia, like other developing countries in Africa (Edwards, 2012; Komba & Nkumbi, 2008; Kretchmar, Nyambe, Robinson, Sadeck, & Zeichner, 2012; Mulkeen, 2010; Onderi, 2011) has recognised the importance of teachers' CPD. It has acknowledged that teachers, like other professionals, have a responsibility to themselves and their profession to deepen their knowledge, refine and extend their professional skills and update themselves on developments affecting their performance as educators (MOE, 1996, 2007). Even though there is no clear stated definition of teachers' CPD, also referred to as on-going PD, in Zambia, the role of CPD in contributing to quality of education delivery has been recognised in the development plans. For instance, one of the focuses of Zambia's SNDP is teachers' CPD and pedagogical

support in the effort to actively pursue an improvement in quality of educational delivery (GRZ, 2011). This has facilitated the Zambian government, through MOE, to invest in teachers' CPD. This investment is partly demonstrated in the guiding principles for provision of CPD prescribed in the EOF policy document: These guiding principles are:

…programmes will be demand driven, responding to identified needs;… will focus on school needs and be based in schools themselves or Resource Centres; cascade models will be given special consideration…; cost-effective programmes which reach large numbers for a relatively small outlay will be given high priority; …distribution of materials to schools, the introduction of new subject content …will normally be accompanied by in-service courses for teachers…(MOE, 1996, p. 116).

It is noteworthy that the principles were produced in 1996 and have not been updated. This stated, it is of significance to move on and briefly discuss some of the issues that the principles bring out. One such significant issue refers to 'needs'. It is explicitly stated that focus of PD will be on school needs. However, whether this implies that teachers' needs are a subset of school needs or school needs are the same as teachers' needs is not clear. It is also not specific on who is to identify the needs: is it the school to identify its needs and those of the teacher? What is the teacher's role in this case? It is worth mentioning here that the extent to which this principle, on identified needs, and the other principles have (not) guided CPD provision in reality and in relation to this study is evident in the discussion running through the thesis.

Another way in which MOE investment into CPD is also partly demonstrated is in the institutionalisation of teachers' and teacher educators' CPD in primary and secondary schools and Colleges of Education respectively (MOE, 2007). This means that CPD has been made a regular feature of school/college plans and programmes. Details on CPD activities in the country have been presented in Chapter 2. Among the recurring challenges in the promotion of teachers' CPD in Zambia are: lack of and inadequate funding; shortages of teaching and learning resources; lack of commitment to PD by school managers and teachers; and lack of skilled human resource for implementing and monitoring CPD (Banda, 2007, 2011; Kabeta, 2015; Lungwangwa et al., 1995). Some other pressing demands on teachers' CPD in Zambia are discussed in the next section.

1.4.1 Contextual demands and challenges on teachers' CPD

Christie, Harley & Penny (2004) based on their study of CPD across 41 countries in Sub-Sahara Africa conclude that '…the discussion on CPD in Africa is as much about the context of CPD as it is about the nature of CPD itself'(Christie et al., 2004, p. 169). Opfer et al.(2011), based on survey responses from 1,126 teachers in England also add that teacher

learning and teacher CPD '…cannot be understood by separating the teachers from the environments in which teachers undertake their learning'(p. 196). A conclusion which is similar to that made by other academics (Bolam & McMahon, 2004; Wheeler, 2001; Mansour, 2015) that CPD can have an impact when it is carefully designed to meet contextual needs. It is imperative to acknowledge that there are several contextual factors and demands on teachers' CPD that cannot simply be overlooked in the discussion on teachers' CPD in Zambia. Christie, Harley & Penny (2004) argue that African models and expectations of CPD, its purpose, foci and other related issues such as its management, sustenance, funding and evaluation, are shaped by contextual forces such as donor funding and health issues citing the devastating impact of HIV/AIDS with teachers as a high risk group. Some of these contextual forces relate to Zambia and have been discussed in relation to the Zambian context in the paragraphs below together with others.

The first point relates to the policies, which give guidelines pertaining to teacher competences to be instilled, developed and enhanced in trainee teachers and serving teachers through their CPD programmes. Some of these policy guidelines are as a result of 'policy borrowing' where ideas from other countries are introduced into home country context with the hope that they would be as successful as evidenced from the country of origin (Phillips, 2015). Most reforms and practices in the education system in Zambia, among them: 'use of Teacher Resource Centre for CPD an idea from the United Kingdom' (Gibbs & Kazilimani, 1999) and 'Lesson Study with its roots in Japan (Stigler & Hiebert, 2009), come from external sources and appear as 'borrowed ideas'. The implementation or assimilation part of the 'borrowed ideas' can be complex and problematic. It has been observed that while Zambia is good at policy borrowing it is either not committed to the borrowed ideas or does not have enough resources to implement the borrowed ideas (Tembo, 2012). A case in point is the use of Resource Centres for teachers' CPD. Gibbs & Kazilimani (1999) and Mubanga (2012) report that Resource Centres which were reported to have been well utilised when CPD workshops and seminars were funded by Department for International Development (DFID) during the Action to Improve English, Mathematics and Science (AIEMS) project are no longer in use for this purpose and appear deserted by the teachers starting the period when the AIEMS project folded. One of the reasons is that attention has shifted to schools with the emphasis of SBCPD.

Government's lack of commitment to or lack of capacity to implement borrowed ideas for the benefit of the people not only affects sustainability prospects of the borrowed ideas, but also

stakeholders' commitment to the implementation of the ideas. If there is no consideration for factors such as national or cultural differences or differences in education philosophies between the country borrowing the ideas and the country from where the ideas are being borrowed, then policy borrowing can contribute to formulation of education initiatives that end up only being a way of attracting foreign investment and not enhancing learning experiences of a nation's citizenry (Edwards, 2012; Nuttall, Seddon, & Phan, 2012). Where CPD is concerned, if national or cultural differences in the focus of CPD are not put into perspective CPD priorities might not be right. It (CPD) might end up being regarded only as a means or way by which teachers are governed and not about how they could continue learning and growing as professionals (Nuttall et al., 2012). The aforementioned could be some of the reasons attributing to the recurring challenges in the promotion of teachers' CPD in Zambia as referred to under section 1.4 above.

The second point is that political changes introduced by the government of the day have an influence on teachers' CPD policy guidelines, investment, provision management and sustenance too. For instance, in 1993 the Movement for Multi-Party Democracy (MMD) Government introduced some reforms that were to be effected through the Public Service Reform Programme (PSRP). In line with the PSRP, MOE embarked on a restructuring and decentralisation programme in an effort to make itself more responsive to the changing needs of the Zambian society. This impacted on CPD provision in that individual schools were asked to locally source for funds related to teachers' CPD programmes and restrictions placed on the number of teachers to pursue further studies to upgrade their qualifications. Similar practices are currently at play in Zambian schools under the Patriotic Front (PF) government. Schools are expected to implement the SBCPD through LS, which is on the national government's agenda for teacher quality improvement. Despite the emphasis on SBCPD through LS, there has been no funding or chronic underfunding to schools to support effective implementation making it difficult to prioritise CPD in practice or even plan for it effectively. Erratic funding patterns mean that it is hard to plan effective CPD programmes for teachers from one year to another year (Gray, 2005). If peradventure schools receive some funding, it is often inadequate and would naturally be directed towards meeting other pressing demands associated with running and managing schools as dictated by school management. Generally, where there is lack of or very limited funding for schools, CPD is displaced as a priority area and is likely be narrowly targeted (Christie et al., 2004). Further, among the goals of the current government, in an effort to raise the standard of education, is to 'upgrade non-degree

or diploma holders through sponsored in-service training' (PF, 2010, p. 9). While there has been an increase in opportunities for teachers to upgrade their qualifications this has not been accompanied by substantial increased budgetary allocation to allow for more teachers to be sponsored to upgrade their qualifications.

Thirdly, health related matters such as HIV/AIDS have a negative impact on education at all the different level (Kelly, 2000b, 2000c). This suggests that no aspect of the education system has been spared by HIV/AIDS and its impact with a concomitant impact on the education budget. The focus for this paragraph of the thesis however is on the impact of HIV/AIDS on teacher supply, teachers themselves and also teachers' CPD. Teachers are a high-risk group. The rate of AIDS related deaths among teachers is '70 per cent higher than for the general population' (Biggs, 2012, p. 25). Some of the possible reasons for teachers being a high risk are: teachers having relatively high socio-economic status and increased mobility (Biggs, 2012; Boler & Jellema, 2005; Kelly, 2000a; Mulkeen, Chapman, Dejaeghere, & Leu, 2007). The '…teacher deaths from AIDS-related illnesses outstrip the output of the country's training colleges…' (Christie et al., 2004, p. 170). The teacher supply problem is made worse by HIV/AIDS because '… the shorter the professional lifetime of teachers in the system the higher the real costs of providing an adequate number of teachers' (Lewin, 1999, p. 22). The training costs to be incurred would be higher in these instances and the greater cost of training is likely to shift attention and resources from other programmes such as teachers' CPD. With such circumstances prevailing, emphasis would be placed on initial teacher training instead of CPD as a way of replacing teachers who would have died. There are other costs that HIV/AIDS imposes on the education system. Such costs include paying salaries to teachers who are absent or on sick leave due to HIV related illnesses (Grassly et al., 2003). While this may be a humane act in this instance, it directly or indirectly ends up impacting negatively on the resources to be spent on education and education initiatives such as teachers' CPD. HIV/AIDS affects both the infected and affected teachers' wellbeing. Its impact is critical in terms of teachers who are sick: infected teachers have to deal with the disease and the effects of having the disease: they have periodic bouts of sickness and then eventually die. Their illness affects productivity, motivation and derails efforts at professional development in ways that may not be quantifiable, but which cannot simply be ignored either.

The fourth point concerns school leadership. School leadership is to show commitment to and actively support teachers' CPD. What is required is a kind of leadership that would provide the needed direction and guidance and that equally allows teachers to take part in decision-making concerning their CPD (Sparks & Loucks-Horsley, 1990). Low commitment among school leaders, in Zambia, in supporting teachers' CPD has been reported to be a challenge to the success of CPD (Banda, 2007; Kabeta, 2015). This could be attributed to their lack of required skills to offer the necessary support as evidenced in other countries such as Kenya (Nyarigoti, 2013). It could also be attributed to their negative view of CPD programmes interrupting the smooth running of what would be considered the normal school programme and perception that CPD is very costly, or is an additional expense with few or no significant returns and as such are less committed to it. These points apply as confirmed by Kabeta's (2015) survey and case study on instructional leadership and its effect on the teaching and learning in Zambia.

In summary, this section has provided background information on teachers' CPD in Zambia. It has provided information to the effect that Zambia's MOE has put in place guiding principles for CPD provision and has institutionalised CPD for teachers' in schools. Although this is the case, it is not clear how effective such efforts have been in contributing toward improving teacher effectiveness and teaching and learning. The effectiveness of CPD in addressing teachers' CPD needs, and especially now in the light of the revised curriculum, which places more demands on the teachers, is equally unclear.

1.5 Focus of the study

1.5.1 Statement of the problem

From the contextual description of CPD landscape in Zambia, it can be seen that the MOE has recognised the importance of CPD and the significant role it can play in contributing towards raising the quality of education in Zambia. Available reviewed literature on CPD for teachers in general in Zambia including Banda's (2013), Mulkeen's (2010) and Mubanga's (2012) work and that involving mathematics and science teachers particularly as conducted by Hambokoma et al. (2002) equally concur with the point that CPD is important and is a must for teachers if the quality of education is to be raised. However, there is a dearth of empirical research findings in Zambia to show that current CPD initiatives are meeting teachers' CPD needs. Teachers' perspectives on whether their CPD needs have been met through their CPD remains unclear and therefore a need for research in the area. While being aware of the

existence of both institutionally driven needs as well as nationally determined CPD priorities, this study aims to investigate secondary school mathematics teachers' perceptions as to whether their CPD meets their CPD needs.

1.5.2 Research aim and questions

The focus of this research is to investigate secondary school mathematics teachers' perceptions of their CPD with the aim of finding out whether and how current CPD meets their CPD needs and to what extent. Within this broad perspective, the research is guided by the following interrelated research questions:

1. How do secondary school mathematics teachers perceive CPD and its value?
2. What CPD activities are secondary school mathematics teachers in Zambia currently engaged in? How do the teachers perceive these CPD activities?
3. What are the perceived CPD needs of secondary school mathematics teachers in Zambia? And
4. What are secondary school mathematics teachers' perspectives of what makes CPD activities (non)effective? What are their perceptions of the (non)effectiveness of current CPD activities in meeting their perceived CPD needs?

1.6 Significance of the study

As earlier stated, the MOE in Zambia recognises the important role that teachers' CPD can play in the provision of quality education. Without acknowledging teachers' perspectives on CPD and without accommodating their CPD needs, CPD can be poorly directed or inadequate. The findings of this study therefore will provide MOE and other key stakeholders with more insight into CPD and particularly CPD for secondary school mathematics teachers' CPD and into the manner in which it (CPD) can be provided, managed, examined and assessed in light of teachers' perceptions. The findings can also inform MOE's most current and future CPD strategy, investment and provision and the support system to sustain this process, which in turn can contribute towards improving the quality of CPD.

There is a paucity of empirical studies, particularly in Zambia, carried out on mathematics teachers' CPD needs with a view to suggesting ways or strategies that would help to link

closely teachers' CPD needs and CPD provision. The current study aims to fill or at least narrow the knowledge gaps in literature related to mathematics teachers' CPD.

The findings of this study will add to the existing body of knowledge and literature within the field of teachers' CPD in general and secondary school mathematics teachers' CPD in particular. It is hoped that the study will also be a basis for further investigation in this area.

1.7 Theoretical framework

This study uses constructivism as its overarching theoretical framework. This decision is made after a consideration of possible potential limitations of constructivism (Karagiorgi & Symeou, 2005; Osborne, 1996) and existence of other possible or alternative theories such as: objectivism (Bryman, 2008); Activity Theory (Engestrom, Miettinen, & Punamaki, 1999); and Identity Theory (Stryker & Burke, 2000). Constructivism is used both as a theoretical framework for analysis and methodological guide. This point has been explained in details in subsection 1.7.1 and 1.7.2 below. Reference is also made to the ALT, on some of the aspects of the study, whose principles are consistent and complementary to constructivism. In addition, as earlier discussed under section 1.4.1 above, teachers' practice need to be studied within the sociocultural contexts of their work and therefore the importance of examining mathematics teachers' perspectives on their CPD with reference to the sociocultural framework. This has been expanded on under section 1.7.3. The use of these theories provided a form of theoretical triangulation allowing for in-depth examination and explanation and hence in-depth understanding of the issues pertaining to the study. UNAIDS (2010) states that the use of more than one theory helps to look at a situation or phenomenon 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'(p. 23). Constructivism as an overarching framework and the Adult Learning theory (ALT) and sociocultural framework are briefly discussed below together with how they related to examining mathematics teachers' CPD and CPD needs.

1.7.1 Constructivism

The conduct of the research is embedded in the constructivism theoretical framework and principles. Constructivism, which has its roots in psychology and philosophy has many forms to it (Boghossian, 2006; Phillips, 1995). However, with reference to literature such as Von Glasersfeld (1996) it can be stated that constructivism is basically rooted in ways in which knowledge is constructed and not reproduced. It is embedded in: (a) valuing individuals'

active engagement in knowledge construction thus their learning and the role of prior knowledge and skills in their learning; and (b) actively constructing knowledge individually or socially through personal experiences and interaction of existing knowledge with the environment and information from others. Hence it suggests that learners have a significant role to play in their learning and learning can take place within a formal and informal context, can be self-regulated and paced or formally structured as long as it is designed in such a way that the learning needs are met. Constructivism has implications for how teachers teach and learn to teach (Bada, 2015). With respect to this study and while acknowledging the limitations of constructivism, it can be deduced that secondary school mathematics teachers have a pivotal role to play in their professional development which can be demonstrated in their ability to actively engage in their CPD through, for instance, reflectively identifying their needs and taking initiative to identify CPD in any learning context to meet their needs and overall taking responsibility for their PD. Further, the teachers' experiences, interactions and perspectives have their significant place in informing and supporting their active knowledge construction, learning and hence their professional development. This of course does not overlook the role of CPD providers and managers as they also have a role to play in creating an enabling environment for and facilitating learning and professional development

1.7.2 Adult Learning Theory (ALT)

The theory demonstrates how adults learn thus providing guidance on how to structure their learning, among other implications. In summary, the principles of adult learning as adapted from the literature (Galbraith & Fouch, 2007; Knowles, Holton, & Swanson, 1998) are that adults: (a) are autonomous and self-directed suggesting that adults need to be actively engaged in their learning and they need to be free to direct themselves in terms of what to learn and how to learn; (b) bring knowledge and life experiences to learning experiences which thus need to be acknowledged. New learning makes use of or builds upon adult learners' prior knowledge and experiences; (c) are goal orientated: thus the goals for learning should be clearly stated and directed at meeting real-life needs; (d) are relevancy orientated; (e) are practical; and (f) like to be respected: this could be through encouraging them to express their ideas and taking interest in and acknowledging their wealth of knowledge and experiences. Even though ALT may have limitations such as not adequately considering the impact or influence of factors such as the adult learners' environment or context of learning, life experiences and gender (Cercone, 2008), it provides some useful guides on how adults learn. Based on the above presented principles of adult learning it can be deduced that adult learning principles are very much based on constructivist theory of learning upholding the

principle of individuals actively engaging in knowledge construction or process of learning among others. They also uphold the ideas that adults need to be actively involved in decisions regarding them and in this case decisions regarding their CPD. The principles of adult learning are complementary to the constructivist theory and practical for use in analysing and understanding secondary school mathematics teachers' CPD and in assessing whether and how CPD meets their CPD needs. Thus, constructivism provides an appropriate overarching framework for analysing secondary school mathematics teachers' perspectives of their CPD, and for analysing and understanding their CPD needs and whether and how current CPD meets their CPD needs. How constructivism has been used as a theoretical framework for analysis is evident through the work presented in this report.

Having established how constructivism acts as a theoretical framework for analysis, attention now turns to why and how constructivism has acted as the overarching methodological guide.

Given the nature of the research questions being asked and the kind of research to be undertaken: soliciting secondary school mathematics teachers' perspectives and lived experiences in relation to CPD in general and whether the current CPD meets their CPD needs, this study is couched within the constructivist ontology. Constructivism is 'an ontological position that asserts that social phenomena and their meanings are continually being accomplished by social actors' (Bryman, 2008, p. 19). This implies that there is no objective reality as objectivists assert. Reality is socially constructed and constructivists are interested in how people are making sense of this reality. Unlike objectivism, which holds the counter claim to the one of constructivism, the principle held is that reality does not possess an independent meaning as the meanings attached to it are formed through social actors' experiences with that reality. These meanings are constructed through interaction with an entity or with people (Snape & Spencer, 2003). 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. The researcher's role is then to work with the research participants to gain an in-depth understanding and interpretation of their perspectives and experiences in relation to their reality. With constructivism as the overarching methodological guide specific methodological approaches were considered and these are elaborated in chapter 3.

1.7.3 Sociocultural framework

Teachers' practices, perceptions and regard for CPD cannot be examined outside the sociocultural context as sociocultural factors significantly shape the thinking or perspectives

whether with regard to their teaching practices in general or their approach to CPD specifically. Understanding Zambian secondary school mathematics teachers' context may, as Mansour (2015) states in his work with reference to teachers of science in Egypt, 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 mathematics education such as identified in the revised curriculum (1.2.3). As Olson (1988) points out, 'what teachers tell us about their practice is fundamentally, a reflection of their culture and cannot be properly understood without reference to that culture' (p. 169). Some of the sociocultural factors are identified above in sections 1.3 and 1.4.1 and include shortage of teachers, time constraints, class sizes, lack of instructional materials, pressure to conform to the objectives set out by the decision makers in the education system and assessment based culture whose central focus is on cognitive aspects. Such factors can constrain, facilitate or influence teachers' perceptions of and approaches to CPD and must therefore be considered in analysing secondary school mathematics teachers' perspectives of their CPD, and for examining and understanding their CPD needs and whether and how current CPD meets their CPD needs which is the focus of this study. The aforementioned provides a rationale for the consideration of the sociocultural framework too in this study.

1.8 Thesis outline

The thesis is divided into six chapters. Chapter 1 presents and discusses the context of the study and provides the research aim, research questions and the significance of the study. It reviews a number of contextual background issues before examining a cross section of relevant literature with regard to CPD in general and CPD for mathematics teachers in chapter 2. Chapter 3 presents the methodological approach used by this thesis and discusses the methods used to collect data in the field. The data analysis process, issues of validity and reliability and ethical considerations are also presented before moving on the next chapter.

Chapter 4 provides the findings and discussions of the thesis. The findings and the discussion of findings are presented in the same chapter as this is regarded to be the best way of presenting this information and also a means to minimising repetitions. The researcher considered it fit to present the findings and discussion of findings in the order of the research questions as this was logical in the way of linking findings and was also a way to ensure that that the research questions had been addressed. Chapter 5 presents a proposed framework for analysis of teachers' CPD needs and how this could contribute towards empowering teachers

to play a significant role in their CPD and subsequently improve teachers' CPD experiences. Chapter 6 gives the summary of the thesis, limitations of the study as well as conclusions and recommendations. The conclusions drawn in relation to the research questions are presented in the same order as the findings and discussions chapter for the purpose of clarity and consistence.

1.9 Chapter Summary

This chapter has introduced the research study, provided background information about the study and the aim and questions guiding the study. The main aim of presenting the context of the study is to help better understand the background within which secondary school mathematics teachers' CPD is rooted. An analysis of teachers' CPD in a low-income and developing country such as Zambia requires a consideration of the specific local context within which the teachers work and the demands of the education and school system which press upon their CPD. Other issues that are covered in this chapter are the theoretical framework for the study and the thesis outline. The next chapter focuses on the review of literature relevant to the study.

Chapter 2: Literature Review

This study investigates secondary school mathematics teachers' perspectives on CPD in Zambia with the aim of establishing whether and how the current CPD meets their needs and to what extent. This chapter reviews some extant literature on CPD as it relates to the aim of the study and the interrelated research questions. The overarching purpose is to provide a background and justification for this research based on the literature. Section 2.1 presents the purpose of the literature review, 2.2 the conceptualisation of the notion of CPD, 2.3 teachers' CPD needs, section 2.4 effectiveness of CPD and section 2.5 provides a chapter summary.

2.1 Purpose of the literature review

The literature search is designed to map existing studies that investigate discussions with regard to teachers' CPD in general and mathematics teachers' CPD in particular. In reviewing the existing literature on CPD, it is evident that a number of articles and books endeavour to explain the basis for CPD and its importance in improving teacher quality, pupil performance and quality of the education system as a whole. However, significant studies on teachers' perspectives on the extent to which CPD provision meets CPD needs are lacking, especially in the Zambian context.

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 in the field as well as identify the gaps. The literature review is guided by the research questions (see section 1.5.2).

2.2 Teachers' CPD

2.2.1 CPD-A problem of definition

The definition of the term CPD is rather complicated. In fact, there are a number of terms in literature such as: PD[4] Professional Learning; In-Service Education and Training (INSET); Staff Development; Continuing Professional and personal Development(CPPD); and Continuing Professional Development and Learning (CPDL) which are all related to CPD. These alternative terms are defined differently, but the meanings are often related and

[4] In this study (Teacher) Professional Development (PD) and Continuing Professional Development (CPD) are used interchangeably.

overlapping, difficult to disentangle, and the terms often used interchangeably (Bolam & McMahon, 2004). For instance, in trying to position the term CPD, Bolam & McMahon (2004) state that staff development is more encompassing than in-service education but CPD is viewed as the overarching term for all kinds of training. The term CPD is also interpreted differently in different professions and likely to be interpreted disparately by key players in the education system such as teachers or teacher supervisors. This is partly because of it (CPD) being '…a complex and developing concept' (Friedman, 2013, p. 5). Neil & Morgan (2003) have identified possible areas for differences in interpretations of the term CPD within the education system including: (a) A teacher's own version of CPD- possibly related to how individual teachers see their own professional needs; (b) Other teachers' interpretations, either within their own school or in other schools; (c) A school's interpretation of CPD related to the country policies and arrangements for implementing CPD and (d) Official government regulations and recommendations as may appear in government documents. Padwad & Dixit (2014) share a similar view and conclude that differences in the interpretation of the term CPD can spell out different priority areas or focus of CPD. It can be interpreted from the above that teachers' understanding of CPD can have an impact on their participation in CPD. This being considered, this section reviews what is in some literature about what is meant by teachers' CPD and thereafter in chapter 4, also present Zambian secondary school mathematics teachers' understanding of the concept of CPD and discuss their views in the light of literature.

An example of a definition of CPD is that provided by Gray (2005) who states that 'CPD embraces the idea that individuals aim for continuous improvement in their professional skills and knowledge, beyond the basic training initially required to carry out the job'(p. 5). In this case, there is a clear focus on individual teacher responsibility and control in relation to CPD and silence on the role of, for instance, national policy makers in the education system, the school system and other key and strategic stakeholders in teachers' PD. Teachers' long term PD is a collective responsibility involving teachers, schools, government and all relevant stakeholders (Day, 1999; Bubb & Earley, 2007).

Another example is drawn from Isaacs (2006) who states that teacher PD is '… 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). This definition recognises that CPD is a continuous long-term process which is standardised involving module(s) as basis of its design. but seems to exclude non systematised processes of PD such as any natural learning experiences or on the job learning.

Day's (1999) definition on the other hand covers this and extends it to several other aspects of PD when he states 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(p. 4).*

The understanding and discussion on CPD in this thesis is consistent with a very broad view of CPD as provided by Day (1999) above. There are several aspects of PD presented by Day's definition above. However, only six have been identified and expanded upon with reference to other literature, in this and the next paragraphs of this section. Firstly, by stating that PD consists of all natural learning experiences and those conscious and planned activities, Day suggests that PD includes the kind of learning and the support activities that go with it which not only take place in work-based settings but also externally. It includes both informal learning experiences as well as formal opportunities for teachers' development that can take place inside or outside a classroom setting, within or beyond the school context. Whilst SBCPD has its own advantages and serves particular purposes, CPD may not only be limited to it. Guskey & Yoon (2009) argue that whilst SBCPD is a good starting point to enhance teachers' professional growth, it is not sufficient in itself (section 2.2.3 has provided details on SBCPD). Day (1999) asserts that it is a reasonable expectation that teachers engage in variety and range of informal and formal professional development activities to enhance their professional development.

The other implication of Day's definition is that PD does not only constitute delivery of information to teachers so as to influence their practice, but also calls for teachers' active participation and engagement in their personal learning. This suggests that it is generally based on constructivism which promotes active engagement in knowledge construction rather than only on a 'transmission-oriented' way of teaching and learning (Villegas-Reimers, 2003). Hamilton (2013) builds on this argument by stating that meaningful professional development takes '… into account participant-driven inquiry, reflection and experimentation'(p. 45). Thus, suggesting that teachers' active engagement in learning can be enhanced with increased opportunities for experimenting, inquiring and reflecting upon learnt materials and learning experiences.

Thirdly, Day (1999) makes reference to the point that teachers' CPD is not entirely on an individual basis in developing acceptable professional practices and level of 'expertise' as may be required in the educational system, but constitutes cooperating and collaborating with others too for the same purpose. Edwards (2012) defines expertise as 'a capacity to work with resources available on problems that one recognises and interprets either alone or with others while engaged in an activity'(p. 266). The idea is that even though there are cases and opportunities for individual isolated work, CPD also involves elements of collaboration between teachers and pupils, teachers and teachers and teachers and other relevant stakeholders (Loucks-Horsley et al., 2010; Villegas-Reimers, 2003). The knowledge and skills therefore that the teachers need is not only meant for their interaction and work with pupils in a classroom setting, but also beyond.

The fourth point is that Day's definition suggests an inclusion of professional, personal and social development dimension of teachers' PD. This is based on his reference to the development of not only knowledge and skills, but also of emotional intelligence needed throughout teachers' teaching lives in the definition of PD. This can be with the view that the meaning of professional development '… is located in teachers' personal and professional lives…' (Day, 1999, p. 1). These (professional, personal and social) dimensions of PD have also been presented by Bell & Gilbert (1996) and are discussed in detail under section 2.3 of this thesis. In addition, Day's definition above attempts to straddle both individual teachers' PD needs and school needs. This point has also been developed under section 2.3.5.3.1

Fifthly, it is inferred from Day's definition above that CPD is perceived as a long-term continuous process that lasts through a teacher's life. PD is thus a long-term engagement in the learning process. It is a learning process and not necessarily an activity or an event (Day, 1999; Guskey, 2002; Harwell, 2003; Hurrell, 2013; Loucks-Horsley et al., 1987; Sparks & Loucks-Horsley, 1998). This process begins with initial teacher training and through all the stages of teaching life (Villegas-Reimers, 2003). The PD process is on-going and in-depth because achieving the kinds of transformational changes in teaching and learning practices or experiences required to make a difference may not take place in a brief teacher-pupil engagement (Bolam & McMahon, 2004; Kirk, 1988). The learning process itself however, cannot necessarily be considered a linear and less complex process. This is partly because teachers cannot simply change their beliefs and practices and start teaching differently, they need to be helped to acquire ways of thinking and reflecting about issues such as learners, learning, teaching itself and the subject matter (Bolam & McMahon, 2004; Mansour, 2009). There is therefore a need for forms of sustained support and follow-up activities during

teachers' learning process. As earlier stated, teachers' long term PD requires collective effort and collective responsibility to succeed.

Lastly, the other implication of Day's definition is that CPD is directed at teachers' learning, enhancing and using appropriate skills and knowledge not only for the direct or indirect benefit of the teachers themselves, but also the learners, as well as the school and education system as a whole. Therefore, suggesting that teachers stand to benefit from CPD, but so do the others: fellow teachers; pupils to name a few. CPD is closely linked to schools and the education system at large (Villegas-Reimers, 2003) and so do the benefits.

Based on literature viewed, there is no one agreed definition of CPD. The CPD concept is broad and has multiple meanings and dimensions (Day & Sachs, 2004; Friedman, Davis, & Phillips, 2001). Day's definition of CPD embraces various dimensions of CPD as illustrated above and is considered holistic and useful including in the context of this study. Having shed light on what is meant by CPD the next section focuses on the value and importance of CPD.

2.2.2 Value of CPD

There are several purposes that teachers' CPD, in different educational contexts and countries, is designed to serve. Some of these functions 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 (Bubb & Earley, 2007). In addition, CPD can be designed in such a way that it contributes to enhancing teachers' confidence. Improvements in teachers' knowledge base, skills, values, attitudes and confidence level can contribute to improvements in teaching practices, which in turn can positively impact on pupils' learning outcomes. This point has been expanded on and discussed further under 2.2.2.2.

West-Burnham & O'Sullivan (1998) state that schools are operating in changing environments and there are increased demands on them as dictated by these environments and society at large. They extend their argument by stating that the redefinition of the nature and purpose of education in such changing environments require learning strategies that are concerned with strategic change and tactical responses. Therefore, there is a need for teachers to be aware and conscious of the political, social and economic changes and their impact on

schools and how to be responsive to them (Taylor, 1980; West-Burnham & O'Sullivan, 1998; (Onderi, 2011). It is on such a premise that the fundamental principles and values of CPD are justified.

CPD can be a means that governments use to direct teachers to national educational priorities. Through CPD, teachers could be prepared to embrace and implement innovations in education as may be deemed by their national government. Villegas-Reimers (2003) has noted that changes and improvement in educational contexts around the world show that many educational innovations ultimately fail because little effort and/or few resources are devoted to preparing teachers for the innovation. This suggests that if changes in the education sector are to be successfully implemented, effort has to be directed at preparing teachers for such changes and hence the need for effective and meaningful CPD initiatives. Although there are a number of complexities in the process of CPD provision, there is evidence linking teachers PD to successful implementation of new policies or innovations in education (Stallings, 1989; Bubb & Earley, 2007). However, this does not mean that CPD should only be viewed as an avenue for implementing reform or policy changes, but also as a means of equipping teachers, individually and collectively, to act as well-informed critics of reforms or policy changes (Bolam & McMahon, 2004). The point on CPD and change has been discussed in more detail under subsection 2.2.2.1.

Another reason advanced for the need for CPD is that pre-service training is inadequate and in some cases there is a level of dissatisfaction with its (pre-service) provision such as would be in the context of a mismatch of expectations of trainee teachers. This argument is coupled with the acknowledgment that even if pre-service provision were good, by its very nature, such a programme would not be able to equip teachers with all they would need for a life time of work in the classroom (Mulkeen, 2010; Taylor, 1980). Kirk (1988) also adds that no matter how thorough and systematic initial training may be, it can never anticipate and prepare comprehensively for all the numerous demands that teachers would encounter throughout all the stages of their full teaching career. This, therefore, implies that teachers should engage in CPD practices to keep themselves up to date with the changing times and circumstances within the school and education system. Initial training is valuable in its own right, and can also be viewed as providing a platform on which CPD will be erected as it paves way for the development of '…the competences, the confidence and the attitudes that will serve as the basis for on-going professional development' (Bubb & Earley, 2007, p. 4). However, it only marks the beginning of teachers' learning and development.

Additionally, central to the core purpose of school(s) and pupils' learning is the view that those responsible for pupils' learning should be learners themselves and thus professional learning models need to reinforce a culture of learning throughout one's career stages (West-Burnham & O'Sullivan, 1998). MOE (2007) equally acknowledges that teaching is a learning profession and that every teacher should also be a learner. CPD is one of the avenues through which teachers can continue learning. This, however, does not overlook the point that the idea of learning is complex and can be surrounded by debates on how adults, teachers in this case, learn and learn effectively. It also does not overlook the argument that teachers can have different types and levels of learning needs. CPD can be a means through which teachers lacking or having inadequate knowledge in their teaching subject, those poorly trained, or those facing challenges in meeting basic learning goals to pupils, unqualified or under qualified, but practicing, those resistant to educational reforms such as new teaching style, new technologies, could be afforded a chance to learn and their learning needs met.

Further, literature (Bubb & Earley, 2007; Day, 1999; Desimone, 2009) suggest that CPD is related to school development, improvement and effectiveness. Hence suggesting that investing in teachers' PD is equally investing in school improvement. This point on the link between teachers' CPD and school development is developed further under section 2.3.5.3.1

Furthermore, CPD can prepare individuals to gain promotion to higher positions (Hickcox & Musella, 1992). This could be through CPD contributing toward widening teachers thinking capacity and enlarging their ability to take action in solving problems which are some examples of qualities that could be taken into consideration for promotion of individuals to higher positions. Another dimension to this perspective is that teachers who have been given additional responsibilities may need CPD to help them develop new skills relevant to their new positions. Promotion opportunities, new or changing roles and responsibilities, all call for new skills and knowledge all of which can be obtained through CPD initiatives (Kirk, 1988). New responsibilities or changing roles can include school management and administrative roles, accounting jobs within or probably outside a school setting among others. Teachers can be well prepared and motivated to take up such positions through engaging in relevant CPD.

Onderi (2011) adds that CPD can equally help in revitalising the general morale of teachers in the teaching profession. Specifically, ACME (2002) argues that CPD can re-enthuse existing teachers of mathematics and renew their enthusiasm for the subject. CPD can help teachers to remain interested and interesting in their teaching of mathematics despite the challenges and

demands on them as mathematics teachers. This demands strategic planning and implementation of various targeted CPD activities, whenever and wherever possible, to be achieved.

This section has highlighted the importance of CPD. Even though some of points discussed refer to teachers in general they are applicable to mathematics teachers. Despite the point that some academics do not consider PD provision in a positive sense (Brookes, 2016) partly because of the disparity between the ability of teachers to determine their own development and government-led agenda (Sugrue, 2004), in light of the definitions of CPD and its value as presented above, it is concluded that the need for CPD is well established. It can be deduced that teachers' CPD should broadly be designed to promote teachers' social, personal and professional growth so as to make teachers more functional in their service. It is relevant both from a perspective of quality service deliverance and professional, social as well personal career development. It is also a means by which policy makers' use to direct teachers to national educational priorities. The level to which each of these is covered and emphasised may vary in different countries and educational settings. What CPD providers and relevant stakeholders need to monitor and establish though is whether CPD provided is serving the purpose(s) for which it is intended.

2.2.2.1 CPD and change

In a changing society change in almost all aspects of an education system is to be expected. A summary of aspects of educational change is: change in educational policy, change among educators' practices as well as change in organisational (school) structure and culture (Fullan, 2001b; Shulman & Shulman, 2004). Fullan (2001b) states that 'Educational change depends on what teachers do and think—it's as simple and as complex as that'(p. 115). This suggests that teachers are at the centre of the change process in the education system. If for instance, a change and improvement in pupils' classroom learning is expected then teachers would naturally be expected to change in certain ways to raise pupil attainment. The change process might not be as easy and as straightforward, but the argument stands that teachers are at the centre of any change affecting the education system in general and the teaching and learning process in particular.

Over the last ten years, teachers in Zambia have witnessed and experienced extensive changes in the context of teaching and learning. Among the notable changes are: changes in the conditions of service; increasing competition for better grades; raising pupil performance and achievement performance monitoring by superiors such as MOE officials; including call for

use of technology in the teaching/leaning process with the most recent changes being: introduction of a new revised curriculum. As a result of the above illustrated changes there are increasing demands on and expectations of teachers. Such demands and expectations require that teachers adopt new roles and gain or expand their knowledge base, pedagogical skills (Guskey, 2000) as well as change their attitude and beliefs for the purpose of improving their classroom practice and subsequently improve pupil learning. Carefully designed CPD can help in that CPD and successful educational change are closely linked (Fullan, 1991). In stressing the link between teachers' PD and changes in the education system, Villegas-Reimers (2003) states that:

Currently in the world, most societies are engaged in some form of educational reform…Regardless of the scope of the reform, the relationship between educational reform and teachers' professional development is a two way, or reciprocal, relationship…educational reforms that do not include teachers and their professional development have not been successful. Professional development initiatives that have not embedded in some form of reform of structures and policies have not been successful either(p. 24).

This to some extent signifies the importance of CPD in the setting of educational change. It can play a role of initiating and/or supporting the educational change (English, 1995). This however, raises questions such as: how and to what extent has (or can) CPD helped teachers to accommodate changes such as illustrated above?

The literature (English, 1995; Fullan, 2001a; Fullan, 2000; Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003) addresses varying ideas about CPD and change in an educational setting. For instance, Fullan (2001, 1991), whose work is valuable on all aspects of educational change and the implications to an education system, underlines the idea that change is a process. He presents four stages of successful change process as being: active initiation and participation; pressure and support; change in behaviour and belief; and lastly ownership. He likewise emphasises that teachers should be part and parcel of the stages of the change process if changes in teaching practices are to be effected.

CPD initiatives, whatever form they may take, should allow for teachers to bring about desired improvements as an important part of their everyday work, whether inside or outside the classroom setting (Fullan, 2001b). It is hoped that teachers learn something from their engagement in CPD activities. The new knowledge and skills that they acquire through engaging in particular CPD should enable them to make a difference in their professional practice (Guskey, 2002). As the title (INSET: initiating change or merely supporting it?) of English's (1995) article suggests, CPD providers in their design or evaluation of current CPD may need to ask the question whether CPD provided is designed or is being designed to

initiate change or support desired change? And perhaps as far as is possible be more explicit on the expected change a particular CPD programme is designed to initiate or support: Is it teachers' attitudinal change, intellectual change or behavioural change as related to their classroom practices?

It can be concluded from literature presenting professional development and change that change is inevitable and that it is a process- and can be a long-term process. It is clear that at the centre of educational change processes are teachers who need to continue learning and who may have to be helped to develop a sense of ownership of the change and desired improvement. This implies that they (teachers) need to be supported and guided through their learning process. A supportive environment and necessary pressure is a must if educational change is to be successfully introduced and implemented. The value of CPD in the educational change processes can therefore not be overstated.

2.2.2.2 CPD and pupil attainment

As earlier highlighted, CPD has the potential to initiate and/or support changes in teachers' teaching and classroom practices which can subsequently contribute to pupil attainment. The literature (Halpin, Croll, & Redman, 1990; McNamara, Jaworski, Rowland, Hodgen, & Prestage, 2002) state that CPD can lead to increased teacher knowledge, positive changes on teaching strategies which can contribute to improved pupil attainment. However, the relationship between teacher improved teaching as a result of CPD and pupil learning and attainment can be difficult to establish (Loucks-Horsley & Matsumoto, 1999; Muijs, Day, Harris, & Lindsay, 2004). Davis (2010) confirms that even though it is considered a logical conclusion that the impact of CPD on teaching would result in improved pupil learning experiences and increased pupil attainment, tangible evidence for this is difficult to provide. This is probably because of the complex nature of evaluating the effect of CPD on learners' learning outcomes. Assessing the impact of CPD programmes on schools, teachers and/or pupils is multidimensional and is equally highly problematic (Coombs, Lewis, & Denning, 2007; Davis, 2010; Flecknoe, 2000). Among the reasons for being problematic is that a change in teaching practice may not automatically translate to a change in pupil attainment. Nearly twenty years ago, Askew et al.'s (1997) study on 'Effective teachers of numeracy' in the United Kingdom(UK) alluded to this point by stating that teachers may approve or accept (good) teaching practices but not be able to change their actual teaching practices, for immediate impact on pupil attainment. This may still be the case as exemplified by studies such as Buczynski & Hansen (2010) who present some possible barriers to implementation

including time constraints, classroom management issues and approved curriculum pacing. However, in a case that teachers changed their actual teaching practice, there is no defined time frame between the point of accepting a good teaching practice, implementing it and actual pupil attainment, thus still making it difficult to evaluate change in pupil learning outcomes and attainment.

The other reason could be that there is a possibility of several factors, or combination of factors, other than teachers' change in practice that can lead to pupil attainment. Flecknoe (2000), in his report describing the evaluation of a teacher CPD programme called 'Managing the raising of attainment' run by Leeds Metropolitan University, ponders that there may be many influences on pupils that could not have anything to do with a teacher's intervention, but still contribute to raising pupil attainment. English (1995) also refers to this point and gives examples of factors such as the nature of pupils and pupils' personal input (effort) which might not have anything to do with teacher intervention and yet can contribute to pupil attainment. Flecknoe also states that it is not easy to isolate the variables and establish casual relationships when it comes to pupil learning outcomes.

In discussing CPD and its impact on pupil attainment some of the difficult questions worth considering are:

1. What kind of CPD and how much of it should a teacher engage in for it to have an impact on pupil attainment?
2. Are teachers who are involved in some kind of CPD supposed to be observed or monitored to ensure that the CPD they attend results in pupil attainment? If so how-what is the criteria to be used?
3. How long is it supposed to take for CPD to have an impact on pupil attainment? This question arises because it could be too early or possibly too late to assess the impact on pupils' learning experiences (Davis, 2010).
4. What guarantee is there that pupil attainment is as a primary direct result of the CPD teachers have attended or been attending? This may lead to asking for the kind of evidence of impact of CPD and measures of pupil learning and attainment. Also how is pupil attainment to be defined-Is it only in terms of exam results?

Other questions that would also need consideration as illustrated by English (1995) are:

5. Is it possible that one and only one factor can aid pupil attainment? If yes, how do we confidently single out this factor? If not what are the other possible contributory factors? And to what extent or proportion do such factors make a contribution to

pupil attainment.

6. Who is the best person to identify the factors contributing to pupil attainment? Is it the teachers, the pupils, the HOD, Head teacher or someone outside the school system such as an MOE official?

Although it is challenging to measure the direct impact of CPD on pupil attainment, there is no evidence yet to prove CPD has no impact on pupil attainment. There is equally no reason ignoring the issue and pondering on what could be done to assess possible impact. Teachers are under increased pressure, at differing levels, from different angles: government, school system, parents, guardians and in some cases pupils themselves to improve the quality of teaching and in turn heighten pupil learning and performance (Bullough Jr, 2009). This is the case for mathematics teachers in Zambia in the face of poor pupil performance and attainment in mathematics as partly illustrated under section 1.3.4. As financial, time and human resource have been attached to designing and implementing effective CPD it is only right that attempts made (or being made) to show that CPD programmes have an impact on pupil attainment are accommodated and well supported. A combination of teacher perspective and pupil perspective on the impact of CPD may provide further, and possibly more detailed, guidance on assessing the impact of CPD on learning and pupil attainment.

2.2.3 Providers of CPD

As previously mentioned, teachers have a significant role to play in their PD, but they also require support from the government and other relevant providers. Academics such as Guskey (2002) and Komba & Nkumbi (2008) state that CPD provision can be strengthened and its success heightened with the cooperation and input of relevant multiple stakeholders at different levels. Several authors (ACME, 2002; Bolam, 2000; Komba & Nkumbi, 2008; Padwad & Dixit, 2014) have identified potential CPD providers and supporters some of which have been presented and their contributions to supporting teachers' CPD summarised below.

National government and international agencies: As the literature (Borko, Jacobs, Koellner, & McGaw, 2010; Guskey, 2000) indicates, governments worldwide are taking initiatives to strengthen teachers' CPD to improve the quality and standards of education in schools. In Africa (Edwards, 2012; Komba & Nkumbi, 2008; Mulkeen, 2010) for example, national governments have even gone to the extent of also partnering with and making arrangements with international agencies to assist in strengthening CPD design and provision in their respective countries.

As stated earlier in chapter 1 Zambia, like other developing and developed countries, has acknowledged the importance of teachers' CPD for the development of quality education. It also appreciates that mathematics is one of the subject areas that is essential for economic growth and innovation both at individual and societal level. It is partly for this reason that Mathematics is a compulsory subject at primary and secondary school level and a 'must pass' subject for one to progress to any higher institution of learning. In an effort to increase the number of qualified Mathematics teachers, the government has been sponsoring some underqualified in-service teachers to upgrade their qualifications at HEIs. Even though the numbers sponsored is small, compared to the demand, government effort can be argued to be a step in the right direction. Mathematics teaching and learning coupled with raising pupil attainment in the subject has been at the centre of CPD projects and initiatives by the government together with the support of International agencies as illustrated below.

International agencies partner with national governments by giving financial or technical support for and towards teachers' CPD. They, in some cases, offer or sponsor capacity building training to teachers or CPD coordinators or CPD managers as it relates to CPD. A greater part of CPD in Zambia is linked to donor-financed projects (Mulkeen, 2010). This is partly due to the financial crisis Zambia has been facing. As far back as the 1990s it was reported that some international organisations have had to step in to offer support seeing that there were a few or no guidelines and a lack of coordination to enable teachers' CPD due to a decline in Zambia's economy (Berstecher & Torres, 1996). Some of the international organisations or agencies that have supported Zambia in the area of teachers' CPD include: Swedish International Development Cooperation Agency (SIDA), Overseas Development Aid (ODA), United States Agency for International Development (USAID) and JICA. Examples of such agencies that have specifically identified mathematics among its focus areas being: DFID with the Action to Improve English Mathematics and Science (AIEMS) project and JICA with the Strengthening Mathematics, Science and Technology Education (SMATSE)-SBCPD through LS. An examination of INSET in Kenya, Malawi and Zambia through the use of grounded theory methodologies by Banda (2013) shows that while there is a degree of interlinking of programmes supported by international agencies, the programmes are being operated from different perspectives and with critical analysis could review some hidden conflicts which could contribute to the programmes being ineffective. Another point to consider is that while receiving financial and/or technical support from international agencies such as illustrated above can facilitate CPD provision, it could to some extent also imply pursuing or upholding the education or CPD agenda proposed by the agencies in question

which if not carefully considered would have a negative effect on the education system of the country on the receiving end as demonstrated in section 1.4. In addition, it raises questions on the extent to which countries such as Zambia are committed to strengthening 'home-grown resources' for teachers' CPD but is beyond the remit of this thesis.

Curriculum Development Organisation: There is a link between CPD and curriculum development. Based on international evidence, 'carefully structured, subject rich curriculum development depends on effective CPD, and acts as a great springboard for it'(CUREE, 2011, p. para 3). Putting this point into consideration, there should be some collaboration between CPD designers and curriculum development officials in designing befitting CPD for teachers.

The Zambian curriculum development section of the MOE is supposed to offer professional guidance to teachers through visits to schools and arrange CPD training courses for them. It is stated though that partly due to shortage of staff in the section, it has not been able to engage in curriculum related research or to consistently arrange CPD training courses/sessions (MOE, 2013a). This is limiting in as far as CPD provision is concerned

Examination Boards: These can offer CPD programmes designed to help teachers improve their teaching standards in the classroom. They can offer face-to-face courses as well as online courses. Through such CPD they can review assessment and assessment procedures, analyse examination item(s), critically assess sample question papers and review examiners' or markers' feedback and introduce new specifications as they may relate to the national examinations they offer. In general, examinations boards can help teachers to teach in the most effective way and assist them in preparing learners for examinations through their CPD programmes.

The examination board in Zambia called Examination Council of Zambia (ECZ) was established in 1983 prior to which was the University of Cambridge Local Examination Syndicate in the UK. ECZ allows for some selected teachers to engage in examination item setting, marking of national exams and associated trainings as one of its functions (UNESCO, 2011; ECZ, 2014). The teachers who have a chance to participate in training arranged by ECZ especially regarding national examination paper marking are encouraged to share relevant information with fellow teachers in schools not in attendance of the same training to support their professional development too. Teachers who attend the training sessions organised by ECZ are paid an allowance while those with whom the information is to be shared with in schools are not. This, to a certain degree, can be a demotivating factor for the teachers not invited for training by ECZ in the first place.

Other organisations such as Non-Governmental Organisations (NGOs): Non-Governmental Organisations can work at addressing issues such as those pertaining to teacher capacity building and development and school improvement. For example, Komba & Nkumbi (2008) report of NGOs in Tanzania, working on such aspects as: information and communication; ownership and accountability; community mobilisation and facilitation; motivation; collaboration; gender mainstreaming; resource mobilisation; and HIV/AIDS as they pertain to school development. Another example is the 'Teacher Education in Sub-Saharan Africa' (TESSA) consortium which works within institutional and national policy systems to support school-based teacher professional development (Thakrar, Zinn, & Wolfenden, 2009). Their work includes provision of locally and culturally relevant educational resources and materials. However, there was no available empirical data to show their work towards supporting secondary school mathematics teachers' CPD in Zambia. The Science Mathematics Technology (SMT) model through the NGO Forum for African Women Educationist in Zambia (FAWEZA) initiated in 2005 is an example of NGO initiated project that has directed its effort toward enhancing SMT teachers' knowledge and pedagogy especially targeting increasing and sustaining interest, participation and performance of girls in SMT subjects at different levels. The above illustrate that each NGO has its own perspective, priorities and agenda for CPD. As observed in the case of international agencies, there is a possibility of some hidden conflicts which could contribute to programmes of such projects or the project themselves being ineffective. Based on the point that each NGO can have different priorities and agenda for CPD, it can be concluded that for teachers to benefit from services offered and hence enhance their PD they may, to start with, need to be aware of their personal PD needs that require meeting. The issue of teachers' CPD needs has been discussed under section 2.3 of this thesis

Professional Association(s): A professional association for teachers can be said to be a group of teachers and for teachers. Professional associations can be significant agents in teachers' general CPD or subject-specific CPD. An association for teachers is expected to work to advance teaching as a profession. It can assist members to further the profession through on-going learning and quality control (NCTL, 2016). Each association offers varying and unique services to its members probably depending on the size of the association, its resources and the needs and interests of its members. While associations can offer several services in support of members' CPD, the subscription fees in some cases appear to be high which may keep some individuals away from joining or renewing their membership.

Among the subject associations in Zambia is ZAME. One of its tasks is to hold workshops or seminars for teachers of Mathematics, on weekends or during school holidays when school is not in session, but there was no available documentation of their work by the time of this thesis writing to enable providing a detailed account of their activities in supporting mathematics teachers' PD in Zambia. In this particular case, a lack of documented evidence of ZAME's work can make it difficult to substantiate their efforts and commitment to supporting PD for mathematics teachers.

Higher Education Institutions (HEIs): Colleges and universities can play a key role in teachers' CPD especially within the context of partnering with the teachers. One such role of HEIs is offering courses that (can) lead to diplomas, first degree, postgraduate studies or MAs/MScs and PhDs in specific subject areas as well as in-house courses for teachers' CPD or (online) professional short courses. Such courses can enhance teacher knowledge, expertise and competences. There are studies conducted over twenty years ago such as Halpin et al. (1990) and in the recent past such as Flecknoe (2000) and Buczynski & Hansen (2010) that exemplify teacher perceptions of enhanced knowledge and skills including a change in their own practice through training courses received through HEI. HEI courses can also include courses designed to offer opportunities for individuals taking up or aspiring to take up new roles such as leadership roles for their career development and pursuit of different other professional roles (Bolam, 1993; Burns & Edwards, 2014). These could include courses or training for (teacher) mentors, aspiring Head teachers, aspiring (or already serving) Heads of Department, CPD coordinators or ICT coordinators to name a few. Based on the above, HEIs can be challenged to take their professional role in professional education seriously by setting up relevant professional schools and courses (Bolam, 2000). This would contribute to creating and sustaining opportunities '…for individual teachers to meet their professional development needs'(Bolam, 2000, p. 278).

Additionally, Komba & Nkumbi (2008) have underscored the point that lecturers in HEIs have a responsibility to conduct research to inform policy formulation, implementation and practice including on matters related to teachers' CPD. Their support can equally include providing access to relevant existing research and research findings in the field and professional reflection on teachers' teaching practices (Cordingley, Bell, Rundell, & Evans, 2003). Komba & Nkumbi (2008) add that lecturers can also provide relevant literature and materials, spanning different subject areas, to support teachers' professional growth and work in schools. This further illustrates the crucial role that HEIs can play in teachers' PD

HEIs in Zambia currently offer courses leading to a Diploma in Education with specific subject specialisation as well as first degree, MAs/MScs in Mathematics and Mathematics related areas on a fulltime basis and through distance learning. The focus of the courses varies as per institution of learning, but is likely to include Mathematics, Mathematics Education and associated research. It is expected that the institutions make use of their expertise and resources to support CPD of teachers in addition to granting pre-service training- a foundation for professional service, but there is no empirical evidence to show that HEIs offer secondary school mathematics teachers other professional services in relation to CPD such as discussed above beyond what would be considered qualifying academic courses. In fact, even though one of the principles of CPD provision as stated in the EOF (section 1.4) is to accompany changes such as introduction of new subject content by in-service teacher courses, this has not been fully realised. There are currently no in-service courses for teachers at HEIs that can go hand in hand with the changes in mathematics content or pedagogy that have come with the new curriculum.

Schools: Schools are one of the natural environments within which teachers can enhance their knowledge and skills. The general view is that concerns arising within a school setting are better solved by people working within that particular school setting through taking appropriate professional action (Kirk, 1988). SBCPD also referred to as School-Centred CPD (McNamara et al., 2002) or School-Focussed CPD (Zuzovsky, 2001) is regarded as a model of self-help (ACME, 2002). It can refer to CPD activities that are taking place within a school and meant to address the concerns that arise in and affect the teachers, pupils and a particular school at large. Nyarigoti (2013) comments that SBCPD is a concept that applies when all teachers meet to discuss matters affecting the whole school such as pupil discipline or pupils' welfare in general. She further argues that departmental meetings act as a subset of SBCPD. With this kind of CPD also come opportunities for discussion of government initiatives and/or specific matters affecting the department and/or school development.

SBCPD is regarded as relevant to teachers' working contexts, convenient and cheap. Cobb et al. (2003) expounds that SBCPD constitutes CPD activities and learning situated within the '… affordances and constraints of the…'(p. 13) practicing school. SBCPD appear to minimise costs and maximise on teachers' expertise within school settings (Day & Leitch, 2007).

There is currently an emphasis on SBCPD programmes in Zambia. Each school is expected to have a CPD policy and someone in charge of CPD referred to as CPD Coordinator. At

departmental level, the HOD is the overseer and is expected to have a plan for departmental CPD. Teachers of mathematics, like teachers of other school subjects, are to attend departmental meetings and all other planned SBCPD related activities (see section 2.2.4.1).

What Banda (2007) has counted as a challenge associated with SBCPD in Zambia in general is that there is a low commitment among school managers in supporting teachers' CPD. This could be attributed to their lack of required skills to offer the necessary support. As referred to in chapter 1, the situation is similar in Kenya where head teachers were required to assume the role of the directors of the SBCPD without receiving training to help them fulfil their responsibilities as regards to this additional task (Nyarigoti, 2013). An investment in education programmes and support structure for school leaders is key in preparing them to carry out their responsibilities of supporting and ensuring quality teachers' CPD. Nyarigoti, (2013) acknowledges this and states that there is need to direct resources for capacity building at school level for SBCPD to be successful. The other suggestion is linking external expertise such as that of HEIs lecturers, to SBCPD activities (Cordingley, Bell, Rundell, & Evans, 2003). This could be in ways such as discussed above concerning HEIs' role in CPD

The other challenge is that some teachers have developed a mentality of viewing training or workshops as income generating activities and not as avenues for learning to continually improve on their practice (Banda, 2007) as they are given an allowance for attending a meeting. For this reason, some teachers shun SBCPD meetings where there is no monetary gain attached. Thirdly, McNamara et al. (2002) state that implementing SBCPD in economically disadvantaged contexts maybe an additional challenge. This is because planning for SBCPD requires not only human and time resource investment but also financial investment for successful implementation and sustainability which economically disadvantaged context may not readily have.

Challenges such as the above can lead to the conclusion that the impact of SBCPD can be limited in yielding intended benefits (Day & Leitch, 2007). Depending entirely on SBCPD can thus be limiting in relation to promoting teachers' PD. Alexander et al. (1992) amplifies on this point. They, in a UK government-commissioned review of evidence of teaching methods and classroom practices, caution that there is also a danger in SBCPD being '…pursued as the only in-service strategy in that it may result in some schools merely recycling their own inadequacies…'(p. 53). They add that '…its impact can be limited by poor design…'(Alexander, Muir & Chant., 1992, p. 53). The recommendation they present is that schools have a 'mixed economy' CPD where there is SBCPD as well as non-SBCPD.

That is, having a combination of school-led/school-based CPD, outside-school training and partnerships among relevant CPD providers to enhance teacher professional growth. This would offer varied learning opportunities in and out of school that can enable teachers to benefit according to their various needs (Day & Leitch, 2007). The suggestion of a 'mixed economy' CPD is worth considering in other contexts such as Zambia, which appears to put emphasis only on SBCPD.

Teachers themselves: Teachers themselves are agents of their CPD. An international review on the teaching profession states that teachers should 'become active agents of their own professional development' (Schleicher, 2012, p. 73). What does this entail? This could include teachers developing professionally through reflecting and learning from their teaching experiences. Day (1999) articulates that teachers learn naturally from experience during their career. While experience in itself can be educative (Taylor, 1980) meaningful learning from teaching experiences can be stimulated by a process that includes 'inquiry', 'doing' and 'reflecting'(Hamilton, 2013; Schmidt 2010). While learning from experience can promote PD, on its own it can be regarded as insufficient. Day (1999) states that learning from experience alone is considered ultimately limiting to development and therefore engaging in additional PD activities can further promote professional growth. Teachers can also play an active role in their personal PD, through identifying their professional needs and engaging in PD activities, within or outside a school setting, through mandated or self-directed learning and/or through engaging in structured or unstructured CPD arrangements, which could potentially meet the identified needs. Section 2.3 below further discusses teachers' CPD needs and section 2.2.4 details on possible CPD activities.

In conclusion, the above presented work illustrates that there are multiple agencies in CPD provision and that CPD provision is a shared responsibility. The role and level of involvement of these CPD providers in CPD design, provision and management however, can vary widely depending on factors such as: interpretation of the notion of CPD; level of awareness of their role in providing and supporting teachers' professional growth; their being recognised as agents in CPD; and the extent to which opportunities are created and availed for them to contribute toward teachers' PD in different contexts. It can be concluded that the quality of CPD provision could be enhanced when CPD providers have opportunities to cooperate in CPD provision and management.

2.2.4 Types of CPD activities

CPD activities can refer to all the opportunities and activities that can facilitate PD to teachers, regardless of whether they are a part of their daily teaching work or formal or informal occurrence (Mansour, Albalawi, & Macleod, 2014; Villegas-Reimers, 2003). They provide opportunities for teachers to engage in and improve themselves as educators and as individuals (Mahmoudi & Özkan, 2015). The literature (Goodall, Day, Lindsay, Muijs, & Harris, 2005; Kennedy, 2005; Lieberman, 1995; Sparks & Loucks-Horsley, 1990; Villegas-Reimers, 2003) has pointed to several different CPD activities that teachers can engage in for their PD. As illustrated below, these activities have been structured and categorised in distinct ways in different contexts for sundry reasons (Adagiri, 2014). For instance, based on a two-year four-phased project study to evaluate the impact of CPD in UK schools using mixed data collection methods, Goodall et al (2005) categorised CPD in three kinds of models or activities. Even though they have stated that categorising CPD activities or experiences is '…in some way an arbitrary exercise; there will be some experiences which cross borders and defy categorisation…' (Goodall et al., 2005, p. 173) they have still categorised the CPD activities. Their argument being that having some form of categorisation of CPD activities would guide with establishing what and how much CPD is taking place and assessing whether there are other forms of CPD, which would be suitable in meeting teachers' perceived needs. The range of CPD activities have been grouped under the headings: 'Direct learning', 'Learning out of school' and 'Learning in school'. The range of CPD activities under each heading are captured here.

- *Direct learning:* Knowledge update, skill update, awareness sessions, initial conversations, charismatic speakers, conferences, courses and workshops, lecture, consultations, self-evaluation and self-directed reading.

- *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.

- *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.

Whilst Goodall et al. (2005) have three categories of CPD activities, Kennedy (2005) has nine

after a consideration of a wide range of international literature along with specific examples drawn from the Scottish context. The nine categories of CPD activities according to Kennedy have been summarised below.

- *Training model* which focuses on updating skills, with delivery by an 'expert' who determines the agenda while the participant generally remains passive.
- *Award Bearing model* usually emphasising the completion of award bearing programmes as maybe offered by institutions of higher learning.
- *Deficit model* which focuses on addressing perceived shortcomings in a teacher's performance.
- *Cascade model* where a teacher or teachers attend a training programme and thereafter disseminates the information acquired to colleagues.
- *Standards Based model* where teachers strive to adopt and demonstrate certain common skills as demanded by national standards.
- *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.
- *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.
- *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.
- *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.

Kennedy (2005) argues that these models will not or should not stand-alone. He further presents the nine models into three broad categories though at the same time agreeing that they may not be the only possible categorisation. The three broad categories are: traditional

(transmissional), transitional and transformative. The first four models as presented above are in the transmissional category where teachers have little or no opportunity to take charge of their own learning and/or influence the learning agenda. The following three (the standards based model, coaching/mentoring model and community of practice model) have increased professional autonomy with the last two (Action research model and transformative model) having greater professional autonomy though it might or might not necessarily be fulfilled depending on the external party which defines the parameters of the activity. It can be stated here that the ideas of teacher autonomy or power relations existing in each CPD model is apparent in Kennedy's categorisation of CPD activities than is in Goodall and others' categorisation as presented above.

While there are some other academics (Lieberman, 1995; Spark & Loucks-Horsley1990) with different categories of teachers' CPD activities, based on the above illustrated 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**.** While being aware that categorisations can overlap (Adagiri, 2014; Byles, 2010), this study has classified CPD activities as 'formal' and 'informal' CPD with CPD activities organised within or outside the school setting. This categorisation has been chosen as it aids in giving a clearer picture of CPD activities in the context of this study. In discussing formal and informal CPD activities some ideas from the aforementioned authors and others including Villegas-Reimers (2003) on CPD activities will be used. The CPD activities considered are presented in detail below.

2.2.4.1 Formal CPD activities.

This includes structured and systematic CPD activities, which can be school-based (on-site) or non-school based (off-site) and generally led or directed by an instructor or trainer. The CPD activities that this study considers as belonging to this category of CPD activities include departmental meetings, staff meetings, (academic) training courses, conferences, seminars and workshops.

2.2.4.1.1 Non-School-based (off-site) CPD activities

These can be in the form of different modes of training as illustrated below.

Training courses: These can be long-term or short-term, award-bearing or non-award bearing. An example of training courses includes those offered by HEIs through distance learning, parttime or fulltime study modes. Training courses 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). However, they also have potential to encourage teachers to neglect their teaching duties so as to pursue their studies as reported in Mulkeen's (2010) study in Sub-Saharan Anglophone countries. In addition, training for the purpose of upgrading qualifications has an impact on planning especially in the areas of teacher supply and finances in terms of large teacher wage bill (Mulkeen, 2010). This is the case in that upgraded qualifications call for an automatic increase in salary and in some cases movement to a different type of school such as from primary to secondary school.

Workshops: These are an example of a traditional form of in-service teacher training (Villegas-Reimers, 2003). Workshops are criticised for not having a lasting influence on teaching practices or not doing much to support the development of (new) skills (Guskey, 2002; Huberman, 2001). This is partly because 'traditionally most of these workshops…are 'one-shot' experiences, completely unrelated to the needs of teachers and providing no follow-up (Villegas-Reimers, 2003, p. 93) While workshops are criticised as cited ,'… they are not a poster child of ineffective practice they are often made out to be'(Guskey & Yoon, 2009, p. 496) they still offer opportunities for acquisition of knowledge and skills that teachers can build on to improve their professional, personal, and social lives. Villegas-Reimers' (2003) has also cited examples of how workshops when accompanied by other PD activities have been successful in promoting teachers' PD

Attendance of workshops is a common feature in Zambia as in other countries. Mathematics teaching and raising of attainment in the subject has been at the centre of some of the workshops but more generally, cross-subject topics such as managing pupil behaviour are discussed during training sessions. The choice of who to attend such trainings is usually made by the school administration. It is common to have one and the same person being asked to attend. As earlier referred to in 2.2.3, those in attendance are usually paid an allowance for attending such trainings, which has contributed to workshops being viewed as valuable additional sources of income (MOE, 2007; Mulkeen, 2010). This results in some teachers shunning educative meetings where there is no financial gain after attendance. The other shortcoming is that where such workshops are held during term time, concerned teachers are absent from their classroom for several times in a term and the situation is worse when there are multiple of such training to be attended by almost the same teacher (Mulkeen, 2010). This in some cases has, to an extent, contributed to pupils' poor attainment in the affected subject areas.

Conferences: Local/regional/national/overseas education related conferences are another CPD activity. They 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 and lead to improvement in one's practice (Goodall et al., 2005).

Cascade model also called training-of-trainers model (Villegas-Reimers, 2003) is a popular model for training used in Zambia as in other countries. It is a model for training when reform agents want to reach many participants in a short period of time (Avalos, 2004). The ideas behind this include a centralised analysis of needs, assumed uniformity throughout the system and reliance on the effective replication of knowledge down the cascade (Gibbs & Kazilimani, 1999; Mulkeen, 2010). In this model, training needs are determined centrally, courses developed centrally too and then delivered at different levels in the system. Training in a particular content is conducted at several levels (Hayes, 2000) starting with the 'trainer of trainers'. For instance, the current focus, across subjects, that is being delivered through the cascade system in Zambia includes 'problem solving', critical thinking' and 'active hands on learning' for pupils. Accordingly, the trainers are trained in the areas of focus, at national level, and equipped with the main ideas of what needs to be learnt. They in turn train others at provincial and district level who then train the teachers at school level. Note be made here that some modification of the original information received at the top of the cascade to suit local contexts and needs for instance, may be necessary as it reaches the lower levels of the cascade (Thair & Treagust, 2003). The cascade model is considered as a cost effective and economical way to train a large proportion of individuals over a relatively short period of time using less resources (Kennedy, 2005; Thair & Treagust, 2003). This is partly one of the reasons why the model is used in some cases alongside school-based CPD model for teacher development in Zambia.

One shortcoming presented against it (cascade model) is the dilution of information by the time it gets to the teachers for whom it is intended (Gibbs & Kazilimani, 1999; Hayes, 2000). Depending on several factors such as trainers' experience, personality, ability to disseminate or interest; and/or, availability or lack of training resources (Bett, 2016; Ono & Ferreira, 2010), the manner of presentation of the information may also not meet the standard as was set at the top of the cascade. The information is watered down or misinterpreted in the process of being passed on to the intended recipients. The other shortcoming of the cascade

model is that of uneven coverage of training programmes (Mulkeen, 2010) in cases where learnt material is not delivered to the intended teachers or is inadequately covered by the presenter. Hayes (2000) suggests that for the cascade training to overcome such weaknesses there may be need to: diffuse expertise as widely as possible through the cascade system so that they are not only concentrated at the top, include different stakeholders in the preparation of the training materials, design and conduct the training in a more experiential and reflective manner than a transmissive way. Thair & Treagust (2003) add some other key elements to the success of the cascade model as being: the facilitation of or provision of good supporting materials at appropriate levels within the cascade; and facilitation of greater authority at different levels down the cascade levels to oversee progress and manage any adjustments to the cascade on the information filtering down the cascade.

In general, trainings attract teachers from different geographical areas and backgrounds together thereby creating opportunities for professional knowledge exchange (Kirk, 1988). During trainings teachers can be offered new information related to their subjects of specialisation in particular or related to their work in general (Villegas-Reimers, 2003). However, because the trainings are designed to for large numbers of teachers from different work environments, the information received through the training may be generalised and thus more theoretical than practical. The knowledge obtained through the trainings can be too generalised partly because they (courses) are determined by the deliverer of the training who might not have first-hand information about teachers' actual experiences and thus not meet the specific needs of the teachers in their work places (Kirk, 1988; Wanzare & Ward, 2000). If information is too generalised it can be considered irrelevant. Kirk's (1988) antidote to this is that such trainings can be designed in consultation with the teachers so as to reflect issues that teachers encounter in their schools. An inclusion of participants' needs assessment (see section 2.3.3) and evaluation of trainings could help in making the training more relevant to the participants. Another criticism raised against training is that there is usually no provision for sustained follow-up. Despite the limitations such as exemplified above, off-site trainings offer PD opportunities which can contribute toward meeting some of teachers' PD needs. The limitations they present can be minimised with careful planning which could include a consideration of participants' identified needs. They can also be offset by using trainings in combination with a variety of other CPD activities (Duncombe, 2005).

2.2.4.1.2 School-Based (on-site) CPD activities

Some of the limitations of off-site PD learning activities for teachers facilitate the promotion of SBCPD. It is however also argued that, in some instances, SBCPD activities can also to an

extent be too general to meet individual teachers' needs if not carefully planned (Duncombe, 2005). Opportunities for CPD within the school setting include staff meetings and departmental meetings among others. Below are other CPD activities that are school-based.

Lesson Study(LS): This is a collaborative type of professional development, which has its roots in Japan. LS can be done in many different forms for different purposes (Lewis & Perry, 2006; Baba, 2007), with the common format being school-based which generally 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; Stigler & Hiebert, 1999; Baba, 2007). Zambia's SBCPD is principally through LS (Banda, 2007; Banda & Baba, 2013; Kabeta, 2015). Teachers, in their subject departments, are supposed to have at least three LS cycles in a three-month school term, document their work, such as what they did, what worked and what they had learnt and then give a report during the stakeholders' workshop held at district level every school holiday.

With LS come opportunities for teachers to share and gain new insights into pedagogy and content knowledge for continued improvement of teaching practices and pupil learning (Burghes & Robinson, 2009; Baba, 2007). It also offers teachers opportunities to take charge of their own professional development (Lee, 2008) partly through taking up responsibility of improving their lesson presentations and the teaching and learning process as a whole (Banda, 2007). On the other hand, there are some challenges associated with LS implementation among in-service teachers which are worth presenting here**.** The challenges can differ in nature, scale and severity depending on the context among other, but they generally include: time constraints; unavailable or inadequate teaching and learning materials to be used as tools in the lesson study process; pressure from extra workload imposed on teachers during the LS process; difficulties in generating interest in and sufficient commitment among teachers to the LS process; teachers' lack of knowledge, skills and disposition needed for implementation of LS; limited opportunities for cross-site learning; and no or inadequate loops linking lesson study to changes in the curriculum (Lewis & Perry, 2006; Lee, 2008; Banda, 2007)

Teacher support group meetings: Teacher support groups are sometimes referred to as learning circles (Tripp, 2004), teacher networks (Day & Sachs, 2004; Villegas-Reimers, 2003), peer networks (Mulkeen, 2010b) and teachers' communities of practice (Kennedy, 2005), communities of enquiry or learning communities (Kennedy, 2011). 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). One form of teacher support group that exists in the Zambian set up is that of mathematics teachers' departmental level communities within a school setting which are expected to be meeting regularly to discuss their work. Teachers in support 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 (Salo & Ronnerman, 2013). It is argued that suggestions from colleagues in a community of practice are usually taken seriously, experimented on and feedback taken back to the group for further discussion and possible development (Hargreaves, Hopkins, Leask, Connoly, & Robinson, 1989). Learning within such groups happens as a result of the interaction among group members (Wenger, 2000) by purposefully studying their work and that of their peers (Hamilton, 2013). Tripp (2004) suggests that teachers can effectively work and learn through such interaction by making use of information and communication technologies too. These could contribute to the development or participation in online (mathematics) professional communities.

Teachers can belong to multiple (professional) communities, which can function differently as avenues and sites for professional development (Moore & Shaw, 2000). Salo & Ronnerman (2013) referring to Wenger's (1998) work on social theory of learning emphasising the concept of communities of practice, expound on this by stating that in their life time, human beings belong to different types of communities of practice and that the nature of belonging and the types of communities people belong to also change over time. McLaughlin (1993) suggests that since there are multiple communities in any teacher's professional map, there should be several strategic sites such as at department, school, professional organisation level among others for the professional growth of teachers within the education system.

Teacher support groups are a good example of teacher collaboration as a professional development tool. However, a question such as: 'what factors make a teacher support group effective enough to promote and enhance learning and PD among the members of a group'? may need to be handled to ensure that the benefits of belonging to teacher groups are maximised.

Coaching/Mentoring model as part of a formal school arrangement: 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.

The coaching/mentoring model can incorporate *Observation model of excellent practice* 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, 2005, p. 22). 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 in the Zambian case have opportunities to observe a teacher. Though not systematic, the observation process includes observation of various teaching aspects. These teaching aspects incorporate lesson preparation and presentation, classroom interaction and management which are also highlighted in Villegas-Reimers' (2003) work. In this case, strengths of a lesson and areas of improvement are noted and discussed with the aim of bringing about improvement in the teaching process. The observation model has the potential to contribute to professional development, but teachers easily relate it to an evaluation and end up having a negative attitude to it, shy away and thus miss out on the necessary feedback and opportunity to be aware of their own strengths and weaknesses especially through reflection.

Research and publication: 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 (MOE, 2013b). 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). Further, Kincheloe (2012) argues that 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'(p. i). It is for this reason that teachers are encouraged to carry out research. Engaging in research facilitates acquisition and further development of research skills, increase in knowledge base, levels of

confidence and also increase in one's teaching practices and decision making abilities. However, the extent to which teachers are enthusiastic about or engage in or are supported to engage in research to improve their practice or inform policy varies widely form context to context.

Research as a CPD activity can go hand in hand with publications. This is the case because once a teacher engages in research they may need to publish their findings for their personal consumption as reflective practitioners or for use by the school community or wider teaching or education community.

2.2.4.2 Informal CPD activities

Formal structured CPD activities have a significant role to play in teachers' professional development, but also have their share of limitations as illustrated in the discussion above. 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' (Cheetham & Chivers, 2001; Desimone, 2009; Kennedy, 2011; Richter, Kunter, Klusmann, Lüdtke, & Baumert, 2011) CPD. This is bearing in mind however that these are not to be misinterpreted as some kind of casual processes or activities, but as processes that can contribute toward achievement of PD goals. Based on relevant literature reviewed (Cheetham & Chivers, 2001; Komba & Nkumbi, 2008; Mahmoudi & Özkan, 2015; Richter et al., 2011) examples of informal CPD activities that are applicable to this study can be summarised to 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; support from a mentor/mentee; 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).

One element for maximizing on the potential benefits of informal CPD activities for teachers' PD is 'self-directedness' (which has been discussed further under 2.2.5). This is where teachers can exercise some degree of autonomy, take initiative and make a conscious decision to engage in such activities and possibly engage in them at their own pace (Mokhele & Jita, 2010; Mushayikwa & Lubben, 2009; Richter et al., 2011) depending on their individual learning needs, aspirations and motivation and their preferred learning style among other factors. However, the efficient use of such activities to promote PD starts with being aware of and recognising their potential to promote PD. Such efforts should be accompanied with efforts to empower teachers to be proactive and take initiative in identifying their individual needs and act to meet them (Mushayikwa & Lubben, 2009) through different PD activities.

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 or planned to serendipitous, from experts, from each other and from their own practices (Bullough Jr, 2009; Collinson & Ono, 2001; Friedman, 2013; Harland & Kinder, 1997; Mansour et al., 2014; Ono & Ferreira, 2010; Steyn, 2010; WestEd, 2000; Zuzovsky, 2001) which can take place in multiple contexts within and outside the school context (Borko, Perissini, Romagnano, Knuth, & Willis, 2004). A logical conclusion is that teachers need to experience most if not all the different forms of CPD activities. However, some studies such as that by Kennedy & McKay, (2011) indicate that teachers may not be aware of the range of CPD opportunities available and or may lack access to the CPD activities. Based on this evidence, it can be considered appropriate to orient or sensitise teachers regarding the multi-dimensional aspects of CPD and CPD activities. Teachers also need to be empowered to exercise their own professional judgement through pinpointing and participating in CPD activities, which they themselves consider to be most beneficial to them (Scheerens, 2010).

No one form of CPD model can be considered as being better than the other(s) and no one model can or should stand on its own in any context (Kennedy, 2005; Schibeci & Hickey, 2003; Villegas-Reimers, 2003). This point is consistent with Timperley et al.(2008) who

maintain that a single activity or form of CPD cannot in itself be more effective than the other or be considered sufficient to improve teaching practices or to meet the varying CPD needs that teachers have. Because no one CPD activity is complete without limitation(s), there is a need to have several that can complement each other. Additionally, 'PD is "not one size fits all'' but rather should be a combination of strategies' (Loucks-Horsley et al., 2010, pp. 152-3). Secondary school mathematics teachers therefore may have to engage in several or a combination of several CPD activities, during their career time to meet their various CPD needs. In discussing CPD activities there is recognition of the notion that teacher learning and professional development can be collaborative or individualised. This has been elaborated in the next section.

2.2.5 Collaborative CPD and Individualised CPD

From the discussion on CPD and types of CPD activities so far it can be deduced that there are forms of collaborative and individualised CPD, which can be formal or informal and which can take place inside or outside classroom context or within and beyond school context. In trying to make the distinction between the two, Kennedy's (2011) work on what constitutes collaborative CPD applies here: '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). With collaborative forms of CPD such as collaborative teaching, collaborative planning, joint preparation of teaching/learning materials and mentoring come 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 (Cordingley et al. 2003; Guskey, 2000; Sparks & Loucks-Horsley, 1998; 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 & 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 that have been identified. 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)

Apart from the above-mentioned limitations of collaborative forms of CPD, there are also challenges that are likely to be faced in effecting collaborative CPD and which could cause teachers not to benefit fully from it. For instance, the success of collaborative CPD depends on the social context. It can be dependent on whether there is a collaborative culture in the department or school set up in as much as it depends on other factors such as whether teachers collaborating have sufficient teacher knowledge base or the social skills for effective collaboration or whether there is time allowing the needed collaboration for PD (Ball & Cohen, 1999; Billingsley, Riga, Taber, & Newdick, 2014; Caena, 2011). Guskey (2003) cautions that with no clear direction and purpose, individuals can collaborate to resist change or obstruct efforts to bring about improvements in the classroom or school set up. This can also count as an important point to bear when arranging collaborative CPD. At this point focus turns to individualised CPD.

The activities that are not fitting in the above-presented category of collaborative CPD fall under individualised or individually guided CPD and they include 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**.** A basic element of individualised CPD is where a teacher can design or plan for or choose to and engage in activities they would consider to promote their learning and development (Guskey, 2000; Sparks & Loucks-Horsley, 1998). This is mainly working with the assumption that an individual teacher can identify his/her own individual learning needs and can act on meeting them (Mushayikwa & Lubben, 2009). It can be argued to be in line with the principle of ALT that adult learners are self-directed and relevancy orientated (1.7.2). 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, its limitation lies in the fact that it can strengthen teacher isolation with its negative tenets. The other limitation lies in a teacher wasting time doing the same thing unnecessarily over and over again a point that Sparks &

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). Self-directed CPD also has limitations in the extent to which teachers can reflect upon their experiences. If they have limited exposure or experience, then their reflections will remain limited and might not be of much service to them in the context of PD.

This section has discussed collaborative CPD and individualised CPD. In summarising and concluding the discussion to this point it can be stated that individualised and collaborative CPD can both facilitate teachers' PD. One form of CPD cannot be considered as enough in the context of teachers' learning and PD. The two forms of CPD cannot completely be separated from each other as they 'complete' and complement each other bearing in mind the limitations that each has. In fact, it can be argued that individual and collaborative CPD can be considered as making a background for each other in promoting teachers' PD. Some of the factors that could influence or guide teachers' engagement in collaborative and/or individualised CPD include: school or national governments' guidelines on CPD, availability or non-availability of resources and a teacher's own PD needs among others. The next section discusses teachers' CPD needs.

2.3 Teachers' CPD needs

There are diverse interpretations attached to the concept of 'need'. A 'need' can be described as: a discrepancy or gap between perceptions of desired performance and observed or actual performance; a change desired by a majority; a direction in which improvement can be predicted to occur;, something whose absence is harmful or presence beneficial (Dunlap, 1995; Stufflebeam, McCormick, Brinkerhoff, & Nelson, 1984). For this study 'needs' is used in the context of individual or group preferences in the perspective of eliminating lack for the achievement of a justifiable purpose (Mansour, Alshamrani, Aldahmash, & Alqudah, 2011; Mansour, Alshamrani, Aldahmash, & Alqudah, 2013; Stufflebeam et al., 1984).

Mathematics teachers' CPD needs thus reflect in the range of issues or concerns teachers participating in CPD activities prefer covered or addressed to enable them acquire the needed knowledge and understanding and develop the needed skills and values for improving their teaching practice and thus contribute toward improvement in pupil attainment in mathematics. It is about the topics of discussion or content addressed within CPD programmes, that are related to mathematics teachers' work and which is useful and practical to their everyday work. Timperley, et al. (2007) state that without relevant '…content on which to base deeper understanding and extending teaching skills there is no foundation for change'(p. xxxi). CPD

is meaningful and relevant when it takes into consideration the needs of the target teachers. What is the nature of secondary school mathematics teachers' needs? To start with, this section discusses the nature of CPD needs in general and then explores mathematics teachers' CPD needs as evidenced from literature.

2.3.1 Nature of CPD needs

Literature points to different needs and categories of needs as being teachers' CPD needs. For instance, based on Hustler et al.'s (2003) survey and case study on teachers' perceptions of CPD in the UK, teachers' CPD needs were gathered and categorised in 11 parts as follows: subject knowledge; ICT; special educational needs; pedagogy; behaviour management; leadership and management skills; personal development; curriculum coordination and development; assessment; more time to reflect, implement; and others. Overall, amongst these needs, leadership and management skills, ICT and subject knowledge, followed by curriculum coordination and development, pedagogy and personal development were the main CPD needs of the respondents. Based on the study, differences on CPD needs were reported as based on gender, age, level of experience and level of education. One of the suggestions from the study is that CPD should prioritise individual teachers' needs.

Another example is based on Goodall et al.'s (2005) study already referred to under 2.2.4. This study presents a categorisation of CPD needs as encompassing only three categories of needs: personal needs, policy needs and organisational needs. Goodall et al, state that personal needs which CPD could fulfil include those individual staff needs which when met could help them function to the best of their ability. Policy needs on the other hand, refer to those needs that are '…centrally mandated or suggested changes or additions to teaching practice or other areas of school life' (Goodall et al., 2005, p. 171). An example given is that of new policy for teaching different grade levels. Organisational needs are those that would enable a school to function as an organisation. This is where teachers as part of the school organisation are able to work, individually or collectively, to ensure interpersonal relationships are viable and work towards completing tasks linked to achieving the school goal(s). Goodall et al (2005) have argued that there should be a balance between the different levels of needs. Even though they have not specifically discussed differences in individual teachers' needs considering factors such as gender or age as in Hustler's study above they have stressed a need to meet the PD needs of teachers. They state that 'without disadvantaging the professional development of particular members of staff, the programme of CPD offered across the school must benefit the organisation as well as meeting the policy needs which are presented to the school'(Goodall et al., 2005, p. 171). This would mean

consciously working at striking a balance, among these different types of CPD needs, even in the face of limited resources that may be allocated for CPD.

Moore & Shaw's (2000) study that used semi-structured format in interviewing 45 secondary school teachers in Canada on the other hand shows that teachers need the kind of PD that is directly relevant to their teaching practice. They state that this kind of PD incorporate aspects that relate to development of knowledge and expertise for improving classroom practices and adapting to changes, such as new curriculum and pedagogy related to their practice. In their concluding remarks, they state that teachers should remain in control of their PD agenda. This could be achieved when their individual or collective practical knowledge, understanding and expertise, inquiry and reflection inform their PD agenda.

Mansour et al.'s (2011) study on perceived PD needs for Saudi Arabian science teachers concluded that science teachers' voices concerning their PD needs should be a guide for their CPD. The study, which is subject specific unlike the other examples above, used a questionnaire to collect data aimed at identifying and exploring science teachers' needs in two main domains: science content knowledge and pedagogical knowledge and skills domains. Under these two main domains science teachers' CPD needs were linked to: generic pedagogical knowledge and skills, knowledge and skills in science subjects; managing and delivering science instruction; diagnosing and evaluating learners; planning science instruction; administering science instructional facilities and equipment; integration of multi-media technology; and informal science learning. According to this study, majority of the teachers expressed that they lacked basic knowledge and skills to teach science. Based on this, Mansour et al. (2011) urge science educators to be aware of teachers' PD needs of both pre-service and in-service teachers in order to provide the kind of training that would be aimed at meeting the identified needs.

Hambokoma et al. (2002)'s national study involving mathematics and science teachers already presented in chapter 1 shows that mathematics teachers would like CPD with a focus on mathematics content knowledge linked to difficult topics; pedagogical knowledge and skills including the use of teaching aids and their improvisation, handling pupils with poor mathematics background; and coping with heavy teaching loads and examination demands. While emphasis remains on mathematics content and pedagogical knowledge and skills like in other studies such as illustrated above, there is also reference to needs related to teachers coping with demands and pressure as associated their work contexts such as coping with heavy workloads.

Bell and Gilbert's (1996) three year mainly qualitative research project in New Zealand concentrating on science teachers' development process covers more than teachers' needs as related to science content knowledge and pedagogical knowledge and skills. This study which used multiple data collection methods resulted in the development of a model of teacher development that encompasses key aspects of professional, personal and social development. These key aspects of teacher development suggest that teachers broadly have professional, personal and social needs each of which has been discussed in detail under section 2.3.2

The preceding discussion illustrates the different needs and categories of teachers' CPD needs. This study has selected Bell and Gilbert's (1996) model for achieving teacher development as a guide in discussing mathematics teachers' CPD needs and hence CPD focus. This is because it expands on teachers' PD needs as presented on the Day's (1999) definition of CPD found useful for this study and captured in section 2.2.1 and to a large extent embraces the nature of various teachers' needs as exemplified under section 2.3.1 above. It also broadly covers the needs of teachers that face an array of challenges in their work as illustrated in chapter 1 (section 1.3) and chapter 2 (section 2.2.2.1). In addition, it has been chosen because it closely captures and illuminates what the MOE in Zambia (MOE, 1996, 2013b) has implied as areas within which teachers are supposed to deepen their knowledge and extend their skills and competences in through their CPD. These areas: '…updating pedagogical approaches, pastoral care for learners, assessment procedures, school organisation and management, and relationship with parents/guardians and the community are highlighted in EOF' (MOE, 1996, p. 116) and repeated in ZECF (MOE, 2013b, p. 60). Further, the model has been chosen because it not only captures, but also further expands on, by including areas not explored by or included on, Hambokoma et al.'s (2000) list of areas teachers (can) need further PD in. It is important to mention here that other literature (Bubb & Earley,2007; Fullan & Hargreaves, 1992; Fraser et al., 2007; Hoyles, 2010; Robertson & Murrihy, 2006; Struthers, 2007) with similar features will be referred to where and when appropriate during the discussion of each of the categories of CPD needs:-professional needs, personal needs and social needs

2.3.2 Nature of mathematics teachers' needs

2.3.2.1 Professional needs

Teachers' professional needs cover the technical knowledge and skills, with associated beliefs and conceptions required to carry out teaching activities in general and as related to a specific

subject area (Bell & Gilbert, 1996; Fraser et al., 2007; Struthers, 2007). The technical knowledge and skills being referred to here can also be called professional knowledge and skills involving '…knowledge and skills needed in order to function successfully in a particular profession' (Tamir, 1991, p. 263).

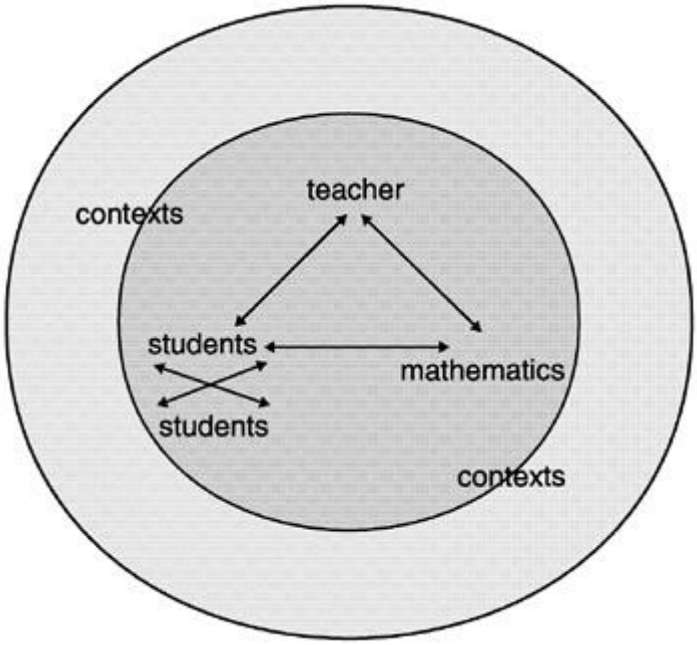
2.3.2.1.1 Teacher knowledge

Teachers' professional knowledge or simply teacher knowledge is not easy to explain (Berry, Loughran, & Van Driel, 2008) nor its boundaries easy to define (Rahman, Scaife, Yahya, & Jalil, 2010). This could be because there is a miscellany of kinds of knowledge that teachers are expected to have to prepare and enable them to teach and guide their actions in the classroom (McNamara et al., 2002). Shulman (1986, 1987) who has based much of his research work in the fields of Science and Mathematics has stipulated a framework for teacher knowledge. His work has identified seven knowledge types from which teachers can draw from during their teaching: Content Knowledge (CK), General Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Curriculum Knowledge, Knowledge of learners and their characteristics, Knowledge of educational contexts such as schools and related cultures and also Knowledge of educational purposes and values. Shulman's work on teacher knowledge has remained influential and has been used as a starting point for many other researchers' work on teacher knowledge with some suggesting some modifications (Banks, Leach, & Moon, 1999; Grossman & Richert, 1988; Nicholson, 1996), others including other dimensions of and sub-dimensions of teacher knowledge for example mathematics-specific teacher knowledge (An, Kulm, & Wu, 2004; Ball, Thames, & Phelps, 2008; Fennema & Franke, 1992; Ma, 1999; Prestage & Perks, 2000) and others still discussing it in general terms such as: Professional and personal knowledge of teachers (Tamir, 1991); Personal Practical Knowledge (Connelly, Clandinin, & He, 1997); and Technological Pedagogical Content Knowledge (TPCK) (Mishra & Koehler, 2006) thus illustrating how broad teacher knowledge can be. Each of the knowledge type mentioned above have potential to directly or indirectly influence the teaching of Mathematics, but the discussion in the next paragraphs uses some of Shulman's (1986, 1987) original teacher knowledge types, with an inclusion of knowledge required for teachers' effective social interaction with others within and beyond the school community, as a starting point as they are within the focus of the study. The next paragraphs in this section build on this.

Firstly, although all of Shulman's original seven knowledge types are of great importance, concentration here is on: CK, PCK and Knowledge of learners and their characteristics. This choice of knowledge types is consistent with the focus of this study. These knowledge types

have been usefully illustrated in Kilpatrick, Swafford, & Findell,'s (2001) report based on an 18-month study project in the United States in which relevant research on mathematics learning was reviewed and synthesised. Kilpatrick, et al. (2001) state that effectiveness of mathematics teaching '…is about a trilateral interaction among teacher, students and content' (p. 11) in particular contexts. This is illustrated on what is called an Instructional triangle, which is shown below.

Figure 2 Instructional Triangle



Source: Kilpatrick at al. (2001, p. 9)

Based on this trilateral interaction among teacher, students and mathematics, Kilpatrick et al. (2001) emphasise that to teach mathematics and teach it well the kinds of teacher knowledge essential are: knowledge of mathematics, knowledge of learners and knowledge of instructional strategies in a wide range of contexts that have a bearing on instruction. Each of these knowledge types can be discussed and debated at length but a brief presentation of each is provided below (2.3.2.1.1.1 and 2.3.2.1.1.2).

Secondly, as stated earlier, concentration on the theme of teacher knowledge is also on knowledge for effective interaction of teachers with others within and beyond the school community. This is not explicitly captured among Shulman's knowledge types, but is considered significant because it links with teachers' social needs which are an important aspect of teachers' professional development needs as earlier identified. This aspect of

teacher knowledge is introduced here and elaborated on fully under teachers' social needs (section 2.3.2.3).

2.3.2.1.1.1 Mathematics CK and PCK

According to Shulman (1986, 1987), CK encompass theories, principles, and concepts of a particular discipline. It is the knowledge that teachers have of the subject that they are teaching. The knowledge, understanding, skills and disposition that school children are to learn. Specifically, Mathematics CK includes knowledge of mathematical facts, concepts, principles, procedures, and the relationships among them, representation of mathematical ideas and knowledge of mathematics itself as a discipline (Kilpatrick et al., 2001). It is expected that teachers of mathematics should have in-depth understanding of concepts in mathematics '…not just breadth of coverage'(Loucks-Horsley, Stiles, & Hewson, 1996, p. 3). Note need to be made that having a deep understanding of mathematical content knowledge is necessary, but not sufficient to teach mathematics (Turnuklu & Yesildere, 2007) as a teacher equally needs to know how to teach the mathematical CK s/he has (Kilpatrick et al., 2001). PK in general refers to the kind of knowledge used for teaching particularly knowledge of teaching techniques, psychological principles, classroom management and organisation, and dealing with everyday task in the teaching and learning processes (Shulman, 1987). PCK is basically a combination of CK and PK unique for a particular group of teachers of a particular subject area. Though it has been modified and expanded on (Hurrell, 2013), PCK can essentially be regarded as the kind of knowledge that teachers need to make content learnable. According to Shulman (1986) PCK '…also includes an understanding of what makes learning of certain concepts easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning'(p. 9). This basically suggests that knowledge of learners is partly covered under PCK. However, Shulman still includes knowledge of learners and their characteristics (KLC) on its own as an independent teacher knowledge type suggesting that there is more to knowledge of learners than is covered under PCK. KCL is further expanded on in the section below (See section 2.3.2.1.1.2).

Based on the description of subject CK and PCK presented above, it can be deduced that the two knowledge types are interdependent within the teaching context. The literature (Peressini, Borko, Romagnano, Knuth, & Willis, 2004; Kilpatrick et al., 2001) states that Mathematics CK and PCK and skills cannot be disjointed as developing PCK in mathematics requires knowledge of mathematics content. This implies that the kind of CPD designed or available for teachers of mathematics must account for the mathematics CK teachers have and

what it could take to deliver it to the learners at levels that can easily be handled by them at each different grade level.

2.3.2.1.1.2 Knowledge of learners and their characteristics (KLC)

As earlier cited, teaching is '…about a trilateral interaction among teacher, students and content' in particular contexts (Kilpatrick et al., 2001, p. 11). However, despite this important relationship and interaction, KLC is not a commonly emphasised feature of CPD as is subject CK and PCK (ACME, 2011; Goodall et al., 2005; Guskey, 2003; Hoyles, 2010; Timperley et al., 2008). What does knowledge of learners and their characteristics entail? KLC is regarded as an understanding of learners and their cognition, motivation and development and how these could be used to inform, specialise or adjust instruction (Kilpatrick et al., 2001; Rahman et al., 2010; Shulman, 1987). Further, in the context of mathematics teaching and learning, knowledge of learners also includes knowledge of learners' personal mathematics knowledge and (mis)conceptions that enables learners to respond to mathematical questions and tasks the way they do (Prestage & Perks, 2000). It also covers how learners learn the mathematics subject matter, and possible signs of learning or confusion as learners learn the subject matter (Kennedy, 1998). Having a solid knowledge of learners and their characteristics is justified as illustrated below.

One such point is that Mathematics is a compulsory subject at school level in most if not all countries in the world including Zambia. This is partly because of its potential benefits to individual learners, communities and the nations at large (UNESCO, 2012b). Offering Mathematics as a compulsory subject to a certain extent works with an underlying assumption that that all learners, no matter the existing differences among them, have the potential to learn mathematics although this may be with the idea that they gain varying degrees of competency and proficiency in the subject. What this implies to a teacher of mathematics is that they have 'to remain committed to the concept that children can and should learn mathematics'(Loucks-Horsley et al., 1996, p. 3). Being committed to this concept implies acceptance that they have to remain sensitive to the diverse learning characteristics and needs of the individual learners and how these could be addressed in order to facilitate the learning of Mathematics.

The other point is that teachers are faced with the responsibility to manage and teach a diverse populace of learners (Banks et al., 2005; McNamara, Jones, & Murray, 2014) and a solid knowledge of such diversity of learners and their characteristics is relevant in fulfilling this role. Learners are heterogeneous in many ways than one. They are different in terms of their

backgrounds, ages, developmental stages, learning styles and intelligences, abilities, motivations and interests and even in the way that they respond to classroom proceedings, activities and teaching strategies (ACTEQ, 2003; Day, 1999; OECD, 2009; Rahman et al., 2010). Each of such varied learner characteristics have potential to influence learners' behaviour, ability to learn or implement instruction in their mathematics lessons. It is for this reason that an understanding of the various learner characteristics, developmental stages or learning needs is crucial for creating meaningful mathematics learning environments which aim at meeting learners' mathematical needs (see section 2.3.5.2.2).

This section has discussed mathematics teachers' professional needs as presented in the context of teacher (professional) knowledge and skills. There is an acknowledgement that teacher knowledge is broad, multifaceted and dynamic. The summary of the above discussed professional needs of teachers of mathematics lie in the knowledge and skills linked to teachers' knowledge of mathematics CK, PCK and KLC. Teachers in the present age need much more than deep and thorough subject CK and PCK, but also need knowledge of learners and their characteristics for them to be life coaches for the learners, promote holistic development of learners and at the same time implement and make curriculum relevant to the learners (Margo, Benton, Withers, Sodha, & Tough, 2008). An understanding of teachers' professional needs should inform the design and focus of CPD. The goal here is not to indoctrinate teachers but to empower them with the knowledge that could help them make sound judgment pertaining to adopting or adapting teaching strategies to suit their context. As Shulman (1987) argued:

The goal of teacher education… is not to indoctrinate or train teachers to behave in prescribed ways, but to educate teachers to reason soundly about their teaching as well as to perform skilfully. Sound reasoning requires both a process of thinking about what they are doing and an adequate base of facts, principles and experiences from which to reason. Teachers must learn to use their knowledge base to provide the grounds for their choices and actions(p. 13)

2.3.2.2 Personal needs

Teachers' work requires teachers' emotional and intellectual investments from teachers that 'draw upon personal and professional capacities and experience, knowledge and skills' (Day et al., 2006, p. xii). This suggests that teachers have personal needs, in addition to professional needs, which CPD could address and thereby help teachers to function at their best and remain inspired and vital even in the face of challenges and the harsh realities of teaching (Intrator & Kunzman, 2006) in general and teaching mathematics in particular especially in resource-constrained personal social and economic contexts. Fulfilling personal

needs could contribute to personal growth. Using and adapting Bell & Gilbert's (1996) description of personal growth to suit mathematics teachers, personal growth includes: constructing and evaluating what it means to be a teacher of mathematics; managing feelings toward change process as it relates to teaching and learning of mathematics; dealing with pressures and stress; understanding own work as teachers in general and teachers of mathematics in particular; and taking responsibility for their own growth and development as teachers. It can be deduced that this description of personal growth in itself points to mathematics teachers' personal needs. Personal needs could also be described in connection with emotional intelligence. (Day (1999). Emotional intelligence can include abilities such as self-awareness, self-motivation, empathy and managing tensions or emotions and being able to manage relationships with others (Goleman, 1995). Other examples of personal needs include: managing work/life balance; being able to coach the best out of people; effectively managing tensions faced by teachers in a classroom setting; self-confidence; being resilient; and being able to build rapport and inspire (Struther, 2007; Intrator& Kunzman, 2007) all of which can be beneficial for teachers of mathematics. The above exemplify the point that teachers are people with inner lives, human qualities and needs (Goodson, 1994; Intrator& Kunzman, 2007) that CPD could fulfil too. However, these are generally overlooked or unacknowledged aspects in CPD initiatives. This is possibly because some of them could be viewed as being less directly related to the actual classroom practice, even though ultimately they can contribute to improvements in teachers' classroom practices (Goodall et al., 2005). This could especially be the case in the common traditional stereotype of mathematics teachers as those merely being in need of technical knowledge and skills.

2.3.2.3 Social needs

Schools, where teachers work, are social structures comprising young people who need to learn, staff who have to teach and/or support learning, parents/guardians and the wider communities which the schools have to serve (McNamara et al., 2014). For teachers to work in such a social system there are social practices that they need to engage in and multiple roles that they need to perform and therefore needing the relevant social and inter-personal skills to function. Bell & Gilbert (1996) add that even though teaching is an individual activity, it is practiced in public and is a social activity governed by some set of rules and regulations to meet expected standards. A point to which Day (1999) adds when he states that '...successful teaching will always demand both intrapersonal and interpersonal skills…'(p. 2). From this premise, it would be argued that teachers have social needs which could be in the form of knowledge and skills to enable them: construct and '…reconstruct socially acceptable roles

and views…' (Kyeongsoon, 2013, p. 31); establish and maintain meaningful working relationships with fellow teachers (within and beyond one's school), with individuals or groups of individuals of similar or different professions and professional backgrounds, pupils and others among them parents, guardians and education officials; consider, value and actively engage in collaborative work with others (Kyeongsoon, 2013) for effectiveness in their work; and know how and when to draw on advice and specialist support' (Chambers & Timlin, 2013, p. xv).

TDA (2009a, 2009b) has identified ways of working with others, which teachers are supposed to be aware of and which are worth referring to at this point. These include: (i) Communicating effectively (formally or informally) with colleagues (in the same or different departments), administrators, parents/guardians and other relevant stakeholders or professionals; (ii) Recognising and respecting the contributions that colleagues, administrators, parents/guardians and other stakeholders or professionals make towards pupils' wellbeing and towards raising the levels of attainment of pupils in particular subject(s); and (iii) Identifying and seizing opportunities for working with colleagues, administrators, parents/guardians and other stakeholders or professionals for learners' wellbeing. Such ways of working can contribute toward creating and sustaining positive school climate. Wong (2003) also adds that maintaining helpful and meaningful working relationships with colleagues not only improves pupil learning but also improves the school climate. Therefore, implying that good working relationships with others can have an impact not only on teachers' work lives, but also on learners and school development.

Thair & Treagust's (2003) review of a PD programme in Thailand also suggest that teacher PD approaches need to pay attention to how to establish '… social interaction processes between teachers, head-teachers, principals and education department personnel…' as these would positively reinforce the intended outcomes of a PD approach (p. 210). Such social skills for successful social interactions can be developed through CPD. Therefore, CPD initiatives, their focus and pedagogy may need to recognise teachers' social needs and create an environment where such needs are addressed and where the required knowledge and skills to promote social growth are enhanced.

In this section, mathematics teachers' CPD needs have been examined. The model put forward by Bell & Gilbert (1996) has been used to give structure to this review while also considering other research studies in the discussion. The argument is that teachers have intricately linked professional, personal and social needs that CPD could fulfil. Even though

it can be a challenge to meet these needs, especially the personal and social needs, all the three categories of needs are significant to teachers' work lives and all deserve attention in the discussion on mathematics teachers' CPD and CPD needs. It is worth noting that since teachers are a heterogeneous group, different teachers and different groups of teachers are likely to have different needs and/or different combination of needs. The needs themselves are likely to differ in complexity and in terms of level of importance and intensity (Hawes & Stephens, 1990). CPD activities and initiatives may need to recognise this reality. CPD may also need to be conceptualised in such a way that it is as responsive and relevant to teachers' individual and/or group needs, concerns and aspirations as it could possibly be.

2.3.3. Needs assessment in the CPD context

Identifying and evaluating teachers' CPD needs is important in deciding which CPD activities would be the most beneficial in teachers' particular situation (Villegas-Reimers, 2003). If teachers' CPD needs are not known, then the focus of CPD may be considered inadequate, not targeted or not appropriate for the targeted teachers. Needs assessment in the CPD context can be described as a systematic process of identifying and examining perceived areas of need, in the form of knowledge or competence gaps or lack, of individual or group of teachers, that CPD could address (Igarashi, Suveges, & Moss, 2002; Stufflebeam et al., 1984). With reference to Zambia, Kenya and Malawi, Banda (2011) has stated that there is a dearth of knowledge concerning the determination of content of CPD. In such instance, needs assessment can help in determining the CPD content for the teachers. Once successfully conducted, needs assessment can provide guidance in the decision making process regarding CPD planning and implementation (Stufflebeam et al., 1984). It can also increase the chances that CPD would be closely linked to teachers' needs in relation to their teaching practices and it in itself can act as a boost to learning as identifying a need can be motivation enough to participate in CPD to meet that need.

Assessing teachers' CPD and learning needs can be conducted at different levels such as at national level, school level and individual teacher (self-perceived) level. Even though there is no one correct way of conducting needs assessment, whichever method is chosen should be appropriate to the issue and situation at hand (Igarashi et al., 2002). The means for collecting data on teachers' CPD needs in literature (Bubb & Earley, 2007; Grobler, 2005; Igarashi et al., 2002; Komba & Nkumbi, 2008) include: teachers reflecting on or evaluating their teaching practices possibly through the use of the SWOT (Strengths, Weaknesses, Opportunities and threats) analysis; asking teachers themselves what their perceived needs are

through interviews or questionnaires; and/or through feedback from pupils as it pertains to teacher instruction and tasks. Teachers can exercise autonomy (see section 2.3.4 below) in identifying their own CPD and learning needs through reflection within the total context of their own teaching practice bearing in mind: the nature of the subject they teach; (anticipated) changes or developments in the area of their teaching subject and the needs of the learners; and the demands and expectations of the school system and the teaching service as a whole. Their ability to do so depends on; their ability and the level to which they can carry out a self-evaluation; the influence and support of school leadership; as well as the school culture (Komba & Nkumbi, 2008). One of the concerns raised in relation to the effectiveness of CPD needs identification and assessment by teachers themselves is that teachers may not know or may not be capable of recognising or may be unaware of what their CPD needs were (Bubb & Earley, 2007; Igarashi et al., 2002). This limitation of self-perceived CPD needs assessment can be offset by other needs assessment methods (Igarashi et al., 2002) such as knowledge tests or others as may be designed by the CPD supervisors, providers or managers.

The other means of identifying teachers' CPD needs is through use of school-based supervisors including CPD coordinators, HOD and non-school-based personnel such as the use of external (subject) experts or officials within the education system. Such personnel may obtain information on teachers' CPD needs through structured teacher observation and/or use of structured assessment procedures, which may include questionnaires or individual teachers' work plans. It is possible that their views or theoretical knowledge of what is considered as common deficiencies in the teaching practice and also what is considered as what effective teachers should be able to do are likely to stand out in the process of teachers' needs identification. In fact, there is a possibility that their findings can be deemed as detached from the realities and complexities of actual teaching practice as can be dictated by specific contexts. Such occurrences can be minimised when their findings concerning teachers' needs are verified.

It is important to note here that while it is possible that teachers' perceived CPD needs can be similar to the needs identified by CPD school-based on non-school based supervisors, there is a likelihood that teachers' perceived CPD needs would differ substantially. Examining the relationship between CPD needs identified by a teacher or teachers and those identified by supervisors can inform action toward meeting the needs.

This section has discussed needs identification and assessment. It has concluded that needs identification is an important aspect of planning and implementing CPD activities and initiatives. Teachers and CPD supervisors, providers, managers and supporters have a role to play in identifying CPD needs and also in ensuring that CPD activities and their focus are relevant to and focussed on meeting the identified needs.

2.3.4 Teacher autonomy in the context of CPD

Who is responsible for teachers' CPD? It is generally assumed that a nation's or national government education officials are responsible for teachers' CPD (Padwad & Dixit, 2014). While it is true that government officials have a role to play in teachers' CPD, teachers have a role to play too. Teachers have a responsibility towards their own CPD. The question is: Do they realise they have such a responsibility and control over their CPD? This leads to the discussion of the notion of teacher autonomy in the CPD context.

There are various definitions for the concept of teacher autonomy in literature (Wilches, 2009). However, some of the elements of what teacher autonomy entails are: 'teachers' willingness, capacity and freedom to take control of their own teaching and learning' (Huang, 2005, p. 4); teachers taking responsibility for their own learning and remaining accountable (Wermke, 2013); and also teachers being able to exercise professional discretion, right to use initiative and remain committed to the principles and laws within the education community (Ballou, 1998; Wilches, 2009). Wilches (2009) argues that there are four different domains where teachers can exercise their autonomy: teaching and assessment; curriculum development; school functioning; and PD. Teacher autonomy is a changeable condition that varies across the identified four different domains of teachers' decision making identified above. While teacher autonomy in all the four domains identified is important to discuss, only the aspect of teacher autonomy in the CPD context will be elaborated on for this study.

In literature (such as; Bell & Gilbert, 1996; Dymoke & Harrison, 2006; Wilches, 2009) exercising teacher autonomy in the context of PD can be demonstrated in: (i) teachers being able to take some degree of control of the PD agenda, which can be a part of, or in addition to, the agenda which the government has for teachers' development (such as successful implementation of the curriculum); (ii) teachers having access to and participating in a range of PD activities depending on their needs in an effort to improve their professional competence and knowledge; and (iii) teachers having a say in the content and process of PD initiatives. It is argued that PD experiences are better received by teachers and have a greater impact on teachers' performance when the topic(s) under discussion relate to the teachers'

concerns, interests and identified needs (Dymoke & Harrison, 2006; Wilches, 2009). This could imply that in a case that teachers cannot or are not able to identify their needs, there should be a way of guiding them, empowering and supporting them in identifying their CPD and learning needs.

Pearson and Moomaw (2005) note that teachers can view autonomy differently. While being aware that what seem like teacher autonomy to one teacher might not be so to another because teachers are different and they perceive or exercise autonomy in different ways depending on factors such as their needs, interests, competences, and areas of expertise, it remains justifiable to ask the question: To what extent can teachers act autonomously in their PD? If teachers are to actively develop as professionals then they should be involved in making decision regarding the goal, direction, vision and processes to facilitate their personal learning and development (Day, 1999). Otherwise it is possible that those from the top can direct teachers, without the teachers themselves having to exercise any degree of autonomy regarding their PD. Thus in designing and implementing CPD initiatives it can be considered appropriate to ask as Dymoke & Harrison (2006) ask: to what extent is teachers' autonomy encouraged? Teachers can comply with demands imposed on them regarding their CPD, but stifling teacher autonomy is detrimental not only to their professional growth but also to their teaching practice. Among the effects of stifling teacher autonomy are that it can impede teachers' ability and creativity and can be a disservice to the teachers who are being encouraged to engage in promoting learner autonomy in the context of learner-centred teaching (Tort-Moloney, 1997). An environment where teachers' freedom and ability to act independently is supported, where direction or guidance that is informational instead of controlling is provided can be the kind of autonomy supportive environment (Deci & Ryan, 2002; Knight, 2007) that is needed in the CPD context.

Wilches (2009) has summarised the factors that can have a constraining effect on the way teachers exercise their autonomy to include: contrived PD, lack of time, contrived collegiality, teachers' problematic interrelationships, excessive workload and lack of support from administrators which could manifest in imposing tasks or offering no support or pressure for continuity. The extent to which these factors affect teacher autonomy in a given context may need to be assessed and actions to address or redress be taken.

This section has discussed teacher autonomy in the context of CPD. The main ideas of the discussion relate to teachers being able to exercise some level of autonomy within the principles and guidelines of the education system within which they work and teachers having

a sense that CPD is something that can be within their control. The other idea relates to enablement of a 'teacher autonomy supportive environment' that would contribute toward increasing teacher autonomy in identifying their CPD needs and also in deciding the CPD activities that have potential to meet perceived needs.

2.3.5 Factors influencing mathematics teachers' CPD needs

Based on literature (Bell & Gilbert, 1996; Borko & Putman, 1996; Huberman, 1989; Hustler et al., 2003; Knight, 2007), there are several factors that can have an influence on teachers' CPD needs. Among the factors that can influence mathematics teachers' CPD needs are: teacher factors (such as teachers' stage within the professional life cycle, years of teaching experience, teachers' affective traits and disposition, teachers' demographic factors and characteristics and the grade level teachers teach), learner factors (such as learners non-subject specific needs, learners mathematics subject specific needs and learners' affective traits and disposition) and school factors (such as school development needs and school resources). Each one of these are discussed below in general terms and with reference to mathematics teachers whenever possible

2.3.5.1 Teacher-level factors

2.3.5.1.1 Teachers' professional life phases

Teachers pass through different stages in their career. Understanding teacher development stages can help in providing CPD appropriate and relevant to meeting the different CPD needs of teachers at their different career stages. There are several models (Day et al.,2006; Fessler, 1985; Huberman, 1989; Steffy & Wolfe, 2001) that explain and illustrate the professional life cycle of teachers. However, this section makes use of Day et al.'s (2006) model based on a 3-year study focusing on work lives of 300 primary and secondary teachers in different schools across England using mixed methods and whose scope is considered internationally unique as a basis in guiding the discussion as it is useful in linking ideas relevant to the focus of this study. The discussion at the same time makes reference to other related relevant literature where appropriate.

Day et al.'s (2006) state that professional life phase ' refers to the number of years a teacher has been teaching' (p. 82). They explain that even though years of teaching experience are generally closely related to teacher's age, there are some teachers who have less experience than they may be expected for their age because of starting their teaching career late or because of taking a break from their career. Based on Day et al.'s (2006) study six professional life phases were identified: 0-3; 4-7; 8-15; 16-23; 24-30; and 31^{+} and further

categorised into subgroups. Accordingly, the key characteristics of the six professional life phases and subgroups and are:

- Professional life phase 0-3-commitment: support and challenge,
- Professional life phase 4-7-identity and efficacy in classroom,
- Professional life phase 8-15- with characteristics of managing changes in role and identity with the two subgroups being sustained engagement or disengagement,
- Professional life phase 16-23-worklife tensions: challenges to motivation and commitment,
- Professional life phase 24-30-challenges to sustaining motivation,
- Professional life phase 31^{+}-sustaining/declining motivation, ability to cope with change, looking to retirement. The two subgroups characterised by maintaining commitment or tired and trapped.

While retaining the characteristics of the original phases the above phases have been regrouped broadly into three phases simply as newly qualified and early career stage 0-7, mid-career 8-23 and late career stage 24^{+} in the discussion on how different career stages have (not) influenced teachers' CPD needs.

It has been noted that even though some teachers can experience going through these stages as they are presented, others can return to some phases, miss some or remain in a particular phase without transitioning (Day et al., 2006; Huberman, 1993). Further, teacher effectiveness does not necessarily grow in relation to teachers' years of experience (Day et al., 2006). However, what is clear from the different career stages is that teachers still need to continue learning through the different stages of their career. What is likely to be different and to change over time in their career are their CPD and learning needs and concerns. In the UK for instance, Boyle, Lamprianou and Boyle's (2005) longitudinal study investigating the influence of PD on the effectiveness of teachers involving a national sample of primary and secondary teachers found that novice and experienced teachers had differentiated needs. It can be implied that such differences in teachers' CPD needs depending on their career stage can also influence their choice and preference of CPD activities to engage in. This is consistent with Ritcher et al.'s (2011) argument that '…teachers tend to choose activities that reflect the demands or professional goals of the career stage they are in'(p. 119). It can

therefore be concluded that the design and plan of CPD activities may need to take into a consideration the teachers' various and diverse needs as may be dictated by their stage on the teachers' professional life cycle. Guskey (1994) asserts that a mixture of CPD experiences taking into account teachers' career life phases qualifies to be effective PD.

2.3.5.1.2 Teachers' level of experience

The levels of experience of teachers in the different career stages are obviously different. With more years in the service of teaching it is expected that teachers would: have a rich knowledge base, be able to make sound judgment on teaching practices based on past experience, be able to solve a wide range of teaching problems, and have better understanding of learners' needs and learner' learning compared to novice or newly qualified teachers (Mahmoudi & Özkan, 2015; Richards & Farrell, 2005). While it is possible for a teacher to have taught for several years but still not meet the above presented standards or characteristics of experienced teachers, based on these characteristics it can be deduced that experienced teachers' CPD needs and aspirations are likely to be different from the newly qualified or novice teachers' needs. A similar conclusion is made by other academics such as Komba & Nkumbi (2008) and Mahmoudi & Özkan (2015) whose study findings show that both experienced and novice teachers in their study benefitted from CPD activities, but of different types depending on their needs and aspirations.

Experience also has a way of affecting teachers' receptivity to new ideas regarding the teaching and learning. Literature (Borko & Putman, 1996; Huberman, 1989; Knight, 2007) has shown that teachers' learning and approaches to learning, attitude, and receptivity toward change are affected by their experience in teaching. It has further shown that experienced teachers can be more resistant to change compared to the newly qualified teachers (Borko & Putman, 1996). It is probably because experienced teachers are assumed to possess more content knowledge and skills for responding to and managing pupils, that they can be more resistant to change of instructional practices for instance, compared to newly qualified teachers with arguably only subject content knowledge, theoretical knowledge of teaching and no professional experience and experience of realities and complexities of the teaching process. This has potential to affect experienced teachers' choice of instructional methods and approaches to implement in their classroom and their own learning (Knight, 2007) and choice of or receptivity to CPD activities or initiatives.

Though there may be exceptional cases, already serving teachers with the necessary experience might generally also be given additional responsibilities such as being a mentor or

taking up an administrative role, as deemed fit by school administration. They therefore would require CPD with focus on empowering them knowledge and skills to enable them function and execute their duties professionally as such. This is consistent with Schibeci & Hickey's (2003) work that states that teachers should be involved in a variety of CPD related to their diverse roles and needs.

2.3.5.1.3 Teachers' affective traits and dispositions

Teachers' affective traits and dispositions can influence teachers' CPD needs, teachers' approach to CPD and/or enhance or constrain teacher learning through CPD. Philipp (2007) defines 'affect' as '…a disposition or tendency or an emotion or feeling attached to an idea or object(p. 259). McLeod (1992) in his seminal chapter 'Research on affect in Mathematics: A reconceptualisation' states that 'the affective domain refers to a wide range of beliefs, feelings, and moods that are beyond the domain of cognition'(p. 576). It can be inferred that the main inter-related components of the affective domain as they relate to mathematics teaching and learning are: Beliefs, attitudes, emotions and feelings. Other components include: 'confidence', 'self-concept', 'mathematics resilience' (Johnston-Wilder & Lee, 2010; McLeod, 1992; Philipp, 2007) and 'values' (Bishop, 2001; DeBellis & Goldin, 2006).

Even though the teaching and learning of Mathematics is viewed principally as cognitive and 'purely rational', 'values-free', and without affective traits and dispositions playing any role in its learning or teaching (Bishop, 2001; DeBellis & Goldin, 2006) discussion on mathematics learning is likely to touch on issues which are affective in nature. Mathematics teachers' CPD too is likely to be influenced by issues that are affective in nature. Examples of such issues include: motivating and sustaining learners' interest in learning mathematics; dealing with frustrations associated with teaching mathematics especially in cases of poor pupil performance; teachers remaining confident and viewing themselves as capable of teaching mathematics; remaining interested and interesting in as far as mathematics teaching and learning is concerned; coping with personal experiences, heavy workloads, associated stress and increasing demands and expectations on them amid concerns of pupils' poor performance in Mathematics. This illustrates that there is an interaction between cognitive and affective domains that has to be acknowledged in Mathematics teaching and learning circles (Carroll, 2005; McLeod, 1992). Even with the methodological difficulties in the design and carrying out of studies on affect and its impact (DeBellis & Goldin, 2006), the impact of affective factors in teaching mathematics can be assumed or viewed from the perspective that teachers' beliefs, values, attitude, emotions and feelings about mathematics can influence the mathematics they teach and how they teach it which can, in turn, influence

learners' beliefs, values, and feelings about mathematics (Keast, 2001; Philipp, 2007; Stipek, Givvin, Salmon, & MacGyvers, 2001).

2.3.5.1.4 Teacher demographic factors and characteristics

The relationship, or lack of it, between teachers' perceptions of or participation in CPD, teachers' perceived CPD needs and teachers' demographic factors such as age or age groups, gender and educational qualifications has been explored at different levels in literature (Hustler et al., 2003; Muijs et al., 2004; Richter et al., 2011). For instance, qualitative and quantitative data from a study by Hustler et al. (2003) found that there were differences in the way that teachers valued their in-service training depending on their age, level of education and gender. Teachers' differences in terms of age or gender or level of education in itself suggests that their needs, aspirations and concerns are likely to vary in light of their demographics. This is further illustrated in the paragraphs below.

There is a relationship between teachers' educational background and teachers' perceived competences. Knight's (2007) quantitative study involving public elementary school learners, teachers and literacy coaches in Texas shows that educational background is linked to '…teachers' perceived competence and self-efficacy'(p. 67). While what constitutes teacher competence is complex to define and differ in different contexts, it can generally be described in terms of teacher knowledge, understanding, skills, experiences, values and attitudes linked to effective performance of tasks and solving problems (EC, 2013; Roelofs & Sanders, 2007). If teachers perceive that they are competent in one or more of the areas and not the others, whether as a result of their educational background and/or teaching experiences then they are likely to focus more on the CPD that concentrates on areas in which they may feel they are deficient in or areas that they require professional growth in.

Based on Richter et al.'s (2011) quantitative analysis of findings from a study involving secondary school teachers of mathematics and other subjects in German, older teachers showed reduced participation in in-service training and high selectivity of CPD focus. While this can be attributed to the teachers' career stage or years of experience it can also be attributed to their age too. It can be assumed that the older a teacher gets the closer they get to retirement and may be more inclined to commit to activity related to preparing for retirement than to improving their teaching practice through in-service With reference to CPD content, Richter et al.'s (2011) study suggest that older teachers may need to have chances to learn the topics that they did not cover during their initial training. These topics could include aspects of technology and technology use to enhance teaching/learning experiences which were

probably not a focus at the beginning or early stage of their teaching career. Therefore, suggesting that this might increase the chances of older teachers engaging more and actively in CPD. However, this might equally apply to younger teachers who may not have covered topics such as the above during their initial training. This point applies especially in the light of curriculum changes.

2.3.5.1.5 Grade level teacher teaches

There are mathematical traits and capabilities, such as making sense of mathematical problems and persevering in solving them which are needed by all pupils to help them be successful in their pursuit of mathematics (Hall, Bush, & Lacefield, 2015). At the same time, there are equally mathematics instructional practices and strategies such as memorizing rules, procedures, facts, allowing for pupils to explain their answers, and development of problem solving skills (Hall et al., 2015; Isac, DaCosta, Araujo, Calvo, & Albergaria-Almeida, 2015) aimed at improving conceptual and procedural understanding of mathematics that apply to all grade levels but are at varying depths and emphasis depending on the grade levels. In addition, mathematics content varies across grade levels, but with certain topics, such as Algebra, continually revisited and further developed. Based on this, it is concluded that teachers should have an understanding of the general 'pace and growth expected of pupils'(Hall et al., 2015, p. 216) throughout their secondary education. They should renew the common core mathematical content and expected common core mathematical practices (Hall et al., 2015) and then also focus on the depth and breadth of content level and instructional practices applicable to the grade level they are teaching. Vartuli's (1999) mixed methods study in the US, though with a focus on exploring how early childhood teachers' beliefs relate to classroom practice, shows that teachers' view of what is considered good teaching practices and actual instructional practices were different across and within grade levels that teachers taught. This can lead to the conclusion that teachers' CPD needs also can be shaped or influenced by the grade level(s) they are teaching.

Although there may still be need for further examination of this hypothesis, it can at this moment be concluded that CPD content and instructional approaches should reflect the differences that exist between experiences of teachers who teach different grade levels at secondary school level(s).

2.3.5.2Learner-level factors

2.3.5.2.1 Learners' non-subject specific needs

Learners' non-subject specific needs include: physical development needs, affective needs, social and general education-related needs (Bastable & Dart, 2007), some of which are beyond the control of the teachers and the schools to meet, but can influence pupils' learning in general and their learning of mathematics in particular. Such learner needs have potential to influence learners' behaviour and ability to learn or implement instruction. Understanding the varied dimensions of learners' needs can lead to an understanding of the learning levels they have reached and how these could be channelled towards helping them learn subject specific concepts. It could also guide teachers in adopting or adapting different ways of teaching to suit the learners and above all in creating meaningful learning environment for the learners in question. For example, for some pupils the issue may be not understanding of concepts being presented, while for others it could be a misunderstanding of the same concepts presented, or simply inability to concentrate on what is being taught and for others still it could be seeking too much attention from either the teacher or fellow learners. Since learners, whether in the same grade level or not, are generally a heterogeneous group the design and plan for lessons would be assumed to be more complex in nature that it would have to be made to meet the learners diverse needs (Bastable & Dart, 2007).

'Effective teaching is fundamentally about starting from where the pupils are and taking them a step further in their knowledge, skills or understanding' (TDA, 2009b, p. 38). This could be where pupils are in terms of mathematics -specific knowledge and skills or could be in terms of their social and emotional development. Based on data collected from three surveys carried out in the EU regional countries, it is concluded that learners' social and emotional development and wellbeing is as essential as their acquisition and mastery of mathematical knowledge and skills in a mathematics class (Isac et al., 2015). The content of teachers' CPD activities therefore may need to reflect this aspect and empower teachers with the knowledge and competences to meet such pupil needs. Teachers' participation in CPD activities can also in itself be because of their understanding of pupil needs and their role in meeting their needs.

2.3.5.2.2 Learners' mathematics-subject specific needs

The nature of mathematics demands that learners' specific mathematical needs, which are additional to learners' general educational needs, are identified (ACME, 2011). Based on the Advisory Committee on Mathematics Education (ACME)'s two-year project in the UK that

investigated what school-age students needed to be effective learners of mathematics, the mathematical needs of learners were classified as: to be proficient in mathematics, to learn learning mathematics well and to engage successfully in mathematics lessons and others (ACME, 2011). The details under each category have been summarised in Table 3 below.

Table 3 Summary of learners' mathematical needs

To be proficient in mathematics, learners need:
• procedural recall, accuracy and fluency in familiar routines. • to develop procedural, conceptual and utilitarian aspects of mathematics together. • the ability to interpret and use representations. • a range of mathematical knowledge and experience. • strategies for problem-solving and hypothesis-testing, including working with current digital technology. • mathematical reasoning. • appreciation of the purpose and usefulness of mathematics and willingness to use it.
To learn mathematics well, learners need:
• to become aware of, familiar with, and fluent in connections in mathematics. • to accumulate mathematical ideas. • to have multiple experiences of mathematical ideas. • time to develop the mathematical confidence to tackle unfamiliar tasks. • to recognise the common ideas of mathematics. • to learn how to listen to mathematical explanations.
To engage successfully in lessons, learners need:
• to read, talk and interpret mathematical text. • to have a sense of achievement. • to use feedback from tasks and results. • to have good-quality explanations (images, representations, language, analogies, models, illustration). • to have explanations that incorporate past knowledge, including familiar images, notations and mathematical ideas. • teachers who understand the need to avoid unhelpful conceptions from particular examples, images and language. • to base new learning on earlier understandings. • teachers who push the boundaries of conceptual understanding.
Learners also need:
• teachers who have sound mathematical, pedagogical and subject-specific pedagogical knowledge.

Source: Adapted from ACME (2011)

Learners' mathematical needs as summarised in the Table 3 above are basically self-explanatory. They, however, raise some issues worth pointing out here. Firstly, the above stated ACME initiated-project to find out what learners' different dimensions of mathematical needs were was conducted in the UK, a developed world and thus suggests that this may or may not be representative of what the mathematical needs of learners in the developing world would be. However, the above summary gives an idea of what learners' different levels of mathematical needs are or can be in terms of what learners need in order to engage successfully in mathematics lessons, to learn mathematics well and to be proficient in it. What may need to happen is where a study such as this one conducted in the UK could be done for a developing country such as Zambia to ascertain the mathematical needs of learners there. In the meantime, teachers may need to find a way of determining whether the needs presented above apply to their context and how they can apply. Teachers will then have to work within their present context, with and apparent constraints and make good use of available resources in order to meet those needs (ACME, 2011).

Secondly, some of the mathematical needs of learners '…can and will vary as they go through different phases of education. It is therefore important to look at learners' typical experiences at different stages of schooling to draw attention to some of the social and emotional, as well as cognitive, factors that may affect their learning of mathematics' (ACME, 2011, p. 15). Effective CPD needs to equip teachers with a broad and solid teacher knowledge base and skills to enable them to teach effectively and meet learners' needs.

Thirdly, learners' mathematical needs, whichever way they are grouped, can be met by teachers with appropriate skills and comprehensive and thorough Mathematical subject content knowledge, subject-specific pedagogical knowledge as well as other relevant knowledge types (See section 2.4.3.1). Initial teacher training education can inform pre-teachers with some of the learners' needs, however, not all of them can be learnt or understood through it, but can be revised, renewed or updated through CPD. It can therefore be deduced that it is not possible to separate learners' needs from the PD of and PD needs of teachers (ACME, 2011).

2.3.5.2.3 Learners' affective traits and disposition

Learners' affective traits and dispositions have potential to influence teachers' CPD needs in more ways than one. To start with, an attempt is made to show how learners' affective traits and dispositions are represented. Firstly, learners hold certain beliefs about mathematics and its nature, the teaching of mathematics and about themselves as learners of mathematics

(McLeod, 1992). They hold certain beliefs about mathematics teachers too. A common view is that, despite its importance, mathematics is generally believed to be boring, too abstract and not practical and meant for a selected few with special abilities. Secondly, learners also experience positive or negative emotions as they learn mathematics (McLeod, 1992; Philipp, 2007; Stipek et al., 2001). Emotions can be demonstrated in the way learners handle mathematical tasks. For instance, they could experience joy or frustration as they work out certain mathematical problems.

Thirdly, learners can develop positive or negative attitudes towards mathematics or some aspects of mathematics during their learning of the subject (McLeod, 1992). Attitudes, positive or negative, once reflected on and acted upon repeatedly can translate into values (Swan, 2014). Learners, to different degrees, bring to mathematics classroom how and the way they value (or not value) mathematics and how it is (to be) taught or not be taught. Their value of mathematics and its pedagogy can influence their engagement in mathematics lessons and consequently performance in the subject. The fourth point is that learners' AN and experiences could also be linked to their preferences or enjoyment or like/dislike for and of certain ways of teaching/learning of certain topics in Mathematics.

Teachers are expected to be aware of the affective issues affecting learners, such as illustrated above, and how they can be managed so as to enhance mathematics classroom instruction and/or learners' performance and attainment in the subject (Carroll, 1998, 2005). This can be accomplished through teachers' engagement in CPD sessions with a focus on learners' affective traits and dispositions toward mathematics and mathematics learning.

2.3.5.3 School-level factors

2.3.5.3.1 Teachers' professional development needs vs school development needs

While investigating secondary school mathematics teachers' perspectives on whether current CPD meets their CPD needs, the researcher is aware of the existence of different levels of seemingly competing CPD needs: institutionally (school) driven needs[5], nationally determined priorities as well as teacher-driven needs which have been identified in the literature (Brown, Edmonds, & Lee, 2001; Burns, 2005; Goodall et al., 2005). The argument

[5] School development needs can be shaped by school contextual factors and externally by nationally determined priorities and needs such as curriculum implementation.

here is that even though the needs appear to be competing there could be a way by which they could be reconciled. They could become complementary if strategic planning was effected (Brown et al., 2001; Bubb & Earley, 2007; Hustler et al., 2003). The underlying point, which has been developed in the next paragraphs, is that CPD can be a tool for school improvement as well as teachers' development (Loucks-Horsley et al., 2003; Loucks-Horsley et al., 2010) and hence there should be a way in which CPD should be linked to both teachers' and school goals and needs. While this has been acknowledged, it should be stated here that '…there will be regular occasions during the life cycle of organisations and at particular times of national reform when different needs will predominate, and at times in individual teachers' career development when their needs must prevail. Needs assessment at both these levels is necessary' (Day & Leitch, 2007, p. 716).

The literature (Darling-Hammomd, 2003; Day, 1999) has established that there is a relationship between teacher PD and school development. Schools can provide a supportive and enabling environment for teachers' CPD (Guskey, 2003) and thus meet teachers' CPD needs. They can raise awareness of CPD activities and provide teachers opportunities to access a range of professional training opportunities too (Harris, Day, Goodall, Lindsay, & Muijs, 2006).

'Successful school development is dependent upon successful teacher development'(Day, 1999, p. 2). Once teachers' access and engage in relevant CPD they would be '…empowered to take action to improve their school' (Loucks-Horsley et al., 2010, p. 130). This could be through giving teachers chance to take on leadership roles. It could also be through enabling them to relate the knowledge, skills and strategies they acquire through their CPD to improve classroom instruction, school improvement and hence contribute toward meeting school development needs. Some of the school development needs, which teachers can help meet, include: improved teaching and learning experiences; improved learner performance; quality professional interaction; and improved relationship with the community and all relevant stakeholders (Gray, 2005). In addition, teachers can play roles in strengthening the school's culture for learning and garnering support towards teaching and learning processes from the general public (Loucks-Horsley et al., 2010). They can also be empowered to play a role in promoting the school culture or school image and in responding to societal changes and issues related to school values.

Further, as an extension of their involvement in CPD, teachers can take leadership roles or play key leading roles beyond their classrooms or department. Based on Loucks-Horsley et

al.'s (2010) work on designing PD for teachers of science and Mathematics, teachers of mathematics can, for instance, play significant role as members of school or community committees that design the curriculum, or develop instructional materials. As teachers engage with the public on matters pertaining to school development they can too use the opportunity to build awareness of the importance of Mathematics and/or engage the public in exploring ways of improving mathematics teaching and learning among. Carefully planned CPD can contribute to addressing the learning needs of both schools and teachers '…in an integrated way that minimises conflict and rewards innovation'(Ferguson, 2006, p. 3). Linking CPD objectives and targets to school improvement plans and teachers' development plans (Bubb & Earley, 2007; Goodall et al., 2005) can heighten the chances of designing, implementing and supporting CPD that would meet the seemingly competing needs of school and teacher development.

Based on the discussion and illustration of the relationship between teachers' CPD and school development in this section, it can be deduced that school development needs can have an influence on teachers' CPD and CPD needs.

2.3.5.3.2 Availability of teaching and learning resources

Teachers' CPD needs and aspirations can be influenced by their work contexts as may be characterised by availability or non-availability of teaching/learning resources. In poor and developing countries such as Zambia, different teaching/learning conditions and environments prevail compared with rich, developed countries with well-resourced teaching and learning environments. As partly illustrated in chapter 1, Zambia like other poor countries in the world experiences immense economic and social development problems and consequentially teachers in these countries experience difficult teaching conditions and environments including overcrowded classrooms, very high teacher: pupil ratios and a lack of basic instructional resources and materials. Teachers have to work within budgetary, and infrastructure constraints. 'The job of teaching in poor countries is defined by the struggle to cope in the absence of basic resources…' no funding, chronic underfunding for effective teaching (Weber, 2007, p. 294). This is compounded by critical shortage of teachers and mathematics teachers in particular. While it can be argued that similar challenges are experienced in developing countries, it has to be borne in mind that the nature, intensity, seriousness and coverage differs to a large extent. The problems faced in less developed countries are 'far greater in both scale and severity' (Wheeler, 2001, p. 12). Given the aforementioned realities, PD has a vital role to play. However, teachers in such contextual environments are likely to have different CPD needs most likely those leaning against coping

strategies in the light of challenges being faced. Wheeler (2001) draws attention to the point that the benefit of CPD in less-developed countries will not be experienced unless there is a careful consideration of the contextual needs of the participating teachers.

This section has highlighted some of the influences on teachers' CPD needs, which to some extent may also be applicable or adapted to teachers of other subjects. The influences on teachers' needs are discussed under the three broad categories: teacher factors, learner factors and school factors. With the above discussed points, inference can be made that teachers' needs are not static, but dynamic and evolving depending on factors such as stated. This could imply that the focus of CPD should not be static either if it has to accommodate or address teachers' needs and keep them up to date, renewed, rejuvenated as they fulfil their role(s).

2.4 Effective CPD

The knowledge of what works or makes CPD effective is valuable to governments that have been prioritizing and investing in CPD and should therefore be strengthened (Desimone, Porter, Garet, Yoon, & Birman, 2002). As earlier discussed in section 2.2.4, there are several CPD activities representing different CPD models. The focus of the CPD activities can vary from CPD activity to another, but there are some common features that emerge as characteristics of effective CPD (Gordon, 2004). Several authors (Bubb & Earley, 2007; Evans, 2008, 2011; Guskey, 2000; Hoyles, 2008; Hustler et al., 2003; Rogers et al., 2006; WestEd, 2000) have presented the characteristics and principles of effective CPD in general and others such as (Back, Hirst, De Geest, Joubert, & Sutherland, 2009; Desimone et al., 2002; Hoyles, 2008; Lee, 2001; Loucks-Horsley et al., 1996; Smith, 2004) the principles for effective PD for mathematics and science teachers in particular most of which the principle sources of data used were interviews and questionnaires. The characteristics of effective CPD are multiple and complex (Guskey, 2003c), but based on reviewed literature the common characteristics of effective CPD for mathematics teachers have been broadly summarised as follows: addresses the needs of teachers, has clear goals, uses appropriate instructional methods and is on-going with follow-up support. Each one of these has been discussed below. In some cases, in the discussion reference has been made to other literature which may not specifically refer to CPD for mathematics teachers as some of the principles are similar and help amplify the points.

2.4.1 Addresses the needs of teachers

Effective CPD is relevant to and addresses the needs of the participating teachers in their work context (Muijs et al., 2004). PD opportunities are likely to have little impact on the teachers or their pupils if they are poorly conceptualised, are insensitive to the cognitive and socio-emotional concerns and needs of individual teacher participants (Day, 1999; Fullan, 1991; Kennedy, 1998, 1999). Kennedy (1998, 1999) who makes a case for attending to the content of teachers' PD programmes states that the starting point to the design of CPD is to ensure is that CPD content reflect teachers' learning needs. One of the principle of adult learning (1.7.2) is that adults are relevancy oriented therefore CPD content should be relevant to them. What individual teachers would consider as relevant CPD content could be determined by various factors such as highlighted in section 2.3.5 and are likely to vary from teacher to teacher with some teachers experiencing more complex needs or combination of needs than others. This hints that the areas of CPD focus have to be wide ranging as exemplified in section 2.3.2 above. It also implies that '…the content of CPD activities should not be beyond the reach of participants and the practical conditions under which they teach' (Ottevanger, Akker, & DeFeiter, 2007, p. 56). This would be based on the idea that the content of any CPD should be closely matched with and focussed on addressing the diverse needs of the teachers for whom it is intended and fitting in their contexts (Bubb & Earley, 2007; Mansour et al., 2014; Steyn, 2010).

For teachers' needs to be addressed, the needs should be known in the first place. For teachers' needs to be known, teachers' voices concerning their CPD orientations, motivation, perceived needs should be heard and considered in CPD programmes. The literature (Day, 1999; Guskey, 2002; Mansour et al., 2013; Poppleton & Williamson, 2004) echo this conclusion.

2.4.2 Clear goals

Effective CPD is linked to clear goals for teachers, learners and the school system. It is driven by coherent plans stating the short as well as long term focus (WestEd, 2000). This starts with clear CPD policy and implementation guidelines at national and school level too. The goals should be guided and defined by a clear and well-defined image of effective teaching and learning and school development (Loucks-Horsley et al., 1996). Without a clear CPD vision and goals there is lack of consistent CPD focus. Effective CPD initiatives reflect and are consistent with teachers' goals and/or school development goals (Desimone et al., 2002). The goals to be achieved through CPD activities may need take into account teachers'

teaching experiences and what teachers already know and are communicated to. This is in line with the principles governing adult learning (1.7.2): Adult learners are goal orientated and therefore the goals for learning should be clearly stated for them.

2.4.3 Uses appropriate instructional methods

Learning is an important component of CPD (Mahmoudi & Özkan, 2015; WestEd, 2000). CPD is effective when appropriate mode of delivery or instructional methods are used as these would enable and support learning. These include active engagement and participation of teachers in the learning process during CPD activities (Borko et al., 2004; Day, 1999; Garet, Porter, Desimone, Birman, & Yoon, 2001; Goodall et al., 2005; King, 2002; Ottevanger et al., 2007; Riding, 2001; Timperley et al., 2008). Borko et al. (2004) for instance, suggests that CPD experiences that give teachers opportunities to actively engage as learners in activities such as problem solving and critical thinking can be considered effective and should be encouraged. King (2002) states that PD should promote inquiry and involve active learning that can lead to significant changes in teaching beliefs and practices thus emphasising the point that instruction during CPD need to move from traditional forms of instruction where teachers are regarded as passive learners. Further, Loucks-Horsley et al., (1996) argue that 'teachers, like students, best learn Mathematics…by doing…Mathematics, by investigating for themselves and building their own understanding, as opposed to being required to memorise what is "already known"'(p. 2). This suggests and supports the use of modes of instruction that will encourage the 'doing' of mathematics and active engagement in the construction and learning of mathematics rather than using knowledge transmissive ways of instruction which is hallmark supported by the principles of constructivism (1.7.1). Desimone et al. (2002), based on data obtained from a three-year longitudinal study involving purposefully selected teachers in the US refers to effective CPD as being the kind that makes use of instructional methods which allow teachers' to actively engage '…in the meaningful analysis of teaching and learning…'(p. 83) such as that which would come with reviewing of pupils' work and getting feedback on their teaching. While using instructional methods befitting adult learners, CPD presenters/facilitators, during CPD engagements may also have to model the methods or illustrations that teachers can use when with their pupils. Loucks-Horsley et al (1996) refer to this point as they discuss the concept of and importance of immersion experience in relation to professional learning during CPD programmes.

The other point worth mentioning here is that whatever instructional methods are adopted during CPD should be accompanied with allowing teachers opportunities for reflection and

continuous inquiry on their beliefs, attitudes and/or their teaching practices. Hamilton (2013), builds on this argument and concludes by stating that meaningful PD takes '… into account 'participant-driven inquiry, reflection and experimentation' (p. 45). which could suggest a call for teachers to be more reflective practitioners

Additionally, instructional strategies should be suitable and applicable to the context within which they are being used. Timperley et al. (2008) qualifies the point by stating that 'Context-specific approaches not only promote teaching practices that are consistent with the principles of effective teaching, but also systematically assist teachers to translate those principles into locally adapted applications'(p. 10). Effective CPD comes with content and instructional methods that are intellectually stimulating (Desimone et al., 2002; Lee, 2001) and is practical and related to teachers' classroom practice with minimal adaptation and easy transferability (Gray, 2005). It is important to state here that whatever instructional methods are adopted during CPD might need to be accompanied with allowing teachers opportunities to build on what they already know and acknowledge their classroom teaching experiences as expounded in the ALT. Lee (2001) recommends that a variety of instructional methods, linked to real life situations, be employed for effective CPD. PD designers therefore may have to consider employing a combination of learning activities that could best meet the specific CPD goals and fit in the context for the target teachers.

Further, effective CPD also allows for opportunities for meaningful collective engagement and participation of teachers, from school department(s) or grade level(s) within a school, or other schools, in the learning process (Desimone et al., 2002; Lee, 2001). Not only can teachers support each other, but they can also enrich each other's' work experiences not only in formal ways CPD experiences, but also in less formal ways (Loucks-Horsley et al., 1996). Details on collaboration in the CPD context have been discussed in section 2.2.5 above.

A discussion on modes of instruction cannot be complete without making reference to use of appropriate teaching/learning resources. These resources can include advice or tips, banks of resources that can easily be applied in the classroom set up with or no major adaptations (Back et al., 2009; Desimone et al., 2002). What p can do and achieve effectively depends on the kind of resources they can draw from, availability of such resources, the goals they are trying to achieve and their orientations which include their beliefs or values or biases (Schoenfeld, 2011). While one of the main goals for effective CPD, in both well-resourced and resource-constrained teaching and learning environments, remains to improve teachers' instructional practices and improve pupil learning and achievement, the type of resources and

availability of such resources have a significant role to play in achieving this goal.

Lastly under this section, the use of appropriate instructional methods and instructional materials depends on the quality of the CPD facilitators or presenters. This is consistent with academics such as Armour & Yelling (2004) who state that the effectiveness of CPD is dependent on the quality of presenters. One of the qualities of quality presenters is having the relevant teaching experience (Lee, 2000). CPD facilitators or presenters may need some kind of training, support and guidance for them to be effective in their work. Academics such as Ball & Even (2009) have stressed the need for CPD facilitators to receive relevant training for the work they do of supporting teachers' PD and learning.

2.4.4 On-going with structure for feedback and follow-up

Effective CPD avails opportunities for giving and receiving feedback and making follow-up on teachers. Literature (Bechtel & O'Sullivan, 2006; Cordingley et al., 2003; Goodall et al., 2005; Steyn, 2011) has identified feedback as an integral part of effective CPD. On-going feedback can allow teachers opportunities to continually reflect on their learning and their practice. However, Hattie & Timperley (2007) caution that even though feedback is an integral part of effective CPD, it can have positive or negative impact on teachers' effectiveness depending on the type of feedback given and the way it is given. It is also important to be aware that teachers are different and change or improve their practices at different rates. Therefore, there may not be a 'one size fits all' kind of feedback for all teachers. What remains unchanging though is that all teachers need the necessarily and relevant feedback and support on the progress or lack of progress in implementing best teaching practices (Kraft & Papay, 2014; WestEd, 2000).

WestEd (2000) explains that '…it is not enough to be exposed to new ideas, we have to know where they fit, and we have to be skilled in using them'(p. 20). This is a point can support the need to evaluate CPD for its effectiveness not only in terms of what is taught, but also in terms of the transfer of learning to the actual teaching practices in the classrooms. With this under consideration, it is inferred that follow-up on teachers' CPD is an important component of effective CPD as it would help assess and give the necessary feedback and clear picture to all concerned with the actual implementation of acquired knowledge and development of relevant skills. Structured, continuous and sustained opportunities for follow-up after CPD activities should be planned for (Goodall et al., 2005; Guskey, 1994; Guskey & Yoon, 2009; Loucks-Horsley et al., 1996). CPD activities, such as some workshops without a provision for making a follow-up and/or sustained support during implementation can be considered as

wasteful (Guskey & Yoon, 2009). Follow-up and assessment of the impact of CPD activities for their effectiveness in promoting teachers' professional growth become meaningful when assessment results guide and inform subsequent CPD efforts.

2.5 Chapter Summary

In this chapter, section 2.1 presents the purpose of the literature review, Section 2.2 discusses teachers' CPD under the subsections 2.2.1 exploring an understanding of teachers' CPD, 2.2.2. the value of CPD, 2.2.3 presenting the providers of CPD, 2.2.4 types of CPD activities and 2.2.5 discussing collaborative and individualised CPD. Section 2.3 has presented teachers' CPD needs with subsection 2.3.2 discussing the nature of mathematics teachers' CPD needs. Section 2.4 explores effective CPD with this last section, 2.5 providing a chapter summary. The next chapter discusses the methodology used by this study.

Chapter 3: Methodology

This chapter explains and justifies the overall methodological plan for conducting the research on secondary school mathematics teachers' perspectives of their CPD in Zambia. It aims to demonstrate that the methodology and methods used for this investigation are in line with what is being investigated. The structure of the chapter is such that Section 3.1 presents the research aim, the research questions for the study and then section 3.2 details the research foundations within which the study is couched. Section 3.3 discusses the research design then section 3.4 follows with information on the pilot study that was conducted, which is followed by section 3.5 with the discussion on data collection methods used and the data collection process. Section 3.6 presents the order of data collection and 3.7 the data analysis procedure. Information pertaining to the reliability and validity of the study is discussed under 3.8. Ethical considerations are presented under section 3.9. The chapter closes with section 3.10, which gives a chapter summary.

3.1 Research aim and questions

This section reviews the aim of this research and the research questions as they pertain to the research design and method. The selection of research method should depend on the research problem at hand because different research problems can call for different methodologies (Bell, 2005; Creswell, 2014; Wood & Smith, 2016).

The focus of this research is to investigate secondary school mathematics teachers' perceptions of their CPD with the aim of finding out whether and how current CPD meets their CPD needs and to what extent. Within this broad perspective, the research is guided by the following interrelated research questions:

1. How do secondary school mathematics teachers perceive CPD and its value?
2. What CPD activities are secondary school mathematics teachers in Zambia currently engaged in? How do the teachers perceive these CPD activities?
3. What are the perceived CPD needs of secondary school mathematics teachers in Zambia? And
4. What are secondary school mathematics teachers' perspectives of what makes CPD activities (non)effective? What are their perceptions of the (non)effectiveness of

current CPD activities in meeting their perceived CPD needs?

3.2 The research's philosophical foundations

3.2.1 Research paradigm

Conducting an empirical research is a reliable way of discovering and explaining phenomenon about the physical and social worlds. However, Social Science, which studies the social world, is more susceptible to researcher-bias in the investigations. As a result, different social scientists can study the same phenomena but see different things. One reason for this is that Social Science researchers are influenced and directed by an overarching worldview about the nature of social reality and how knowledge about this reality can be obtained. The worldview constitutes the researcher's ontological and epistemological assumptions. Ontology studies reality and the nature of reality. It 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). Simply stated, epistemology deals with how we know about that reality and how we justify our beliefs about it.

In order to understand a research or study and be able to pass judgement on its quality it is important that the ontological, epistemological and methodological standpoint of the researcher is known. This helps to expose and minimise the researcher's actual and potential biases. Ontological, epistemological, and methodological considerations also help to frame the research design so that the research process can unfold into a coherent picture and representation of reality. Thus the following section presents the philosophical assumptions underpinning the current study.

3.2.1.1 Ontological underpinning

As already highlighted in chapter 1 under section 1.7, this study is couched within the constructionist (another term for constructivism) ontological position that asserts that reality is socially constructed and therefore there are multiple realities, which constitute multiple connections and interpretations. This is unlike the objectivist ontological position that asserts that reality exists independent of human beings and that there is a single objective reality. Because this research focuses on the perspectives and lived experiences of secondary school mathematics teachers' CPD in relation to whether their CPD meets their CPD needs, and on the in-depth understanding and interpretation of these perspectives and lived experiences, it is more aligned with the constructivism ontology. The choice of constructivism ontology is aligned with the choice of interpretivism epistemology.

3.2.1.2 Epistemological underpinning

The two main epistemological strands are positivism and interpretivism (Bryman, 2008). Positivism is 'an approach to social research that seeks to apply the natural science model of research to investigate social phenomena and explanations of the social world' (Denscombe, 2002, p. 14). This include testing theories and hypothesis since reality or truth can only be discovered by being tested, experimented on and results analysed statistically (Basit, 2010). Therefore, statistical and mathematical methods have a key role in positivism.

Interpretivism on the other hand holds the counter claim to that of positivism. Denscombe (2002) describes it as a research approach that aims at understanding the complex 'life world' from the research participants' own perspectives. The social world does not exist independently from peoples' experiences (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, the social world is complex in such a way that theories with definite laws, such as advocated by positivism, may not always be the most effective way of understanding it as there are always other situational considerations that may need to be made. Even though there are some quantifiable aspects of this study, this research takes on the interpretive epistemological stance by drawing on research participants' perceptions, experiences concerning CPD in seeking to understand and interpret CPD circumstances in the Zambian context in order to make recommendations that would render CPD more meaningful to the secondary school mathematics teachers. This is an appropriate philosophical position because the aim is to probe research participants in order to gain an in-depth understanding and interpretation of their perspectives, opinions and experiences in relation to their current CPD, whether it meets their CPD needs and to what extent. The phenomenon is understood through perceived knowledge.

The aforementioned epistemological approaches have explained the distinction between quantitative and qualitative research ideas respectively (Denscombe, 2002). Quantitative research is more aligned with the objectivist ontology and the positivist epistemology while qualitative research is guided by the constructionist ontology and interpretivist epistemology.

3.2.1.3Quantitative and Qualitative research

Quantitative research is focused on details that can be numerically measured to produce results for making statistical analysis. 'It uses numbers and statistical methods and…tends to be based on numerical measurements of a specific phenomenon' (Thomas, 2003, p. 2). The emphasis is on collecting and analysing numerical data. Therefore, quantitative data

collection methods such as experiments and tests are more predominant (Mackenzie & Knipe, 2006). Thomas (2003) affirms that quantitative researchers seek predictions or explanations that can be generalised to other people or places.

Qualitative research on the other hand is backed by the argument that data about individuals' feelings, attitudes, perceptions or judgement are too complex to be quantified (Berg & Lune, 2014). It thus involves examining of, for instance, attitudes and perceptions. It is concerned with an understanding of the meanings that people attach to their actions, decisions, beliefs or values within their social world (Ritchie & Lewis, 2003). Qualitative methods of data collection such as interviews and observations are more predominant (Mackenzie & Knipe, 2006). Researchers who subscribe to a qualitative research type approach assume commitment to view events through the eyes of the people that they are studying. It is therefore viewed as an interpretive research type. Bryman (2008) argues that in qualitative research, the social world is interpreted from the perspective of the people being studied, rather than assuming that those being studied are not capable of having their own reflections on an event or the social world.

Even though the nature of quantitative and qualitative research questions may differ, each is designed to answer research questions about a social reality. The difference between the two research types are that quantitative research relies on the principle of verification emphasising quantification in the collection and analysis of data while qualitative research involves description and thus stresses 'words' rather than in terms of quantification in both the collection and analysis of data (Bryman, 2004; Kombo & Tromp, 2006). Bryman (2008) has provided further common contrasting features between quantitative and qualitative research as presented in Table 4 below.

Table 4 Some common contrasts between quantitative and qualitative research.

Quantitative	Qualitative
• Numbers • Point of view of researcher • Researcher distant • Theory testing • Static • Structured • Generalisation • Hard, reliable data • Macro • Behaviour • Artificial setting	• Words • Point of view of participants • Researcher close • Theory emergent • Process • Unstructured • Contextual understanding • Rich, deep data • Micro • Meaning • Natural setting

Source: Bryman (2008, p. 393)

Each type of research has its own advantages and limitations. The features of quantitative and qualitative research presented in Table 4 above provide a simplified guide in contrasting the two major research types and also give out an indication of the assumed advantages and limitations of each single research type. The knowledge of the key features of quantitative and qualitative research type as presented in the analysis above can equally facilitate decision-making in relation to which research type best suits a particular study.

Given that this research is focussed on capturing the experiences of secondary school mathematics teachers in relation to their CPD and their perspectives on how it has contributed to meeting their CPD needs, this study is broadly qualitative in nature. This comes from a consideration of several factors including the ones discussed below.

An in-depth analysis of CPD is needed to broaden an understanding of teachers' perspectives on whether and to what extent CPD meets their needs thus a qualitative research approach is considered to be more appropriate for this study. Creswell (2009) supports such an approach in his observation that when the aim of the research to be undertaken is to broaden understanding of people's experiences and to solicit their views about a particular subject then a qualitative research is more fitting. Therefore, the nature of the study to be undertaken and the expected analysis of data have prompted the selection of qualitative research for this study.

Further, the nature of the research questions asked (Boeije, 2010; Creswell, 2009) supports qualitative research approach. Qualitative research is suited to answer questions that start with words such as 'how' or 'what' as they make it possible to deal with '…descriptive

questions as well as with explanatory questions' (Boeije, 2010, p. 24). Research questions of this nature formed part of this study because they were deemed helpful in capturing secondary school mathematics teachers' perceptions of their CPD.

Even though this study is broadly qualitative in nature it has made use of not only qualitative data but also quantitative data obtained through using mixed methods of data collection: questionnaire, interviews, focus group discussions and document analysis (details of each of these methods are given under section 3.5). These data collection methods helped to collect both quantitative and qualitative data to contextualise a wide range of issues on mathematics teachers' CPD and CPD needs and provided in-depth information on perceptions of the extent to which they are met.

3.3 Research design

There are several different research designs that can be adopted for a study depending on the research problem and the purpose of the study. Among these designs are: experimental research, case study, archival analysis, historical research and survey (Bryman, 2004; Leedy & Ormrod, 2001). This research adopted a case study research design for reasons elucidated in the next section.

3.3.1 Case study

Basically, a case study is a research design (Bryman, 2004) also referred to as a type of qualitative research (Creswell, 2007; Leedy & Ormrod, 2001) or a research method (Yin, 2009) that involves in-depth and intensive investigation of a case or cases (Bryman, 2008; David & Sutton, 2011; Thomas, 2009). A 'case' in a case study can be an event, a person, a situation, a problem or a phenomenon. A case study can either take the form of a 'single' case or 'multiple' cases being studied or conducted within its real-life context (Yin, 2009). This study is best described as a case study of secondary school mathematics teachers' CPD in one district of Central Zambia (This is discussed further under section 3.3.3 below). Because this study focused on the phenomenon of secondary school mathematics teachers' CPD and was based on one district in central Zambia, it is a single case study.

As stated in the above paragraph, a case study allows for in-depth research or study and analysis of a case. As such, the approach was appropriate for this study, which sought to collect in-depth data for providing in-depth description, analysis and understanding of CPD for secondary school mathematics teachers' in the selected district of Central Zambia through the eyes and experiences of the teachers themselves and thereby adequately addressing the

research questions for this study. Cohen et al. (2011) state that one of the hallmarks of a case study is to understand individual or group actors' perceptions of an event(s).

Another reason for the choice of a case study approach is that it is applicable when few or no studies have been done in a particular subject area and context. A case study is applicable where there is need to learn more about an unknown or poorly understood situation (Leedy & Ormrod, 2001). Benbasat et al. (1987) also state that a case study is viable when '…research is being conducted in an area where few, if any, previous studies have been undertaken…'(p. 370). As stated in chapter 1 there is a dearth of empirical research findings in Zambia to show that current CPD initiatives are meeting teachers' CPD needs. Teachers' perspectives on whether their CPD needs have been met through their CPD remains unclear. There is therefore a need for empirical studies in the area, and specifically relating to mathematics teachers, in the Zambian context. To do this a case study approach is considered expedient.

A case study approach accommodates the use of both numerical and qualitative data (Cohen et al., 2011). Given that the research was to make use of qualitative data and some quantitative data to handle the research questions fully, a case study was fitting. Yin (2009) states that some form of quantitative data could be collected to allow for analysis of what is going on in a particular case. In this case for instance, statistical data obtained through the closed-ended questionnaire items gave a general picture of CPD activities that secondary school mathematics teachers engaged in and their perceived CPD needs. The quantitative data collected was then discussed beyond the level of numbers to a level where meanings was derived in relation to this study that is exploring secondary school mathematics teachers' perspectives of CPD. Even though there are possibilities that qualitative data may not be an exact representation of real life experiences and thus having limitations (Boeije, 2010), qualitative data made it possible to attach details about teachers' perceptions of the CPD activities and their perceived needs to the numerical or statistical data obtained. Further, to understand the extent to which secondary school mathematics teachers' CPD needs were met by CPD they engaged in, open-ended questionnaire items, interviews and discussions helped to capture the qualitative data: teachers' voices, feelings, thoughts that enriched the study. Hence in order to collect the quantitative and qualitative data needed to adequately answer the research questions, multiple data collection methods were used: questionnaire, interviews, discussions and document review (section 3.5). The use of several data collection methods is applicable within case studies (Denscombe, 2003) for complementarity and/or triangulation purposes.

Among the notable limitations of a case study are that it has a limited basis for scientific generalisation (Robbin, 2009; Yin, 2009). Consequently, the findings of this research into secondary school mathematics teachers' CPD in one particular district of Central Zambia cannot be generalised. However, according to Marshall & Rossman (2011) although qualitative studies of this nature cannot usually be generalised in a statistical sense, their findings can be transferable to other similar contexts. On this basis, the results of this study could be used in similar other contexts and can also be used for further research in the area pertaining to mathematics teachers' CPD and their CPD needs.

3.3.2 Research participants

The selection of research participants followed some sampling and sample selection procedures and guidelines. Sampling refers to the process involving the selection of a portion or a small number of individuals for study out of a given overall population (Wood & Smith, 2016). Sampling therefore helps in generating a suitable sample, which would allow for collecting the data needed for a study.

There are two types of sampling that are generally used in Social Sciences: probability and non-probability sampling. Probability sampling requires the use mathematical probability methods in selecting the sample from the population with the aim of seeking representativeness of the wider population (Cohen et al., 2011). Among the types of probability sampling are: simple random sampling; systematic random sampling; and stratified sampling all of which contain a degree of representativeness. However, not all research in Social Science is based on the idea of representativeness, but on the idea that samples be selected on the grounds that they are appropriate to the purpose(s) of an investigation (Bryman, 2008). This leads to the discussion on non-probability sampling.

Non–probability sampling is not based on probability rules which are a cornerstone of probability sampling, but based on the subjective judgement of the researcher depending on their theoretical and/or practical reasons as linked to their study (Boeije, 2010). It enables the researcher to exercise their judgement in selecting sample members who would best enable them to answer the research questions and therefore meet the aim of the study. Examples of non-probability sampling include convenience sampling, purposive sampling and snowball sampling (Wood & Smith, 2016). Qualitative research is typically associated with non-probability sampling because of the need to acquire in-depth knowledge and understanding of

a particular practice existing within a particular location, context and time (Gray, 2014) and without emphasis on statistical representativeness or generalisation.

3.3.2.1 Key research participants

Purposive sampling, where the researcher purposefully targets individuals or a group of individuals considered to be the best fit for a study (Kombo & Tromp, 2006), was employed because the study required participants who were serving secondary school mathematics teachers and thus better positioned to provide information that would meet the aim of this study. All the 103 secondary school mathematics teachers found in the purposely-selected research site (details presented under 3.3.3 below) formed part of the sample. The demographics of the ninety teachers who actually participated in the study are provided under section 4.1.1 of chapter 4.

Why secondary school mathematics teachers?

The decision to focus on mathematics teachers was partly because of the researcher's interest in Mathematics as a subject and its invaluable contributions to improving lives. The decision also lay in a desire to contribute toward making a difference in the way in which mathematics is taught, learnt and subsequently contribute toward improving pupil attainment in the subject. Such a contribution can be realised through focus on mathematics teachers' CPD. The focus is on secondary school level because secondary education is the chain that connects the other levels of education: primary education and tertiary education. If there are inadequacies in the way mathematics is taught and learnt at primary school level, then these could be handled during the secondary education phase. Without good performance in mathematics at the end of secondary education one cannot progress to tertiary level of education as mathematics is regarded as a 'must pass' secondary school subject in Zambia. Therefore, secondary school level is a crucial stage for handling inadequacies associated with mathematics teaching/learning that could have been faced at primary school, strengthening the mathematical background of learners and also for adequately preparing learners to proceed to tertiary level of education. My background as a secondary school mathematics teacher and now secondary school mathematics teacher trainer also partly contributed to making the decision about the focus of the study.

Further, there have been calls to remodel and improve the teaching and learning of mathematics, through the new and revised curriculum, based on outcome-based education and on the constructivist principles and views of teaching and learning (see chapter 1 section 1.2.3). Changes in teacher conceptualisation of teaching, pedagogical practices and teachers'

roles are expected. This being the case, one of the general questions that could be asked is: how and to what extent are teachers being supported during this remodelling phase? A focus on mathematics teachers' CPD, which is a means through which teachers could be supported, was inevitable.

3.3.2.2 Key informant participants

While the key respondent participants in the study were secondary school teachers of mathematics, there were also key informant participants who were purposively selected to participate in the study: MOE representative officials such as the officer in charge of Teacher Education and Development; Education Standard Officer specialised in Mathematics at national and provincial levels; curriculum development specialist concerned with mathematics at CDC; public university lecturer; school CPD coordinators who were collectively referred to as key informant in CPD provision and management.

Even though commonly engaged in ethnographic studies, key informant participants are also applicable and pertinent in case study research (Lodico, Spaulding, & Voegtle, 2010). The key informants in this study were individuals selected because they were involved in and/or had some element of responsibilities attached to the design, provision and/or management of CPD programmes for teachers in general and mathematics teachers in particular. The key informants mentioned above were purposefully selected to participate in the study because they are key to interpreting and implementing CPD initiatives and guidelines. They also possess in-depth knowledge about the teaching and learning of mathematics and also about CPD because of their professional role and/or experiences. The key formants were thus in a strategic position to offer rich insight into the issues being addressed in the study (Lodico et al., 2010). They provided data for cross-contextual comparison. It has to be stated here that although the reason for involving the key informants was to develop an in-depth understanding of secondary school mathematics teachers' CPD, I was aware that it is possible that some of their responses could have been influenced by their personal values, and interpretation and as such took necessarily precaution and steps in probing further and verifying the information provided with information from other sources.

Yin (2003) identifies the need for key informants in case study research by stating that, 'such persons not only provide the case study investigator with insights into a matter but also can suggest sources of corroboratory or contrary evidence and also initiate the access to such sources'(p. 90). The key informant participants in this study suggested and, whenever

possible, gave out documents that were deemed to have relevant information for me for the purpose of obtaining further in-depth information on teachers' CPD.

3.3.3 Research site

The specific location for this study was Kabwe district, one of the eleven districts in the Central province of Zambia. The study site constituted urban, peri-urban and rural secondary schools within which the target teachers worked. It was chosen because it offered more opportunities to learn more about secondary school mathematics teachers' CPD experiences. Kabwe district has the largest number of secondary schools in the central province of Zambia and the largest number of secondary school mathematics teachers too and therefore offers wide variety in terms of the characteristics of teachers working therein. It is also characteristically similar and representative of the districts that have been the target of CPD initiatives including the current SBCPD through LS, which has now been rolled out to all districts in the country. In addition, the district was chosen because of offering easy accessibility to the population of interest and therefore presenting a higher response rate. According to the information provided by the gatekeepers giving assess to the research field, the total number of secondary school mathematics teachers in all the 14 secondary schools in the chosen district was 103 and these were all considered for the study.

3.4 Pilot study

The pilot study was conducted in Zambia in August/September 2014. It aided preparation of the 'ground' for the main fieldwork. The research and research plan were discussed with the gatekeepers: MOE official overseeing MOE activities at provincial and district levels and the needed permission was granted (see Appendix B1&B2) to carry out the pilot study and the main fieldwork that was scheduled for April to August 2015.

The research instruments were also pre-tested and piloted during the pilot study period. To start with, secondary school teachers of mathematics from a district different from the research site (3.3.3) and officers whose work was directly related to CPD provision and/or management were interviewed following the prepared interview schedule and the interviews were tape-recorded. The interviews were transcribed and analysed in the light of the research focus. As Yin (2003) notes, the pilot study assisted in identifying areas that needed to be examined or further clarified in relation to the study. The researcher began with ideas identified from personal past experience as a secondary school teacher of mathematics and from reviewing literature on CPD in general and CPD for mathematics teachers. Analysis of the views of the teachers in the pilot study confirmed some of the ideas the researcher had on

CPD, but from the teachers' perspectives. The researcher's ideas needed expansion in order to accommodate the factors currently related to CPD, which had made an impact on the teachers' CPD experiences in Zambia. The key constructs that emerged from the pilot interviews where further refined accordingly to produce a new revised and refined set of interview questions and also facilitated further development of a questionnaire, interview schedule for CPD providers other than the MOE officials and FGD guide. The literature (Bell, 2005; Cohen et al., 2011) states that data collection instruments should be pre-tested. Some of the reasons for this are to ascertain whether they would sufficiently and comprehensively help in addressing the research questions, whether they were clear enough for the respondents and approximately how long it would take to handle the set questions. In view of the importance of pre-testing data collection instruments, the questionnaire, interview schedule and FGD guide were pre-tested, piloted and modified accordingly before being administered during the main fieldwork.

The participants in the pilot study were not participants in the main data collection process as their contributions had already informed the research and the chances of producing predetermined answers would have been high if they were to take part again.

3.5 Data collection methods

This study adopted mixed data collection methods where more than one data source was used to collect both quantitative and qualitative data needed for the study. These data collection methods were: questionnaire, interviews, discussions and document analysis. The use of several data collection methods is advantageous for complementarity, triangulation, development, initiation and/or expansion purposes (Gray, 2014). With the use of several data collection methods complementarity (ie clarification, or elaboration of data from one method with data from the other method) is made possible. Triangulation is another advantage of using several data collection methods as it contributes to improving reliability and validity of data collected. Denscombe (2003) argues that a range of methods can allow for capturing the details related to the matter under scrutiny and thus enable the validation of data through triangulation (3.6.1). The use of mixed data collection method presented opportunities for the collection of more relevant data than would have been possible through adoption of a single method. The possibility of learning more when multiple methods are used is heightened than when we are limited to only one method (Leedy & Ormrod, 2001). Details on each of the methods used are presented in the subsequent sections.

3.5.1 Questionnaire

A questionnaire (Appendix C) was used to collect both qualitative and quantitative data. What guided the development of the questionnaire items was the information and ideas obtained from the review of the Zambia's EOF policy document (MOE, 1996) including other MOE documentation (MOE, 2007, 2013b) and review of some other relevant literature (ACME, 2002; ACTEQ, 2003; Goodall et al., 2005; Gray, 2005; Hustler et al., 2003; Krauss, Baumert, & Blume, 2008; Mansour et al., 2011; 2014; McNamara et al., 2002; Westwell & Lee, 2011) as well as information drawn from the interviews conducted during the pilot study (section 3.4). The ideas obtained were carefully considered in an attempt to discover what the key factors, in relation to describing or investigating secondary school mathematics teachers' CPD were. The key factors from this careful consideration were used as starting points to assist with the study in terms of data to be collected. The researcher then used the analysis of the information to both develop the questionnaire and refine the interview questions to be used.

3.5.1.1 Questionnaire structure

The questionnaire was divided into six main sections with each section focussing on a specific theme. As mentioned above, the development of the questionnaire items was guided by ideas obtained from the review of some of MOE documentation (MOE, 1996, 2007, 2013b) and review of some other relevant literature (ACME, 2002; ACTEQ, 2003; Goodall et al., 2005; Gray, 2005; Hustler et al., 2003; Krauss, Baumert, & Blume, 2008; Mansour et al., 2011; 2014; McNamara et al., 2002; Westwell & Lee, 2011) as well as information from pilot study (section 3.4) participants. Part A focussed on understanding of CPD and perception of CPD activities, Part B focussed on effectiveness of CPD, while Part C focussed on participation in CPD and CPD needs. Part D concentrated on career and professional plans with the last Part: Part E focussing on the respondents' background information which included gender, age, highest educational level, years of teaching experience, current grade level teaching, current position and subject(s) teaching. The researcher chose to have questions on the respondents' background information toward the of the end of the questionnaire to enable the respondents get straight into providing responses to the main questionnaire questions and to keep it (background information) from influencing or interfering with their responses to the questions in the questionnaire.

The questionnaire consisted of a combination of the closed and numerical type questions and open, word-based structure as the researcher thought that this would be the best way of

capturing the perceptions of the teachers. It also gave the respondents an option to clarify their answers and express their opinions, in the way they thought they would best be expressed, on CPD and thus help address the research questions for this study.

The closed-ended questions consisted of a range of options from which the respondents had to choose. Cohen et al. (2011) state that closed questions are generally easy for the respondents to complete and for the researcher to code and analyse. Their limitation however, lies in there being biases in them and in the risk that options provided may not be exhaustive. For this study, the closed questions included the likert-type questions, fixed alternative questions and a ranking question. Part A had one likert-type question related to the CPD activities respondents were involved in. Respondents had to choose by placing a tick ( ) on the options *'never', 'rarely', 'often'* and *'always'*. Part C had likert-type questions reflected under C1 and C2 with options *'never', 'rarely', 'often' and 'always'* on one end *and 'Strongly Disagree', 'Disagree', 'Agree'* and *'Strongly Agree'* on the other end. The researcher chose the four-point likert-type scale over the five-point likert-type scale to encourage respondents to make a commitment either way without feeling the need to opt out. The fixed alternative questions were mainly used under Part D and E of the questionnaire, which focussed on respondents' career and professional plans and on the respondents', background information respectively. Part D also had one ranking question.

The open-ended questions allowed respondents opportunities to give qualitative responses and additional personal comments. Open-ended questions were included under each of the five sections: Parts A, B, C and D except under Part E which focused on respondents' background information. With open-ended questions respondents were free to respond as they wished. According to Cohen et al. (2011) open-ended questions can capture authenticity, depth of responses and details related to a particular situation, which is important in qualitative research. However, they have potential to put some individuals off as they take up more time to complete and some people find it difficult to express themselves in writing (Bryman, 2008) and on the part of the researcher, the responses from open-ended questions are not as easy to code, classify and analyse as compared to the closed-ended responses (Cohen et al., 2011). In this study in particular, whether for reasons cited by Bryman (2008) above or any others but not sought, not all the respondents responded to all the open-ended questions. Despite this the responses provided by those who did raised issues valuable to the study.

3.5.1.2 Questionnaire administration process

The researcher contacted the secondary school Head teachers and presented the introductory letters (See Appendix B1&2) from the MOE Provincial and District offices to ask for permission to conduct the research in their school. Upon approval, both the questionnaires together with the information sheet and consent forms explaining the purpose of the research and also assuring the teachers of confidentiality were given. It was explained to the teachers that filling in of the questionnaire was on a voluntary basis. In some schools the researcher had to wait for the teachers to complete the questionnaires and collected them. One of the advantages of such an arrangement is that the completion and return rate is often higher (Wood & Smith, 2016). However, this was not possible in certain other schools where the researcher had to leave the questionnaires behind especially if the teachers were found to be teaching or committed to other duties in the school. This contributed to not having 100% questionnaire return rate. In such cases the researcher made follow up visits to the schools and sometimes had to re-administer the questionnaire and wait for the responses. In some instances, the respondents denoted that they were too busy and thus they needed more time to complete it, which was granted. The postage system in Zambia is not as efficient and reliable therefore the researcher did not count on using it to distribute and/or collect questionnaires. The follow-up visits where necessary because if left to the teachers themselves questionnaire completion and return may never have been done. In total, 83 (out of 103) questionnaires were completed and received back, giving a response rate of 81%.

Respondents could respond to questions truthfully if and when assured of anonymity (Leedy & Ormrod, 2001). All the respondents were assured of confidentiality of their responses and that the information was going to be used purely for academic purposes and as indicated in the consent form (Appendix E1) that accompanied the questionnaire and which they had to complete. This was enhanced by the fact that the teachers were not required to write their names on the questionnaires. There were some cases though where the respondents wrote their name such as when they wanted to have a follow up in-depth discussion through a face-to face interview. It has to be restated here that participation in the study through completing the questionnaire and face-to-face interviews were all done on a voluntary basis. It could be because of such freedom given that some teachers choose to be interviewed only as opposed to completing the questionnaire while others chose to complete the questionnaire and to be interviewed too.

There was a question at the end of the questionnaire about whether the respondents wanted to participate in a follow-up interview or not. Forty-three (52%) of the respondents indicated

that they wanted to participate in the face-to-face interview. Teachers' positive response to participate formed the basis of the decision regarding who was to be part of the follow-up in-depth interview sample. Seven (7) teachers, even though they had not taken part in responding to the questionnaire, showed willingness to be interviewed. Their participation was welcomed. Their responses to the interview questions helped with crosschecking and complementing the responses provided by those who had a chance of completing the questionnaire and then being interviewed also. Appendix I gives details of all the interviewed participants.

Cohen et al. (2000, p. 260) state that 'pre-testing a questionnaire is crucial for its success'. The questionnaire was pre-tested and piloted before being administered. This did not only increase reliability and validity, but also its practicability: to ensure that questionnaire items fit in well with the research questions and that ambiguous and/or difficult questionnaire items were revised and repeated questions handled for relatively ease completion by the respondents. All points considered, the questionnaire made it possible for the respondents to express their opinions on CPD, CPD activities and CPD needs and their responses were valuable in addressing the research questions for this study.

3.5.2 Interviews

Data was also obtained through face-to face in-depth interviews, which were conducted with secondary school mathematics teachers and key informants in this study. Interviews are widely used in the collection of qualitative data (Seidman, 2013; Silverman, 2004). Cohen et al. (2000) state that interviews enable participants to 'discuss their interpretations of the world in which they live, and to express how they regard situations from their own point of view'(p. 267). Therefore, interviews produce rich and deep insight into interviewees' experiences and opinions.

The interviews provided an extended understanding and deeper insight into issues that were raised through the questionnaire as they allowed the researcher to probe further and make a follow up on the questionnaire responses in a way that a questionnaire would not do. Additionally, interviews helped in filling in gaps for some questions in the questionnaire that were not adequately handled. Further, interviews allowed for accommodating new insights and comments made by participants. This proved to be the case more especially from the seven teachers who had not completed the questionnaire, but agreed to be interviewed. The crucial role of interviews in gaining deeper insight into issues under investigation is further expounded on in literature (Bell, 2005; Cohen et al., 2011).

The interviews were conducted with the aid of separate interview guides, for the teachers and for the key informants, which the researcher developed (Appendix F1 and F2, F3, F4 respectively). Having an interview guide helped in staying focused on the research area as well as with maintaining some consistence in what interviewees were being asked on. However, the researcher was flexible enough to probe further when the interviewee said something 'interesting' in relation to the research area.

3.4.2.1 Semi-structured interviews

Interviewing both the teachers and key informants was considered appropriate for the study as it helped with crosschecking the data collected. The researcher particularly chose to carry out semi-structured interviews, over the other interview types: structured interviews and unstructured interviews (Bell, 2005), with the teachers and the key informants as they fitted in the purpose of this study: to gain deep insight into mathematics teachers' CPD experiences which this study examines. They were also chosen because they enabled the interviewees to express themselves on the topic, but it also at the same time allowed for the researcher to probe in more depth, follow up and seek clarification to responses provided (Bryman, 2008; McMillan & Schumacher, 2010).

A review of literature has shown that semi-structured interviews in particular have been used in several studies, related to teachers' perceptions of CPD(Burns, 2005; Darling-Hammond, 2001; Steyn, 2009). While the semi-structured interviews were used with the key informants, the researcher particularly used the semi-structured narrative in-depth interviews with the teachers to collect data, which accommodated narrative accounts that the respondents were to give in response to questions during interviews. The narratives conveyed more than opinions and information from the interviewees and featured details of their life experiences (Riessman, 2006, 2013) as related to their CPD in this particular case. The use of semi-structured narrative interviews helped to accommodate the extended accounts the interviewees were giving during the course of the interview as they shared their experience(s) in relation to CPD especially in relation to their CPD needs. Seidman (2013) in discussing the purpose of interviews states that 'At the root of in-depth interviews is an interest in understanding the lived experiences of other people and the meaning they make of that experience'(p. 9). 'Experience happens narratively ... Therefore, educational experience should be studied narratively'(Clandinin & Connelly, 2000, p. 19).

The narrative segments of the interview allowed for gaining in-depth understanding of mathematics teachers' perspectives and experiences of their CPD. To make the point on narratives clearer, Riessman (2013) illustrates that the narrative segments can come out in such forms as: 'I'll clarify this with an example…' '…This is a classic example of…' or a lengthy story related to a particular experience' (p. 173). The narrative segments during the interviews for this study came out in a similar form and included such forms as…. 'I'll give you a real life example to clarify my point' 'A classic example is …' 'A very good example on this is…', 'let me share with you what happened when…' or …a lengthy story about a particular CPD experience. The narrative segments were a typical feature of the responses to interview questions classified within the categories: understanding of CPD, CPD content and needs, effectiveness of CPD and opportunities/barriers to CPD. The interview schedule (Appendix F1) attached reflects an engagement with teachers to draw out their views, perspectives and experiences and Appendix I gives some information about the interviewees together with the time and length of interviews. Note should be made here that the researcher made efforts such as suggested by Creswell (2007) and Ary et al. (2009) to validate the accuracy of the narratives given by the participants. One such way is the researcher taking the opportunity to seek for clarification and details when need arose.

3.5.2.2 Interview process

The interviews with the key informants (mentioned above under 3.3,2) were usually held in their offices while the interviews with the teachers were usually in a place deemed to be convenient for the teacher and conducive for carrying out an interview. This included Mathematics Department office or the staffroom. These venues seemed convenient for the teachers and there was generally less disturbances especially that the interviews were conducted at a time that was deemed as 'best time' and 'appropriate time' for the teachers than in the case were the time and place for the interview were to be dictated.

Conducting the interviews did not go without any challenges such as those associated with making appointments for the interviews, confirming and/or rescheduling the appointments. This was worse with the key informants who would be in their offices but unavailable for the scheduled interviews or on duty out of their workstation. For most of the time this meant rescheduling.

All the interviewees were assured of anonymity and confidentiality. Both the interviews and discussions with teachers of mathematics and the key informants were tape-recorded with

permission from the interviewees and later transcribed. One advantage of tape-recording over note taking during interviews is that a tape recording gives a complete record of the interview, which can be played over and over again and thoroughly studied, compared to notetaking where the chances of consciously or unconscious selecting data to note are high.

The total number of key participants who were interviewed was 41: out of which 31 (76%) were with the secondary school mathematics teachers without additional responsibilities and 10 (24%) had additional responsibilities of HOD and/or school CPD coordinator. The total number of key informants interviewed was 6.

The researcher also had 'informal chats' which were connected to the research study with an officer from; ZAME; ECZ specialised in Mathematics; Teacher Resource Centre and JICA technical support team in Zambia. Some of this data informed the data collection process and contributed to the richness of data collected.

3.5.3 Focus Group Discussions

In addition to questionnaires and interviews were Focus Group Discussions (FGDs). Two FGDs, involving 13 teachers altogether were carried out. One group consisted of 6 while the other 7 secondary school mathematics teachers. The discussions were on for between 25 and 37 minutes respectively. The FGDs were used to help with triangulating with interview and questionnaire data. As participants interacted with each other on the topic at hand, their views helped in providing further evidence on secondary school mathematics teachers' CPD and CPD needs and in clarifying any assumptions on the same. Appendix G shows the questions that guided the discussions.

3.5.4 Document review

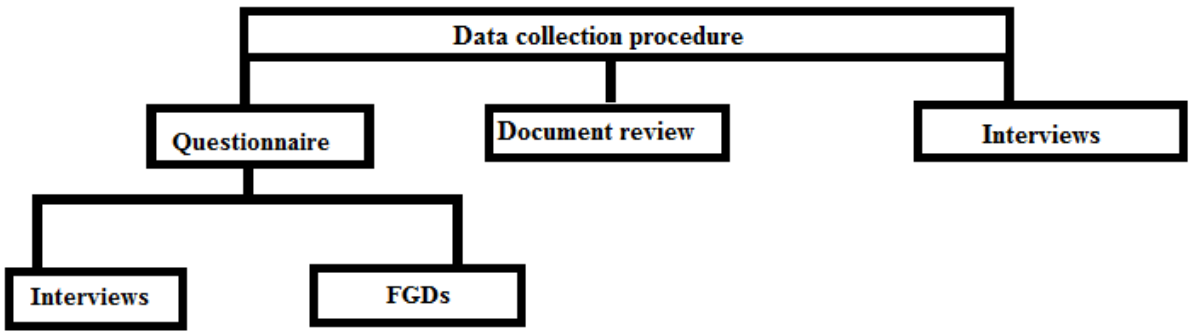
Documents are a source of data in qualitative research (Bowen, 2009). Document review can involve studying document excerpts and/or the entire documents and interpreting the information therein in relation to a study in order to gain meaning and understanding. Bowen (2009) defines document analysis as 'a systematic procedure for reviewing or evaluating documents-both printed and electronic…'(p. 27). This systematic way of reviewing documents can include coding document information into themes and analysing them in a similar way as would be done for interview data, which has been transcribed. The guiding principle in document review as Bell (2005) advises is to remain critical and thus provide a critical analysis of information in documents. This includes confirming that the relevant documents are genuine and authentic. Document review was used in combination with the

other data collection methods: Questionnaire, interviews and FGDs as a means of triangulation. The documents that the researcher reviewed in relation to the study included: minutes of CPD meetings, EOF policy document and other MOE documents such as: FOL; 2013 ZECF; FNDP (2006-2010); SNDP (2011-2015); Zambia's 'Vision 2030'; and Educational Statistical Bulletins with information relevant to teachers' CPD and considered crucial in providing an in-depth understanding and situation analysis of teachers' CPD in Zambia.

3.6 Data collection order

During the main data collection period that took place April to August 2015, the researcher administered the questionnaire first followed by interviews and FGDs arranged at a later time. This sequence provided more opportunities for crosschecking information provided by the research participants. As for the key informant participants (3.3.2.2) who did not have to respond to the questionnaire and those teachers who chose to be interviewed only as opposed to responding to the questionnaire as well, interviews only were conducted. Regarding the review of documents, some documents were reviewed before, others during and after the actual data collection period depending on the availability of and need for reviewing the documents (see section 3.5.4). Figure 3 below shows the phases of the data collection.

Figure 3 Data collection procedure



3.7 Data analysis

Data analysis can be considered as processing data for the purpose of answering the research questions (Boeije, 2010). As already stated, both quantitative and qualitative data was needed and hence collected for this study. Both types of data had to be analysed, but in different ways as illustrated below.

The analysis of quantitative data depends on statistics-based technique (Wood & Smith, 2016) and statistical analysis tools or software packages. The quantitative data from the responses to closed-ended questionnaire items in this study were analysed using the statistical analysis software, Statistical Package for Social Sciences (SPSS) version 21. The software package was used for its convenience in analysing data to answer the research questions and in producing tables relevant to the study compared to others such as STAT which the researcher was not as familiar with. Data was analysed by use of basic descriptive statistics of frequencies and percentages, which were deemed sufficient for analysing the data for the purpose of answering the research questions. Descriptive statistics were used to identify the CPD activities that secondary school mathematics teachers engaged in and their perceived CPD needs. The quantitative data collected was then discussed and interpreted beyond the level of numbers to a level where meanings were derived in relation to this study. However, it should be mentioned here that because of limited space not all questionnaire data from the participants was used for this study. This included data collected for questionnaire item C1 related to opportunities/barriers to CPD. Despite this, whatever data has been used and analysed has adequately addressed the research questions for the study

Qualitative data was obtained from the responses to open-ended questionnaire items, interviews and discussions. Qualitative data analysis is said to involve two basic activities: segmenting data into parts and reassembling the parts into a coherent whole, carried out from the perspective of the research questions and aim of the research (Boeije, 2010). In order to get through these activities data condensation, which used to be called data reduction by Miles & Huberman (1994), techniques were used. Starting with reading, rereading and coding, data condensation techniques 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 questions under consideration and the overall interrelated research questions for the study. Attention was given to comments that helped to identify, explain and clarify CPD experiences and situations-whether referring to the past or giving an indication of (future) expectations, as it was hoped that such comments would inform later recommendations regarding mathematics teachers’ CPD. As with questionnaire data, due to limited space not all interview or FGD data from the participants was used for this study. Despite this, whatever data has been used has adequately contributed to addressing the research questions for the study.

The researcher engaged in the qualitative data analysis process without using any Computer Assisted Qualitative Data Analysis Software (CAQDAS) such as NVivo or ATLAS, but by using traditional techniques for coding. The traditional technique which started with reading and rereading the transcripts involved using colour highlighters to mark and highlight emerging codes and themes and subthemes, using pen/pencil to add notes and comments to the printed transcribed text, cutting and pasting of key words and phrases from printed text and notecards. This option was chosen not only for the purpose of familiarizing with data but also for the researcher to thoroughly and deeply 'engage' with the data for the purpose of having an in-depth understanding of the narrative data. Wood & Smith (2016) also refer to the importance of familiarizing with data and gaining in-depth understanding as they discuss analysis of qualitative data in their work. The Word processor (Microsoft Word) effectively aided the effective management and storage of the collected and analysed data.

Taylor & Gibbs (2010) state that the coding process can be informed or guided by themes identified from a range of sources among them previous research or theory, research questions being addressed, questions and topics from data collection instruments such as questionnaire and interview guides or from priori. In general, the coding process was informed by the research questions and ideas drawn from the literature reviewed. Some of the interview data, such as the subthemes under 'CPD content', was first organised based on the themes that were predetermined in the questionnaire. The researcher was also open to emergent ideas. The responses and explanation that were given to some of the questionnaire items and interviews, but did not fit in the predetermined themes or subthemes were considered and analysed. This resulted in generation of new, but not disconnected, themes to accommodate this data as the data was providing answers to the research questions. Through this process data from all who participated in the research at different levels was captured. It has to be stated here that the qualitative data and quantitative data collected and analysed were compared and contrasted and both were used in a complementary and triangulating way to support, elaborate, emphasise and confirm data findings as they appeared relevant to answering the research questions guiding the study. From the data collected and analysed for this study, it was been possible to obtain an overview of secondary school mathematics teachers' CPD in the research site and answer the research questions.

There are bound to be biases in the data analysis phase right through to the process of data interpretation and reporting. Cohen et al. (2011) states that one thing peculiar to qualitative research that needs to be considered is the limitation linked to researcher bias and subjectivity. The researcher was aware of this and exercised caution to avoid and minimise bias by dealing with and disregarding preconceived ideas and opinionated impressions such as those that were linked to the researcher's past experiences as a secondary school teacher of mathematics and recent past experience as a secondary school mathematics teacher trainer, which could potentially have had an influence on the analysis and interpretation of the collected data. The researcher ensured reflexivity (discussed again later under 3.7.2), which allowed researcher influence to be consciously scrutinised, evaluated and probed when analysing data as was the case throughout the other stages of the research. It entailed critical self-reflection and examination especially with regard to potential biases (Johnson & Christensen, 2010).

3.8 Reliability and validity

The ideas of reliability and validity are commonly associated with positivisim paradigm and hence with quantitative research and arguably not consistent with constructivism (Golafshani, 2003; Lincoln & Guba, 1985). One of the arguments is that the criterion for reliability in quantitative research methodologies differs from that in qualitative research methodologies (Cohen et al., 2011). In fact, in some studies such as Lincoln & Cuba (1985) the concept of 'trustworthiness' has been used as an alternative concept to 'reliability' and 'validity' with reference to qualitative research types such as case studies. In other studies (Ary et al., 2009; Johnson & Christensen, 2010) the terms credibility and trustworthiness are used in qualitative research when referring to 'validity' and 'reliability'. It can be deduced that what 'validity' and 'reliability' is to quantitative research is what 'credibility' and 'trustworthiness' is to qualitative research: serving a similar purpose of ensuring that research and research findings are sound, authentic, meaningful and dependable with a possibility of some common and other somewhat differing criteria. Table 5 below helps in summarizing the use of the terms used to ensure quality of research.

Table 5 Standards for quality research

Quantitative	Qualitative	Issue addressed
Internal validity	Credibility	Truth value
External validity	Transferability	Generalizability
Reliability	Dependability or Trustworthiness	Consistency

Adapted from Ary et al. (2009)

Simply stated, 'credibility' is about the truthfulness of the research findings (Ary et al., 2009) and 'trustworthiness' is about the extent to which the research findings are consistent and could be repeated (Bassey, 1999; Boeije, 2010). While it may not possible to completely remove all the threats to the validity, reliability or credibility and trustworthiness of research there are some steps that can be taken to minimise them (Cohen et al., 2011). The criteria and steps more suitable for assessing the credibility and trustworthiness used in this study as evidenced from the literature (Boeije, 2010; Cohen et al., 2011; Creswell & Miller, 2000) include: triangulation, researcher reflexivity, debriefing by peers, member checks and thick, rich description which are presented in turn.

3.8.1 Triangulation

According to Boeije (2010), triangulation refers to 'the examination of a social phenomenon from different angles'(p. 176). It can also be considered as the use of different methods within one study to ensure that the data collected is telling the story that the researcher thinks they are getting (Bryman, 2008). This study used questionnaire, interviews, FGDs and document analysis as sources of data. Even though there are some epistemological issues surrounding the issue of combining data collection methods (Creswell, 2007; Johnson & Onwuegbuzie, 2004), it is evident that use of mixed methodology is useful for triangulation purposes and thus increases validity and reliability. The data collected was crosschecked from different sources to establish the perspectives of the secondary school mathematics teachers on their CPD and whether it meets their CPD needs.

At another level, triangulation can also be regarded as use of more than one theoretical perspective to examine and interpret data (Boeije, 2010). This is based on the argument that one theoretical perspective cannot sufficiently explain the phenomenon under study. As stated in chapter 1, the study used constructivist theory and ALT including the sociocultural framework in the examination and interpretation of data collected. This helped to '…make the data collection and analysis more accurate or the inferences more useful' (Rocco, Bliss,

Gallagher, & Perez-Prado, 2003, p. 21). This leads to greater confidence being placed on the conclusions drawn from the study.

3.8.2 Researcher Reflexivity

Researchers in qualitative research can be subjective in their view of findings, analysis of findings and reporting (Johnson & Christensen, 2010). In order to deal with researcher bias at all stages of this project, the researcher ensured reflexivity, as suggested in the literature (Anderson, 2008; Denzin & Lincoln, 2005; Finlay, 2002; Gray, 2014; Johnson &Christensen, 2010). Reflexivity entails critical self-reflection and examination especially with regard to potential biases (Johnson & Christensen, 2010). As already highlighted above (3.3.2 and 3.5), potential biases could have been linked to the researcher's past experiences which had brought valuable insight to secondary school mathematics teachers' experiences, but could also impact upon the researcher' interpretation of data for instance. Reflexivity entailed that researcher influence 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 PhD students, professional peers, research participants and engaging with the field notes, which included notes on reflections of the data collected.

3.8.3 Debriefing by peers

Peer debriefing involves the use of peers to comment on the research, including the research findings and conclusions, based on the argument that an alternative view can enable emergence of different or new and additional perceptions or interpretations of the data (Lincoln & Guba, 1985). The researcher engaged in informal and formal conversations and discussions with peers at the university to discuss the research and their advice was vital as it contributed to greater and richer understanding of the research process in general and research findings in particular. Other discussions were at conferences such as: University of Reading Institute of Education Postgraduate Research Conference; British Society for Research into Learning Mathematics (BSRLM) conference; British Educational Research Association (BERA); and University Research Group meetings where aspects of the research and the research findings were presented.

3.8.4 Member checks

This is also known as 'member validation' or 'feedback to participants' (Ary et al., 2009; Boeije, 2010). This is concerned with a researcher(s) confirming the findings with the research participants. It involves presenting the findings to the participants and asking them

whether or not they recognise the findings and consider them correct (Boeije, 2010). For this study, some of research participants verified the emerging findings, which were presented to them. Even though the participants concerned found this to be an unusual research practice in their context, they were able to give feedback and their contributions at this stage allowed for some refinements to the findings where necessary.

3.8.5 Thick, rich description

This refers to the provision of detailed write up that would help the potential readers to have an idea of and understanding of the setting and context of the study in its complexity and also to be able to make their own conclusions concerning a research (Ary et al., 2009; Creswell & Miller, 2000; Lincoln & Guba, 1985). The thick rich description can also help the reader to make their own conclusions regarding whether and the extent to which the conclusions or findings of a particular research can be replicated or is transferable to another setting, situation or people. This detailed write up can include detailed description in the analysis of data (Creswell & Miller, 2000). This study endeavoured to provide detailed description of the setting of the study including the data collection process and the findings for the purpose described in this section.

3.8.6 Low inference descriptors

This involves 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 study made careful use of and presented accounts of what participants said for the purpose of illustrating different participants' comments and perceptions related to the relevant aspects of the study and also in giving examples of representative responses as illustrated in chapter 4. The study also got literal citations from document data for the purpose of strengthening the interpretations of the data (Ary et al., 2009) that was collected and presented especially in the different sections of the findings and discussions chapter of this thesis.

Another point that can be regarded as an extension of the ideas covered in the above paragraph on low-inference descriptors is that associated with tape recording interviews. Tape recording interviews helped in keeping the data in its 'raw' form. The recorded interviews were then played over and over again to facilitate thorough transcription. As noted earlier under 3.4.2.2, this reduced the chances of unnecessarily altering the data compared to note-taking where the chances of the researcher consciously or unconscious selecting data to note, based on some preconceived ideas, are high. Seale (1999) states that tape recording is a

way of '…removing the selective effect of researchers' perceptual skills' thereby contributing to preserving data in its 'raw' form' (p. 148). For instance, when reporting, the researcher ensured that emphasis was placed on identified aspects of the teachers' comments in a similar way as the teacher had placed emphasis on the words spoken. In this way, the researcher was making efforts to let the data speak for itself. Therefore, the researcher is confident that data reported is correct and accurate.

3.9 Ethical Considerations

Ethical considerations in the research context can involve a researcher having regard and respect for the research participants (and the research site) and being sensitive to their rights. The University of Reading Code of good practice states that 'the dignity, rights, safety and wellbeing of participants must be the primary consideration of any research study'(UOR, 2012, p. 16). Boeije (2010) identifies some of the general ethical principles or ethical considerations that a researcher needs to adhere to when carrying out research: informed consent, privacy, confidentiality and anonymity. The following subsections shade light on the application of these principles in this study.

3.9.1 Informed consent

To start with, the researcher followed the University of Reading ethical guidelines as approved by the University Board for research and innovation and was allowed to proceed with the research. The researcher also obtained permission to carry out the research from the MOE officials at provincial and district levels (Appendix B1 & B2) to get access to the secondary school sites where the secondary school mathematics teachers were to be found.

'Informed consent' defined as an agreement to take part in a study after being informed of the purpose and procedures of the study, its risks, benefits, alternative procedures and the limits of confidentiality if any (Johnson & Christensen, 2010) was sought from the teachers before data collection commenced. This helped in building a trusting relationship with the participants. A brief summary of the research including its aim was explained to the participants before the interviews and before administering the questionnaire and a copy of a section on it was included on the consent form (Appendix E1) which the participants had to complete before engaging in the research and information sheet (Appendix D). The participants were given a chance to willingly participate in the research without any form of coercion. They were also informed that they could opt out at any point if they felt they needed to without any form of pressure or repercussion from the researcher. Informed written

consent was obtained from the participating secondary school mathematics teachers and key informants that took part in this research.

3.9.2 Privacy, confidentiality and anonymity

In order to ensure the privacy of the research participants, the researcher did not identify the participants by name with the information that was collected and presented in the thesis. This was the case even for the participants that included their names and phone numbers on the completed questionnaires. The contact details they provided were only used for the purpose of getting in touch with them concerning this study and not to be disclosed under any other circumstances.

Participants' real names and the schools in which they taught were not disclosed in any way in this thesis. For the sake of anonymity code names could be used instead of participants real names (Wood & Smith, 2016). In reporting the responses to interview questions for instance, the researcher used interview numbers instead of interviewees' real names as it was thought that readers would not be able to or would not find it easy to track or relate interview numbers to the interviewed persons. Participants were assured that the information they had provided was only to be used for purposes of this study as stated in the signed consent form and not be used against them in any way. In addition, the participants were informed that the audio recording data were to be stored securely on a password-protected computer and data destroyed after a period of five years as stated in the signed consent form. Further, participants were informed that they could have a copy of the report based on the data collected if they wished to have one.

3.10 Chapter summary

This chapter has presented detailed information about the research methodology. The study is broadly qualitative in nature and the reasons for this have been provided. Multiple sources of the qualitative and quantitative data that was needed to address the research questions and present information related to whether and how CPD meets secondary school mathematics teachers' needs and to what extent have been presented. It is clear that with the use of multiple methods the strength of one method complemented the insufficiencies of the other methods under consideration and that each method played a significant role in providing in-depth information for this study. The chapter has also presented the steps that were taken to reduce the threats to the research's credibility and trustworthiness before concluding. 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 and discussion of findings

The preceding chapter concentrated on the research methodology used to obtain data for this study. This chapter presents and discusses the main findings of the study. It starts with an overview description of participants in the study and then a presentation and examination of data in relation to the research questions. Thus Section 4.1 provides an overview of the participants in the study. The subsequent sections represent responses and interpretation of responses to each one of the research questions. The presentation and discussion of findings follows the order in which the research questions were addressed: Section 4.2 presents the findings of the research with section 4.2.1 focusing on the findings that relate to research question one, section 4.2.2 the findings related to research question two, section 4.2.3 presenting the findings associated with research question three and finally section 4.2.4 with findings and discussion related to research question four. Section 4.3 gives the chapter summary.

4.1 Overview of participants in this study

In this study, secondary school mathematics teachers' perspectives of their CPD were investigated. The views of key informants (3.3.2) who were broadly representing CPD providers and managers were also obtained as they are at the top of the hierarchy and have an influence on the planning and management and support of secondary school mathematics teachers' CPD practices. Their knowledge on CPD to an extent translates into guidelines on CPD and into particular CPD practices. Ninety (90) secondary school mathematics teachers and 6 key informants participated in this study. As stated earlier, questionnaire, face-to-face in-depth interviews, FGDs and documents for analysis were used in data collection. The key informants did not complete any questionnaire but only interviewed in order to obtain data for the study. They also provided access to some of the relevant documents that were analysed for this study.

4.1.1 Background information of teachers

4.1.1.1 Gender of teachers

The distribution of the 90 teachers who participated in the study by gender is shown in Table 6 below.

Table 6 Distribution of teacher participants by gender

	Number	**Percentage (%)**
Male	63	70
Female	27	30
Total	90	100

Of the 90 secondary school mathematics teachers who participated in this study, 60 (70%) were male and 27(30%) female. This shows that majority of the teachers of mathematics are male. The numbers of female Heads of Mathematics Department is even lower. Out of the total of 14 HODs who participated in this study only 2 (14%) were female. This is fairly indicative of gender trends in mathematics teaching in Zambia.

4.1.1.2 Age group of teachers

The age group distribution of teachers that participated in the study is presented in Table 7 below.

Table 7 Age groups of teachers

Age group	**Nº of teachers**	**Percentage (%)**
20 - 25 years	9	10.0
26 - 30 years	15	16.7
31 - 35 years	16	17.8
36 - 40 years	18	20.0
41 - 45 years	18	20.0
46 - 50 years	11	12.2
Above 50 years	3	3.3
Total	90	100.0

The table above shows that 10% of the teachers were in the youngest age group of 20-25, approximately 12% in the older age group of 46-50 years and only 3.3% in the oldest age group of 50 years and above. As for the age groups starting with the 26-30 right up to the 41-45 years age group there is almost uniform distribution of the number of teachers. Based on the information provided in Table 7, it can be deduced that more than half (64.5%) of the

teachers are aged 40 or below whereas those aged 41 and above make up only 35.5% of the total number of teachers who participated in the study. Inference can be made that there is a relatively young population of secondary school mathematics teachers in the study context.

4.1.1.3 Teachers' highest academic qualifications

The academic qualifications teachers who participated in this study are shown in Table 8 below.

Table 8 Teachers' highest academic qualification

Academic Qualification	Nº of teachers	Percentage (%)
Certificate of Education (or equivalent)	9	10.0
Diploma	50	55.6
Bachelor's Degree	30	33.3
Master's Degree	1	1.1
Total	90	100.0

Out of the 90 teacher participants, 9 (10%) had a Certificate in Education and 50 (55.6%) had a secondary school teaching qualifying Diploma, a number made up of 38 with a Diploma in Education and 12 with an Advanced Diploma in Education. Thirty (33.3%) had a Bachelor's Degree and 1 (1.1%) with a Master's Degree. It is clear from Table 8 above that even though the minimum qualification for teachers at secondary school level is Bachelor's degree in a teaching field, there is still a relatively large percentage i.e. 65.6% (59 out of 90) of the secondary school mathematics teachers who are underqualified and needing upgrading. There are some teachers with Diploma in Education who are currently upgrading. The information above however does not give a clear picture of how many they are as this information was not made available to the researcher. With the increase in the number of public universities and the mushrooming private universities in the country and a provision for Distance Education, it is expected that currently serving teachers are enrolled or planning to enrol in order to upgrade their qualifications.

4.1.1.4 Years of teaching experience

The years of teaching experience of the 83 secondary school mathematics teachers is given in Table 9 below.

Table 9 Teachers' number of years of teaching experience

Years of experience	Nº of teachers	Percentage (%)
0-3 years	10	11.1
4-7 years	18	20.0
8-15 years	35	38.9
16-23 years	17	18.9
24-30 years	7	7.8
31^{+} years	3	3.3
Total	90	100.0

The categorisation of teachers' years of experience followed Day et al.'s (2006) model and was incorporated in the questionnaire (Appendix C). According to the findings, the secondary school mathematics teachers in this study had teaching experiencing varying from less than a year to more than 30 years of teaching experience. The majority of the teachers 35(38.9%) have 8-15 years of experience and the least number, 3(3.3%) falling within the 30^{+} years of teaching experience. With further reference to the categorisation presented under 2.3.5.1.1, the largest number of teachers 52(57.8%) are in the mid-career stage followed by 28(31.1%) teachers in the newly qualified and early career stage career, and the smallest number 10(11.1%) in the late career stage.

4.1.1.5 Grade level teachers taught

The respondents were asked to state which grade level they currently teach. The responses are shown in Table 10 below.

Table 10 Grade level(s) teachers' taught

	Nº of teachers	Percentage (%)
Junior secondary school grades (8-9)	27	30.0
Senior secondary school grades (10-12)	28	31.1
All secondary school grades (8-12)	35	38.9
Total	90	100

Table 10 shows that out of the 90 secondary school mathematics teachers who participated in the study, almost the same number: 27(30.0%) and 28(31.1%) taught at junior secondary school level (Grades 8-9) and senior secondary school level (Grades 10-12) respectively. A bigger number of the teachers, that is, 35 (38.9%) taught all grade levels. From further analysis of data that compares the teacher qualification and grade level taught (Table 11 below) it is deduced that not all teachers teach the grade levels they were trained to teach.

Table 11 Teachers' highest academic qualification*Grade level(s) currently teaching cross tabulation

Teachers' highest academic qualification	**Grade level(s) currently teaching**			**Total**
	Junior secondary school	Senior secondary school	All Secondary School grades	
Certificate of Education (or equivalent)	5	4	0	9
Diploma	14	14	22	50
Bachelor's Degree	8	9	13	30
Master's Degree	0	1	0	1
Total	27	28	35	90

For example, Table 11 above shows that 14 out of 28 teachers who taught at senior secondary school level and 22 of the 35 who taught all secondary school grade levels had Diploma qualifications and ideally only expected to teach at junior secondary school level. The same applies to teachers with a Bachelors' Degree. While those with Certificate of Education are supposed to teach at primary school level, they teach secondary school level grades. The possible explanation for this is the critical shortage of qualified mathematics teachers, which has also contributed to the available mathematics teachers having heavy workloads, compared to teachers of other subjects.

4.2 Research findings and discussions

As earlier stated, the presentation and discussion of the findings follow the research questions.

4.2.1 Research question one

The first research question is: 'How do secondary school mathematics teachers perceive CPD and its value?' This question considered secondary school mathematics teachers' conceptualisation of CPD and in their responses, as presented through the questionnaire, interviews and FGDs, teachers shared their understanding and interpretation of CPD in general and what it meant to them and in relation to their work. Although most teachers were not able to state correctly what the letters in the acronym CPD represented they appeared to be familiar with the acronym and were able to share what they understood by CPD. An analysis of their responses led to the following emerging themes and categorisation of the understanding of the nature and value of CPD: CPD as an event; CPD as a collective activity; CPD as learning; CPD as a government directive; and CPD as a ladder to promotion. The teachers' responses pertaining to each one of these categories are presented below.

4.2.1.1 CPD as an event.

In an attempt to share their understanding of CPD and its value most teachers referred to events such as peer observing a lesson or attending a meeting pertaining to LS as being CPD. An example of teachers' responses is: '*CPD is when you have Lesson Study cycle'*. (Questionnaire)

In the same line, one teacher stated that: *'It is not practical for me to have Lesson Study [*referring to CPD*] when it is just one person in the department. Because CPD is when you have Lesson Study meeting…*(Interview 20*)*

Another said *'CPD is attending workshops, but people like me have not had a chance to attend any workshop in a long time so no CPD... '*(Interview 4)

It can be concluded that some teachers' understanding of CPD is linked and limited to a specific kind of (CPD) event. However, literature such as Day (1999) indicates that CPD goes beyond attendance of a CPD activity. It is not necessarily an event itself, but a process. Other literature (Day, 1999; Friedman, 2013; Guskey, 2002; Harwell, 2003; Loucks-Horsley et al., 1987; Sparks & Loucks-Horsley, 1998; Villegas-Reimers, 2003) also emphasise the point that CPD in itself is a process that goes beyond an event or particular activity or collection of activities (see section 2.1). CPD activities such as LS provide opportunities and are avenue intended to facilitate teachers' professional, personal and social development (2.3.2) and improve teachers' practice (Harwell, 2003; Mahmoudi & Özkan, 2015; Mansour et al., 2014).

If focus is on an event such as lesson planning then it shifts attention from other formal CPD activities and less formal PD such as personal study or on-the job learning, which are equally important avenues for PD. It shifts attention from holistic picture of PD, which covers '…all natural learning experiences and those conscious and planned activities…'(Day, 1999, p. 4).

4.2.1.2CPD as a collective activity

Teachers' responses during interviews, discussions and questionnaire referred to the point that CPD was about coming together as a group to share ideas and resources for teaching for the purpose of improving their teaching practices. Excerpts representative of this view are:

I am sure there is a definition for CPD somewhere, but in my opinion based on experience, CPD is when you meet with other teachers to share ideas on teaching challenging topics in Mathematics, and plan a lesson to teach based on the shared ideas. (Interview 1)

CPD is when you arrange to and meet with others and have a chance to share ideas concerning teaching with colleagues. (Questionnaire)

Such arguments could have their roots in the fact that LS, which is a major form of teachers' CPD in Zambia, is largely based on collaborative approach to teacher learning (1.1.4: 2.2.3: 2.2.4). Collaboration in general and in the specific areas as attached to LS has a crucial role to play in teachers' PD (section 2.2.5). However, some teachers in this study pointed out that this collaborative nature of CPD is a contributing factor toward some teachers shying CPD meetings.

One HOD said:

…It is a put off for some teachers who don't seem to have anything to contribute or share during meetings…because one doesn't only have to get ideas from others, but they also need to share their knowledge. The atmosphere itself makes them feel under pressure to share something…when not comfortable they stay away. (Interview 32)

One teacher's comment seemed to confirm the HOD's view point by stating that:

I feel under pressure to say something during these CPD meetings. Whenever I manage to say something I feel like it is undermined or ignored. It is like nothing I say is really up to the standard of a trained teacher as I feel others ignore or simply do not take in any of my contributions on… (Interview 36)

While arguing that collaboration is one of the important tools in teachers' CPD with considerable benefits, it has to be stated that barriers to its success such as school culture and structural factors and working relationships should be addressed. There should be a means to making a provision for collaboration and/or ensure that teachers understand the value of collaboration in the context of CPD (Billingsley et al., 2014; Bolam & McMahon, 2004;

Kennedy, 2011). Such means may have to be context specific depending on the nature and complexity of the barriers to collaboration in different contexts.

The conceptualisation of CPD as a collective activity raises the question on '…how far CPD is perceived as an 'individual' activity… as opposed to a 'group' activity, in which teachers work as a team...' (Gray, 2005, p. 11). It can be argued that these two are not conflicting. (Kennedy, 2011) asserts that collaborative learning is not meant to replace or compete with individual learning, but rather to complement it. Individualised and collaborative CPD can both facilitate teachers' PD (section 2.2.5).

4.2.1.3CPD as learning and developing

Teachers' understanding of CPD was linked to learning. Representative of this view are the following comments from teachers:

It is about learning, it is about learning and growing in what I know about teaching mathematics and how to teach it... '(Questionnaire) 'Learning is a continuous process that never ends for us teachers and CPD is about us continuing learning, updating our professional knowledge and skills. For example, I have been learning a lot about teaching topics like Transformation, Trigonometry, Probability, Linear Programming and Earth Geometry topics in which I found myself wanting (Interview 5)

CPD is learning whether it is new things or revising what you already knew...the bottom line is it is all about learning and you continue learning (Questionnaire)

Several teachers were of the view that CPD was essential and that they supported the idea of CPD being about learning, unlearning and relearning. Similar findings emerged in Banda, et al.'s (2007, 2011) studies conducted in the central province of Zambia. Similar conclusion have been made in other literature on teachers' CPD (Bell & Gilbert, 1996; Day, 1999). While several teachers were of the view that CPD was an essential part of their work, some teachers expressed reservations to the idea especially with how it is presented in practice. For example, teachers had this to say:

The idea of CPD is very good for us teachers to become more knowledgeable in our fields and improve our practice, but along the way it has lost its value in the way it is being done. Like it is nothing about what I would like to learn, but about what other people at the top want me to learn (Interview 2).

This contradicts what one MOE official stated concerning CPD in practice:

…Of course we have some target learning areas for teachers at national level…but what it is is that teachers know that they are free to learn what they want to learn and learn however they want to learn what they want for their PD (Interview 18)

In line with and expanding on the point on what CPD is in practice some teachers stated that*:*

…CPD is about learning, but it is boring,' (Questionnaire)*; 'It is generally about superficial learning' (Questionnaire); 'It is monotonous, unnecessary repetition of the same things* (Interview 19).

If CPD is about learning, growing or developing then at least I need to know where I am and what could be done to help me grow from one level to another. Or I should be able to assess whether I am progressing or am static? When certain things are imposed on me I don't see how that can bring about any development there. Because I should be given a free mind to think and bring on board areas I think I am lacking and need to work on for me to grow (Interview 20)

Another explained that:

…the idea of 'continuing' in CPD-Continuing Professional Development to me means that I am aware of where I am in terms of the knowledge and the skills on which I have to keep building (Interview 1*)*

The above is an indication that while CPD is indeed about learning there is one aspect that has not been paid attention to: teachers being aware of the point where they are in terms of knowledge and skills and also be able to design a path for their development by identifying possible ways to meet the identified needs. The teachers' concerns are similar to those Day (1997) has made reference to in his work when he states that 'without a clear conception of what this 'growth' might look like it is difficult to determine a path for professional development' (p. 40). Similar arguments are raised by other literature (James & McCormick, 2009; Timperley et al., 2007). In addition, teaching teachers requires '…having a good sense of where they are starting from by clarifying their initial conceptions about mathematics… so that enrichment activities will be appropriate for them'(Loucks-Horsley et al., 1996, p. 4). Thus suggesting that it is imperative that CPD providers are equally aware of the knowledge and skills levels and needs of the target teachers.

One teacher's concern was that:

I can say CPD is about learning and developing as a result, but what puzzles me is the 'development' part, which we do not seem to be working out correctly here. Developing what exactly? We can't all say we need to 'develop' in one and the same area. If we call it development, then it is not clear what this development is and what it looks like to me for me to proudly say 'yes' I have been learning and I have developed (Interview 24)

One of the issues that emerge here is that meaningful learning is facilitated with individuals' active engagement in the process of knowledge construction and reconstruction which can be accomplished through reflection and involving metacognition where teachers are able to know about, monitor and evaluate their own learning. This is consistent with the principles of

constructivism and also supported by the principles of the theory of Adult Learning (1.7.1: 1.7.2).

Even though what is learnt was in some cases not stated in most of the other cases it was limited to mathematics content knowledge and pedagogy with a few referring to knowledge and skills for coping with personal life struggles. Examples of teachers' comments are:

…the whole idea of CPD is about increasing teachers' knowledge in what to teach and how we are to teach…(Questionnaire)

CPD is about teachers developing in their way of teaching the topics in the syllabus and helping them with improving pupils' performance (FGD 2)

It is deduced that even though teachers considered CPD as learning and developing, their focus was mainly learning as related to acquiring technical mathematics knowledge and teaching skills and less on considering knowledge and skills pertaining to the social and personal development. This shows that many teachers' perspective of CPD for them as learners is limited. This is because CPD should contribute to the development of both hard and soft knowledge and skills (Struthers, 2007; Heckman & Kautz, 2012). PD is accompanied by social and personal development (2.3.2: 2.3.2.1 - 2.3.2.3)

4.2.1.4 CPD as a directive from government.

Some teachers in this study viewed CPD as a directive from government and they needed to comply. One teacher had this to say:

In my opinion, CPD is something that is being used by government as a way of making sure teachers change along with the new curriculum. It is a way of making teachers get ideas of how to implement the curriculum the way we have the new curriculum…(FGD1)

CPD can be a means governments use to direct teachers to national educational priorities (2.2.2). Thus, it can be considered as justifiable especially in the light of the changes that have come with the new and revised curriculum. The new curriculum has, among other issues, spelt out some changes in the mathematics content and in the way mathematics is to be taught (1.2.3).

Another teacher stated:

CPD is about doing what government wants us to do: do lesson planning together, observe one of you teach, discuss the lesson afterwards- and we go through the motions just like that …so that we satisfy our employers (FGD 2)

Yet another stated that:

CPD is about doing what you are told to do by your employers as being of benefit to the job. I say this because if I do anything that is not described or recognised by government as CPD it will not be accepted as CPD. So, I think the principle here is to do as you are told. (Interview 7)

Such views point of CPD being a top-down initiative with government at the top, with the school management and administration team running it at school level and teachers at the bottom and therefore benefiting school management and administration team and government itself and not individual teacher development. Further, the views point to a lack of recognition of the point that there are multiple agents in CPD provision (2.2.3). Government is one of them, but there are several others. Furthermore, such views of CPD solely as a directive from government suggest that CPD can only be CPD when it is formal and structured and thus detaches teachers' self-directed learning and informal CPD as an aspect of CPD. CPD activities encompass formal and structured CPD and informal CPD activities too (2.2.4.1: 2.2.4.2). While there is to be an element of complying with professional standards set by government, there should also be an element of and recognition of a degree of teacher autonomy (2.4.4.4) regarding their PD. This appears not to be recognised. One teacher's comment to this effect was:

Most of us have been attending LS as a formality, to fulfil government expectation for teachers. Given a choice, I would commit to other ways of promoting professional growth, that is, if they were there and they were recognised (FGD1)

One HOD pointed out that:

…sometimes teachers use attendance of LS as a way of running away from attending to their classes… they seem to have a very perfect excuse: that the government through the MOE has directed us to attend LS at all cost…(Interview 16)

Similar findings emerge from other studies in Central Zambia such as that by Kabeta (2015) which confirm that LS is the main form of CPD. The negative attitude toward this form of CPD could stem from the point that there is limited awareness of the nature of CPD and CPD possibilities. It could also stem from the idea that current CPD initiative does not take into account their diverse needs, aspirations and priorities.

CPD issues are burdensome. We already have a lot of work as it is. It is a shame as it is like the government wants to overload us with more work, actually more unnecessary work as there are more pressing things we could be doing (Interview 22)

As if reacting to teachers' sentiment presented above, one MOE official stated that*:*

…the government is doing the right thing to give some sense of direction in terms of CPD for teachers. Teachers should not regard SBCPD through LS simply as government imposition… They should not simply dismiss SBCPD through LS as an additional burden or a way of imposing. It is meant to help them get better at their work. (Interview 15)

Another teacher's comment worth noting here is:

I see CPD as a way of experimenting with the ideas that government borrows from other countries it considers as cooperating partners to strengthen their relationship. This time our government has borrowed from Japan this CPD -LS thing. We are likely to move on to something else after some time, but in the meantime whether I am comfortable with it or not it has to be done according to governments' recognised way.(Interview 26)

It is not surprising that teachers expressed uncertainty about the positive effects of ways of working that are 'borrowed' from other countries and being adopted in their work context. Neither is it surprising that they expressed negative feelings toward imposed top-down directives. With such views, it is highly likely that some teachers ignore the directives and carry on with their work as before. The literature (Bailey, Blackstock-Bernstein, & Heritage, 2015; Fullan, 1991) makes reference to sentiments and ways of working as expressed above. However, it is important to note that most reforms in the education system come from external sources and appear as 'borrowed ideas'. What is important to note also is that the literature (Fullan, 2002) has also shown that there are ways of reducing resistance to implementation of reforms from external sources such as: informing teachers of change, giving teachers some degree of control or say and input in the planning for and actual implementation process of the changes. This can contribute towards teachers starting to view change and embrace the new ideas as their own even though coming from an external source. When teachers are working in an autonomy supportive environment (Knight, 2007) it is relatively easier for them to embrace change as their own (2.3.4).

4.2.1.5 CPD as a ladder to promotion

Teachers regarded CPD as a way that increases chances of being given additional recognizable responsibilities and positions within the school, of being promoted to a higher position in the MOE or enabling them to change their careers.

CPD for me is a way of preparing me to get to the top as an administrator… I don't see myself remaining a teacher for the rest of my life. (Interview 6)

When those in higher positions see your commitment to CPD they are likely to give you some extra duties from which you can make some extra cash or they can promote you. …I know of colleagues who were very committed to this CPD thing that they even got themselves promoted...(FGD 2)

There were a few however who made contradicting comments to the effect that there was no obvious relationship between commitment to CPD and being promoted. An example of their responses to this effect is:

Mathematics teachers are in most cases not promoted because if they were, then they would create further shortages at the school level. So those who think they are going to be promoted are simply dreaming.(FGD 2)

The findings of this study are consistent with findings from studies such as by Hustler et al. (2003) and Kombe & Nkumbi (2008) in which some teachers stated that CPD is a ladder for their promotion while others also argued that it had little impact on their promotion outlooks.

A school CPD coordinator mentioned during the interview that:

There aren't many positions for teachers to take up and therefore teachers should not be thinking that involvement in CPD would eventually translate into promotion. He further added that, 'however, in order to keep their morale high there may be need for government to show some recognition of some kind for those teachers who have consistently committed to CPD…this could be some kind of motivation like in the form of an incentive…it is something that government should work on... (Interview 21)

The views shared by the CPD coordinator was similar to that shared by one MOE officer who stated that:

It is not 100% right to attach promotion to CPD. There are very few positions in the Ministry to which teachers can be promoted to. Besides we need teachers to remain in their teaching positions. The best is to think of CPD as a way of improving oneself as a teacher so as to be more productive. CPD is rewarding in its own right, but may be to motivate the teachers further the government should find a way of recognizing teachers' commitment to CPD…(Interview 15)

Despite comments to the effect that mathematics teachers are rarely promoted or given additional responsibilities due to the shortage of mathematics teachers and heavy workloads, there were some mathematics teachers who had additional responsibilities such as HOD, school CPD coordinator among other roles. What may be considerable action would be to allow for teachers to engage in CPD related to their diverse roles. A point that is consistent with work such as that by Schibeci & Hickey (2003).

In response to questionnaire item under Part D about teachers' career prospects, most teachers appeared to have a career path or prospect in mind. As shown in Table 12 below, the biggest group of teachers in the study that is, 39 (47%) wanted to be lecturers at college or university level followed by 16 (19%) who want to be HOD and only 7(8%) who wanted remain as Mathematics class teacher.

Table 12 Mathematics teachers' long term career plan

	N^{O} OF TEACHERS	**PERCENTAGE (%)**	**RANKING**
Lecturer at a college or University Class teacher	39	47	1
HOD	16	19	2
Head teacher	8	10	3
Class teacher	7	8	4
Deputy Head teacher	4	5	5
Become an administrator (at District, Provincial or National level)	4	5	5
Stop teaching and look for another job	3	4	6
Retire	2	2	7
TOTAL	**83**	**100**	

Working on assumption that the thirty-nine teachers actually become lecturers it would be right to plan on increasing the supply of secondary school mathematics teachers. It would also mean that CPD should be designed in such a way that contributes toward retaining, generating and maintaining teachers' (dying) enthusiasm for classroom teaching especially with respect to the 8% who indicated that they wanted to remain class teachers. This is in line with the observation made by AU(2012) that a focus on addressing the shortage of teachers should go hand in hand with focus on addressing the needs of the teachers who are actually serving and supporting them in the process of lifelong learning. An argument which Smith (2004) underscores: '**…**to improve retention in the profession, there is a need to revive and sustain the enthusiasm of existing qualified teachers of mathematics, as well as a need to support and develop them throughout their teaching careers…'(p. 109). Indeed, in the face of critical shortages of secondary school mathematics teachers in Zambia, it matters a lot that leaders at local and national level join and heighten efforts directed at retaining the few mathematics teachers that are currently serving. A suggestion by Hambokoma et al. (2002) of creating, within the realm of teaching, positions of responsibility or salary scales that would allow individual teachers to receive salary increases and still continue teaching is worth considering.

While it is true that CPD supports career aspirations and progression (Friedman, 2013) of the teachers, thus benefiting the teachers themselves, it is meant to benefit others too (section 2.2.1: 2.2.1). It is meant to be of benefit to pupils, fellow teachers, the school system to mention but a few. This argument is supported by authors such as Day (1999) and Friedman, (2013). Day (1999) particularly states that CPD is '…intended to be of direct or indirect benefit to the individual, group or school and which contribute through these to the quality of education…' Therefore, the need for CPD participants to look beyond the benefits to themselves and embrace the broader picture of CPD that looks to benefiting others too. Based on literature reviewed so far (see section 2.2.1; 2.2.2) it is deduced that CPD is vital for individual teacher development and essential for development of effective teaching practice whether this results into promotion or not.

4.2.1.6 Summary of findings and discussion

Understanding how teachers perceive CPD and its value can help explain their participation in and commitment to CPD. Having an understanding of the meaning that teachers attach to CPD and its value can inform design and provision of CPD that can meet the perceived needs, expectations and aspirations of the target teachers.

Teachers in this study viewed CPD as 'an event', 'a collective activity', 'learning', 'a government directive' and/or 'a ladder for promotion'. The summary of key findings regarding teachers' perception of CPD and its value is presented below.

Teachers' responses show that their conception of CPD differs and so does the value that they attach to CPD. This could be because there is no clear-shared definition of CPD. How committed teachers are to CPD can be explained or determined by their conception of CPD. Despite there being variations in teachers' conception of CPD, teachers' responses show that they have an understanding of the concept of CPD and its value but their understanding is narrow. Their perception and description of CPD is limited and limiting at the same time. For instance, teachers' conceptualisation of CPD as learners is devoid of a consideration for knowledge and skills for personal and social development in addition to knowledge and skills for their PD (2.3.2.1: 2.3.2.2: 2.3.2.3). Putting evidence from the various aspects of CPD and CPD needs in this chapter and making reference to relevant literature, it can be suggested that an approach to CPD that needs to be embraced is the kind of CPD that covers all activities that would promote teachers' professional and accompanying personal and social development. This is further expanded on under research question two. Additionally, what counts as CPD is limited to formally structured CPD. Teachers' self-directed CPD and

learning (2.2.4.2) is an aspect of CPD that is detached from the commonly held perceptions of CPD by teachers in the study. Based on teachers' conceptualisations of CPD and their engagement in CPD, there is little evidence and scope of integrating greater teacher autonomy within the context PD (see section 2.3.4).

All the differing, and sometimes seemingly conflicting perspectives of CPD need to be brought together for a shared understanding (Padwad & Dixit, 2014). A broad and all-inclusive definition of CPD is essential not only for teachers but also for all potential CPD providers (2.2.3). Relevant key stakeholder need to be aware of this broad and shared conception of PD (Lieberman, 1995). Having a broad and all-inclusive shared definition of CPD could pave way for meaningful cooperation between and among relevant stakeholders in CPD provision and more opportunities for widening the content of CPD sessions so as to meet teachers' various and diverse CPD needs (2.3). Provision of a broader CPD content is necessary considering the various perceived CPD needs (Lieberman & Miller, 1991; Timperly et al., 2007). Having a broad CPD content (2.3: 2.3.2: 2.3.2.1 - 2.3.2.3: 4.2.3.1 - 4.2.3.6) can only be a reality with the cooperation of and support of multiple relevant key stakeholders and agents of CPD (2.2.3). This point is in line with the Ministry of Education statement in the EOF policy document that:

The Ministry of Education's capacity to offer in-service is quite limited. Meeting the diverse needs of teachers for on-going professional and personal development is too extensive a task to be the responsibility of the ministry alone. It requires the participation of a number of agencies working along several different lines of approach. (MOE, 1996, p. 115).

4.2.2 Research question two

The second research question is 'What CPD activities are secondary school mathematics teachers in Zambia currently engaged in? How do the teachers perceive these CPD activities?' This question was concerned with determining the types of CPD activities that secondary school mathematics teachers actually engaged in and establishing their perception of these activities. It is important to note here that apart from the Framework for SBCPD through LS (Appendix L) there is no CPD Framework among the government documents that lists the CPD activities that schools and teachers could ideally consider at each stage in a teacher's career in Zambia. The list of CPD activities under item A2 of the questionnaire considered a mix of formal and informal, compulsory and self-directed professional learning experiences as presented and discussed in chapter 2 (2.2.4: 2.2.4.1: 2.2.4.2: 2.2.5). These were of interest to this study because they allowed for insight into the forms of professional learning opportunities that are available for the secondary school teachers of mathematics.

In response to questionnaire item A2 about CPD activities teachers had been involved in, teacher responses were indicated by ticks ( ) to denote the option representing their choice. Table 13 below summarises their responses.

Table 13 CPD activities teachers participated in

CPD Activities	**Number and Percentage (%) of teacher per category**					
	N	R	**N+R**	O	A	**O+A**
Lesson Study	2 (2.4)	4 (4.8)	**6 (7.2)**	29 (34.9)	47 (56.6)	**76 (91.6)**
Peer class Observation (Observe colleagues teach)	7 (8.4)	5 (6.0)	**12 (14.4)**	40 (48.2)	31 (37.3)	**71 (85.5)**
Collaborative teaching	8 (9.6)	5 (6.0)	**13 (15.6)**	41 (50.6)	28 (33.7)	**70 (84.3)**
Personal study (e.g reading subject related/education/profession-related literature)	6 (7.2)	9 (10.8)	**15 (18.1)**	26 (31.3)	42 50	**68 (81.9)**
Departmental meetings	5 (6.0)	11 (13.3)	**16 (19.2)**	27 (32.5)	40 (48.2)	**67 (80.7)**
Higher academic Qualification studies (e.g attending courses at college or University)	21 (25.3)	6 (7.2)	**27 (32.5)**	39 (47.0)	17 (20.5)	**56 (67.5)**
Informal Networking with colleagues (informal dialogue to improve teaching and learning)	9 (10.8)	32 (38.6)	**41 (49.4)**	22 (26.5)	20 (24.1)	**42 (50.6)**
Mentoring (as mentee or mentor)	7 (8.4)	53 (63.9)	**60 (72.3)**	18 (21.7)	5 (6.0)	**23 (27.7)**
Demonstration Lessons by CPD providers	36 (43.4)	24 (28.9)	**60 (72.3)**	17 (20.4)	3 (3.6)	**20 (24.1)**
Local/Regional/National Education-related conferences, workshops and seminar	38 (45.7)	27 (33.5)	**65 (78.3)**	15 (18.1)	3 (3.6)	**18 (21.7**
Visits to other schools to share teaching experiences	46 (55.4)	23 (27.7)	**69 (83.0)**	9 (10.8)	5 (6.0)	**14 (16.9)**
Online learning	52 (62.7)	21 (25.3)	**73 (88.0)**	7 (8.4)	2 (2.4)	**9 (10.8)**
Research (e.g Action research or individual or collaborative research etc)	58 (69.9)	19 (22.9)	**77 (92.7)**	4 (4.8)	2 (2.4)	**6 (7.2)**
Publications	61 (73.5)	17 (20.5)	**78 (94.0)**	3 (3.6)	2 (2.4)	**5 (6.0)**
School-University partnerships	67 (80.7)	12 (14.5)	**79 (95.2)**	2 (2.4)	2 (2.4)	**4 (4.8)**
Overseas Education-related conferences, workshops and seminar and exchange visits	78 (94.0)	2 (2.4)	**80 (96.4)**	3 (3.6)	0 (0)	**3 (3.6)**

Key: N-Never, R=Rarely, Never and Rare=N+ R, O = Often, A= Always, Often and Always=O+A

4.2.2.1 Lesson Study

Table 13 above, shows that majority (92%) of the respondents in the study stated that they often and always participated in LS. This view was confirmed during interviews and FGDs too. An example of a comment raised to this effect was: '*what we know is that CPD is when you have LS and that is what we have been doing'* (FGD1). LS is a direct policy initiative

from government and teachers are expected to comply (2.2.4.1.2: 1.4: 4.1). One teacher had this to say:

We are expected to have three study cycles in a term'. We are supposed to give reports on the study cycles we have had to the Standards officers when they visit the school or present them at the stakeholders' meetings held almost every school holiday- it is always on the agenda (Interview 1*).*

Teachers' comments imply that LS is the most common CPD activity they engage in. A study by Kabeta (2015) presented similar findings stating that the most common type of CPD was LS. This is in line with MOE expectation (MOE, 2010). The benefits of LS have been presented by an array of authors (such as Banda, 2011; Stigler & Hiebert, 2009) and have been discussed in Chapter 2 (2.2.4.1.2). Some teachers in this study shared some of the benefits of engaging in LS. An example of a comment made includes:

Yes, it is imposed on us, but I have come to learn some things from my colleagues. A very good example is I now feel I have understood Earth Geometry as a topic in maths and can teach it with confidence. Some fellow mathematics teachers just have a way of lifting other teachers' spirits and for me this is the highlight of one of the LS I have attended. Most of them are boring I must confess, but there was this particular one I attended and felt rejuvenated (Interview 3)

The noted downsides in the Zambian situation have equally been identified by studies such as those by Kabeta (2015) and Banda (2007, 2011) and analysed under section 2.2.4.1.2.. Teachers in this study in particular consistently expressed their reluctance to engage in LS and that they felt under pressure with engaging in LS cycle citing factors such as: heavy workloads; poor collaborative culture among teachers and; lack of social skills sufficient to carry out collaborative tasks as demanded in conducting LS. Representative comments from the teachers to this respect include:

I feel under pressure with the whole idea of planning, observing a lesson and then critiquing it afterwards and revising the lesson plan…It takes up so much time and it is extremely difficult to do with people with whom there is poor or no form of good relations (Interview 43)

The whole idea of LS cycle to me is an additional workload as it takes up so much time and is a lot of work to plan a lesson collaboratively and then observe it, revise it and reteach it when you have to prepare several lessons for you own classes, mark piles and piles of pupils' books. It takes up my time to be with my pupils. I have had to miss lessons with my classes in order to fulfil this duty of attending to a LS cycle. (Interview 5)

The above could be some of the reasons for not being able to do the expected three LS cycles in a term as directed by MOE. Almost all the teachers in this study consistently stated that they have not been able to meet up to this expectation. Examples of comments to this effect were:

It is practically impossible for us to do three LS cycles in a term. We have too many commitments and our workloads are heavy. There is no time. If we have failed to complete even one LS cycle, how would one expect us to complete three in so limited time? (Interview 7)

We can't manage to do the three LS cycles…there is no time. MOE expectation and demands on us teacher are too high. (Interview 38)

4.2.2.2 Peer class observation

Even though peer class observations (2.2.4.2) was stated as an independent CPD activity on the questionnaire used in this study and 86% of the respondents indicated that they often and always participated in this CPD activity, it was clear from the interviews and discussions that the teachers mainly identified, and discussed, this CPD activity in the context of LS and not on its own right. Teacher observation of lessons and subsequent discussion of the taught lesson is an important component of the LS cycle (2.2.4.1.2). One teacher's comment concerning peer class observations in the context of LS was*:*

Let me share with you this. In the three years that I have served as a teacher, I have had several chances of observing other teachers when they are teaching a lesson that was jointly planned as part of the LS cycle. I have not had a chance to observe someone teach a lesson they had planned on their own and neither have I been observed myself. (Interview 3*)*

It cannot be stated with certainty whether teachers' peer observation experiences would be different, or the same, if the teachers were to peer observe in a context other than the LS context. The only evidence at hand is from the HOD's experiences who had had opportunities to peer observe lessons outside the LS context. One HOD had this to say:

…I have observed other teachers teach before because it is expected of me as HOD to observe them. I consider it is a duty- for appraisal or to investigate and confirm underperformance and I don't really see it has anything to do with my PD (Interview 17)

This view is consistent with literature (Cosh, 1998; Goosling, 2002; Villegas-Reimers, 2003) which state that peer observation is also conducted for the purposes of appraisal, promotion or investigating underperformance. When asked why the HOD did not consider peer observation as means for his own PD his response was: *'I have just never thought of it in that way'*. It can be concluded that what counts as CPD activities is largely limited to LS (4.2.2.1).

Teachers expressed some concerns regarding peer class observations through the interviews and FGDs. Some of the concerns are represented in the teachers' responses as indicated below:

I do it for formality and I think most of the teachers do'. Peer lesson observations are done superficially. 'I think it is a waste of valuable time because there is usually nothing much out of the peer observing that feeds back into my own practice (Interview 45)

It is like the aim is to judge the person, the teacher presenting the lesson and that is what I see us doing most, if not all the time. This I think makes us miss the lessons from there for improving our own practice (Interview 30)

Based on evidence from the teachers in this study judging the observed teacher, even with its negative effects to the observed teacher's confidence levels and to the supportive teaching environment, appears to be common occurrence. A similar observation has been made in the literature (Cosh, 1998; Goosling, 2002). Such practices are unlikely to add value to teachers' PD. It is argued that peer observation can be effective in enhancing teachers' CPD if concerns such as the ones above raised by teachers are accounted for and addressed.

4.2.2.3 Collaborative teaching

While collaborative teaching was indicated as a stand-alone CPD activity in the questionnaire used to obtain data for this study, it was clear from the interviews and discussions that the participating teachers discussed it within the context of LS. This could be explained by the point that, as earlier stated (2.2.4.1.2), LS is a collaborative form of CPD and as a result some of the teachers in this study considered collaborative teaching only as an element of or similar to LS. The majority of the teachers (84%) indicated on the questionnaire that they had often or always engaged in collaborative teaching. The rest (16%) indicated that they had never or rarely engaged in collaborative teaching and attributed this to the critical shortage of mathematics teachers.

For instance one teacher had this to say: *'I am the only mathematics teacher in this school at the moment so there is nothing like working together with other teachers in the department...'*(Interview 25). Another had this to say: *'It is almost impossible to collaborate when you have heavy workloads like I do'* (Interview 2). Different reasons applied for other teachers, for example:

I do not have all the details on collaborative teaching, but I am inclined to think it goes deeper than what we do under the LS setting. So, for that reason I would not want to say I have been engaging in collaborative teaching (Interview 21)

Literature on collaborative teaching (Nevin, Thousand, & Villa, 2007; Villa, Thousand, & Nevine, 2008) clearly indicate that collaborative teaching covers much more than what appears under LS as collaborative teaching. It can also include: teaching together (team teaching) in a teaching session; or a situation where one teaches and the other(s) observes; or

one teaches and the other(s) provides the needed support to learners during teaching time or two or more teachers working with the different groups of learners at the same (Nevin et al., 2007; Villa et al., 2008).

4.2.2.4 Personal study

Personal study was another CPD activity, which a relatively big number of teachers (82%) indicated they often/always engaged in. However, it is interesting to note that during interviews, the teachers consistently stated that they did not consider personal study as a form of CPD. Some teachers had this to say:

Reading is what we teachers are expected to do. I read stuff especially Mathematics textbooks when I am preparing my lessons or not, but I have not considered it as CPD (Interview 4*)*

It could be, but let me ask you this: Which officer from the Ministry of Education would accept that you do CPD when you tell them that you have been doing personal study? LS is what is known as CPD and that is what I know they will ask about: things like the number of LS cycles done not how much personal study or reading one has done…(Interview 7)

This suggests that, from the secondary school mathematics teachers' perspective, even though personal study involving reading subject related or education and professional related literature stimulates learning and is potentially important in promoting PD (2.2.4: 2.2.4.2), it is not recognised as CPD. This could be because of it being regarded as 'what teachers do or what teachers are supposed to be doing' or because of the complexity associated with proof of personal study, quantification and assessment of learning outcomes of personal study. Teachers' responses during the interviews, also intimated that even though they stated that they engage in personal study or reading of professional literature on the questionnaire their reading resources are very limited and limiting.

It is not easy to find proper reading material that can build you as the teacher. We only have access to limited mathematics related textbooks most of which are out-dated. Other education related literature is not easy to find either. If you manage to find any of such reading materials, they are most likely to be out-dated. Access to the reading material on the Internet is also very limited and restricted partly because of lack of computers and due to lack of or poor Internet facilities. We don't have Internet facilities in schools where we spend most of our time.(Interview 20)

The above comment was similar to the observation made by an MOE official concerning Teacher Resource Centres: '*We don't have a variety of reading materials for teachers. And from whatever we have it may be only one or two…mostly one copy available'* (Interview 9)

Reading professional publications or literature can be a source of general or subject-specific information such as giving information on instructional strategies, curriculum implementation processes and generally strategies for coping with work related demands (1.3.2; 1.3.3;

2.2.2.1). and other information relevant to teachers and their work. The reading culture in Zambia among school-going pupils, adults and professionals is however reportedly poor with lack of access to reading materials as one of the causes. This is consistent with reports on Zambia and Zambian's reading culture including in one of the leading newspapers in the country (Ndhlovu, 2015).

4.2.2.5 Departmental meetings

Departmental meetings (2.2.4.1: 2.2.4.1.2) were among the top five CPD activities that teachers in this study indicated they had often/always engaged in. Eight-one per cent (81%) of the teachers who completed the questionnaire stated that they attended Departmental meetings often/always compared to 19% who stated they never/rarely attended. Majority of the teachers confirmed, during the interviews and discussions, frequent attendance of departmental meetings. The teachers stated that it was a school requirement to attend departmental meetings. During the interviews and FGDs, teachers in this study indicated that the main activities that took off during these meetings were linked to planning and carrying out LS activities. Even though several other good ideas and practices for promoting PD and improving teaching practices can be conceived or shared and trainings offered during departmental meetings this was not as common. A copy of a CPD plan and minutes of a departmental meeting availed to the researcher is provided (see Appendix J and K).

Among the 19% of teachers who never/rarely attended departmental meetings stated that even though they are expected to hold departmental meetings it does not always work out as such in practice. One teacher in this category had this to say:

Our HOD is a very busy man… so it has not been possible to have departmental meetings. We haven't had any departmental meetings this year… (Interview 28)

It can be concluded that these teachers in particular did not comply with school regulations and government directives to carry out LS too. It also suggests a management crisis where there is no delegation of responsibilities in the event that the HOD is unavailable.

4.2.2.6 Local Regional/National Education related conferences and workshops

More than three quarters (79%) of the teachers stated that they never/rarely participated in workshops or conferences (2.2.4.1) at regional and national level where mathematics subject matter or pedagogy and/or other education-related topics are shared. This was attributed to the fact that they were not aware of the workshops they could attend, with others stating that even if they were aware of workshops to attend they doubted they would attend because of

lack of financial support to attend and/or permission not being granted by the school administration. One teacher lamented that: *'…It is rare that we are told about these workshops'* (Interview 46). As if to clarify the comment made by the teacher during interview 46, another teacher had this to say:

We are not aware of the workshops and even if we were, we would obviously not be among the invited people. The Head teacher, Deputy head or the HOD are the ones who usually attend these workshops leaving out the subject teachers. To make matters worse they quite alright attend the workshop but when they come back to their work base they fail to explain what was discussed with the concerned subject teachers. (FGD 2)

One teacher explained that one of the reasons why the Head teachers attend the workshops could simply be for monetary gain as there was always an incentive for attending. There was no follow up on this matter as it was considered to be beyond the scope of this study. One HOD however confirmed attending most of the organised workshops. The HOD had this to say:

Yes, we attend most if not all of these workshops because the organisers of the workshop invite the HODs specifically. I am not aware of any workshop where the HODs were not invited. There are however some few cases where the workshop organisers write to invite the HOD and another member of the department to attend, but because of financial constraints in schools only one person ends up attending and that has to be the HOD. (Interview 8)

Only 21% had often/always participated in workshops. The few that stated that they had participated in the local workshops also shared that they had not had the chance to share with colleagues what they had learnt. They shared comments similar to the one below:

I have been among the privileged few to attend a workshop with the HOD. As far as I can remember we were supposed to share the workshop information with other teachers in the department who did not attend. But this has never happened up to this date and it is almost 2 years now since we attended that very educative workshop…(Interview 28)

Even though in the literature (Hustler et al., 2003) the commonly held perception of CPD activities is linked to that of workshops, it does not appear to be the case for teachers in this study who viewed workshops as 'for a privileged few'. This is partly because HODs for instance, have more if not all the opportunities to attend conferences compared to other teachers in the Mathematics Department. It is assumed that by nature of their position, they would pass on or share the acquired information to teachers not in attendance. This remains an assumption as based on teachers' responses information is not shared as expected. It can also be inferred from the above evidence that even though knowledge and information is meant to be shared with teachers not in attendance of workshops, there is no or less emphasis on this to actually take place. This points to one of the limitations of the cascade model

(2.2.4: 2.2.4.1). It also contradicts the principle governing CPD provision as stated in EOF (1.4) that emphasis would be placed on knowledge sharing through the cascade model which is supposed to be given special consideration.

4.2.2.7 Overseas Education related conferences and exchange visits

The smallest number of teachers (4%) indicated that they often/always attended overseas education related conferences, workshops and seminars including some exchange visits with the rest (96%) indicating never/rarely having a chance to. The few that had participated stated that the international exchange visits they had been a part of were organised by MOE in conjunction with JICA in order to facilitate the implementation of LS. They were a part of the team sponsored to go to Japan, Kenya and Malaysia mainly in connection with lessons linked to 'LS', 'problem solving' and 'critical thinking'. One teacher who had a chance to be a part of such an international trip to Japan shared that:

I have had an opportunity to travel to Japan and witness how they conduct lessons and carry out LS. It was transforming experience as it gave me the exposure and informed my teaching practice. (Interview 33)

With reference to the above excerpt, it is obvious that opportunities are there to attend international conferences or workshops, but only very few teachers actually attend. Some of the reasons for this include lack of finances or financial support, the perception that this was for the privileged few and simply lack of awareness of such opportunities.

4.2.2.8 Higher academic study

More than half the teachers in the study (68%) stated they often/always participated in higher academic studies. Higher academic studies (section 2.2.3) allow for improvement of both teachers' academic standing and teacher competences and professional growth (Boyle et al., 2005; Komba & Nkumbi, 2008). However, the perspective of teachers, majority being those with Certificates and Diploma in Education in this study was that Higher Education study was simply to upgrade their qualifications and not necessarily as for improving their professional competencies and growth. One of the reasons advanced is that:

…there isn't really any connection between getting a degree and changing how to teach. You simply get a paper and that paper is yours. What happens after that may not have anything to do with improving teaching (Interview 39)

This reasoning is similar to one of the findings from Boyle et al.(2005), based on a longitudinal study described in chapter 2, that even though studying to obtain a degree can contribute to acquiring new knowledge and professional skills some teachers may not

directly link it to change in teaching strategies. The 59 underqualified teachers (Table 8), in this study consistently stated that they needed a higher qualification to fully qualify to teach secondary school pupils.

I have had no intentions of pursuing a degree course because of almost reaching retirement age. But now I will be forced to do it because the Ministry wants us to have our first degrees and you know retirement age has been pushed to 65 years instead of the 55 years we knew. So, if I have to continue working as a secondary school teacher I have to go for further studies. (Interview 42)

Several among these teachers had fears linked to pursuing a degree programme which they expressed as indicated below:

The Ministry of Education would like all the secondary school teachers to have a degree. I wish it was a degree in any subject. But they insist it has to be in the subject one teaches-Mathematics in this case. But Mathematic at university level is tough. Many of our colleagues have failed several of the Mathematics course they are doing at university level, they keep repeating and are not going to graduate as scheduled which I think can be frustrating. Others have for that reason ended up changing to specialising in other subject areas like Religious Education, Civic Education which are considered easier compared to Mathematics…(Interview 43)

Teachers' comments such as the above raise questions regarding the nature of mathematics courses offered at university level as well as the calibre of mathematics teachers there is in the Zambian school education system which however are beyond the scope of this study. Mathematics teacher trainer at state universities in the country confirmed that a large number of in-service teachers fail and drop out of university in first year and that numbers keep on dropping as students progress through the programme. Section 1.3.2 has also highlighted this point. .For instance, he stated that out of the 254 in-service students who started the Bachelors' programme with Mathematics as a subject of specialisation in 2011 only 40 reached their final year. He stated that:

…the programme is specially designed and suited for the teachers' level of understanding and comparably meets the standards for a course to be pursued at university level. Some in-service teachers are hardworking and committed to their course while others think it is a walk over and do not commit to doing their work as expected. This difference in attitude and student work culture makes some to pass and others to fail and in some cases change areas of specialisation. (Interview 11)

Some officials in MOE raised similar concerns regarding a reduction in number of qualified teachers of mathematics despite efforts at sponsoring some to pursue their first degree for them to have the right qualifications for teaching mathematics at secondary school level. Even though the government states that there is a provision to sponsor mathematics teachers to upgrade through the selected universities in the country only a few teachers are government sponsored. The majority in this study who are upgrading claimed that they are self-funded or self-sponsored. With lack of sponsors, low salaries and several other financial commitments

some teachers could use this as an excuse for not enrolling to study for a degree programme they fear they might not successfully complete.

It is important to note that there were teachers who pointed out that they were upgrading their qualification to degree but in other subject areas other than Mathematics simply because that is where their interest at the moment lay. For them it was desire to engage in subject areas they claimed mathematics is applied in such as Economics, Commerce, Accounts among others for their own benefit and to an extent the benefit of the learners.

4.2.2.9Visits to other schools to share teaching experiences

Only 17% of the teachers who completed the questionnaire indicated that they often/always had chance to visit other schools to share teaching experiences. One teacher had this to say about the visits:

…we have visited other schools to share ideas. A classic example is this one time we discussed linear programming: the part where you have to come up with the equations of the lines to be drawn and how to teach it and I found it very helpful and easy to apply in my teaching…(Interview 34)

Teacher visits to other schools to share teaching experiences can widen opportunities for learning (2.2.4.1). However, majority of the teachers (83%) indicated that they had never/rarely had chance to visit other schools for this purpose. In trying to explain why this was the case, one teacher stated that '*We have not simply considered visiting other schools for our CPD'* (Interview 21). Another stated: '*The only thing I can say is there is lack of administrative support for such…We have proposed such visits before to our administrators, but they have not given a go ahead…'* (FGD 1). Another teacher shared similar concerns and added that *'…I think it could be because of financial implications that the school administration has not facilitated such an arrangement for us…'* (FGD1)

4.2.2.10 Online learning

Eighty-eight per cent (88%) of the respondents in this study stated that they have never or rarely engaged in online learning compared to 12% per cent who stated that they had. Those who had participated were able to state the benefits of online learning during the interviews and FGDs. They expressed that it was convenient and generally fits in well with the individual teachers' learning needs and interests. An example of an excerpt in form of lengthy narratives to confirm their use of online learning as a way of supporting their professional growth include the following:

I learn a lot of things about teaching mathematics on the internet. I think that it has helped me in having a solid knowledge of the content in mathematics as prescribed in the school syllabus. I find that the background information about a topic or its history gives a strong backing to the way you teach a particular topic and helps one to see the value of teaching or learning a given topic. I have seen that no textbooks in our schools and very few teachers ever focus on this. So, I have been using the internet sources to fill this gap for my pupils and myself. For example, from internet sources I have used some of the aspects of the history of Geometry-relating to line segments, shapes etc to help pupils see the importance of geometry and how geometric principles apply in our everyday lives. The Internet is flexible, convenient and easy to use. The only problem is that it is not easy to have access to the internet-it is costly. (Interview 1)

Teachers' responses on the benefits of online learning for individual teachers' personal development is consistent with arguments in the literature (Mushayikwa & Lubben, 2009; Wellington, 2005). It equally confirms arguments that teachers can take initiative to identify their needs and act to meet those needs.

It is interesting to note that the majority of the teachers who stated, during the interviews, that they were aware of and engaged in online learning for their PD were those newly qualified and early career stage teachers and had their first degree. These teachers attributed their acquisition of knowledge and expertise in the use of ICT to the time they were pursuing their undergraduate training at university.

The majority of the teachers who stated that they did not engage in online learning capitalised on the challenges of use of ICT such as: no or inadequate facilities such as computers in schools, lack of access to the internet, internet facilities being costly, lack of or inadequate knowledge and skills to allow for use of computers. Negative attitude toward online learning and ICT in general was on the list too. For instance, one teacher had this to say:

This computer thing is not my thing. I have been teaching without using computers or the internet for over twenty years now I don't see the difference that it would possibly make in my teaching…(Interview 42)

Another had this to say: '*The whole idea of using computers appears to be time consuming…'* (Interview 2)

However, this will have to change now as teachers need some computer-related-knowledge and skills as 'computer' is now one of the topics in the secondary school mathematics syllabus based on the new curriculum. In addition, to be relevant in the technological era calls for one to be aware of and possess some skills related to use of technology to be able to function.

Other teachers admitted that online learning would be convenient if they had the facilities for it, but at the same time stated that they would still want to continue engaging in face-to-face CPD activities.

4.2.2.11 Informal networking with colleagues

About 51% of the teachers in this study indicated that they often/always engaged in informal networking and dialoguing to improve teaching and learning. However, similar to the argument on personal study being a CPD activity, teachers during interviews, consistently stated that they did not consider or recognise informal networking as a form of CPD. Representative comments from teachers interviewed are: *Informal talk about our work is what teachers do. Why would you consider that as CPD?* (Interview 1)

Some of us teachers do sometimes share teaching ideas among ourselves at an informal level. Like you meet in the corridors and share ideas, but I don't think I can call that CPD. Not even the Head teacher or HOD or the SESO [Senior Education Standards Officer] would regard it as CPD (Interview 4)

Even though engaging in informal networking and dialogue on improving teaching and learning was perceived as what 'teachers do on the job', some teachers expressed the challenges they experienced in trying to engage in informal dialogue with colleagues.

There are critical shortages of mathematics teachers. I am the only teacher of mathematics in the school, so there is nothing like informal dialogue with fellow mathematics teachers in the school...(Interview 25)

I struggle with making conversation…Mathematics teachers in our department are not all that friendly and accommodating (Interview 3)

Other teachers explained that: *'…some of our colleagues claim to be too busy for such dialogue* (FGD2) *'…some of our fellow mathematics teachers simply look down on some of us who are underqualified. They probably think we have nothing much to bring to the conversation'* (FGD2*)*

4.2.2.12 Mentoring

A relatively small number of teachers (28%) in this study indicated that they had often/always participated in mentoring programmes. Most of these teachers were the newly qualified teachers. The benefits of mentoring to teachers have been explored in the literature review (2.2.4: 2.2.4.1.2). During interviews, some teachers also confirmed the benefits of school mentoring programmes. One teacher had this to say: *'My HOD was my mentor for some time and it helped me to settle down at school and be able to find my way in terms of teaching*.' (Interview 4)

Some HODs stated that they are required to mentor the newly qualified teachers. One HOD

had this to say: *Even though we have not received any formal training on this, we are expected to mentor new teachers…* (Interview 12). Another had this to say: *'we are required to mentor teachers, but the school administrators do not really reinforce this…we easily get away with not doing it'* (Interview 27). It can be deduced from the HODs' comments and from the large percentage of teachers (72%) that stated that they had never or rarely engaged in mentoring programmes that formal policies and practices for induction and for mentoring of new teachers do not exist in the secondary schools where the teachers teach or they exist, but not reinforced. This, however, may need to be followed-up in other studies.

4.2.2.12 Research, publications and school-university partnerships

Research, publications and school-university partnerships are three CPD activities that majority of the teachers indicated they had not engaged in. Only 7%, 6% and 5% indicated that they often/always engaged in research, publications school-university partnerships respectively. While the rest stated that they have never or they rarely did. Teachers' perception as expressed during the interviews and discussions was that 'publishing' is not in their job description. Their reasoning was that such kind of work is supposed to be done by college and/or university lecturers. One teacher pointed out that:

Publishing is not the kind of thing that is meant for me as a teacher. It is something people with higher qualifications like lecturers at university level do(Interview 28)

It sounds like a good thing to engage in, but even if I wanted to do it I don't have the necessary skills for such… (Interview 37)

I think publications are very involving and they take up too much time-researching, writing and the like. I don't think I have that kind of time and patience for such. (Interview 44)

However, the few that had published before stated that they wrote learning materials for either pupils' and teachers' use. These learning materials included pamphlets. One of such teachers said that:

…we write and produce pamphlets with information on how pupils can handle some mathematics sample exam questions. It is a good experience for professionals like us (Interview 41)

Even though making publications is something some teachers were interested in doing, they expressed that they needed some skills for it. A representative comment was:

I have written a paper before with one of the Standards Officers at the Ministry of Education Provincial office- or I should just say I contributed something to the paper that was written. I know I don't have what it takes to do it on my own or to even initiate it (Interview 40)

Generally, teachers in Zambia rarely actively engage in research activities. Based on teachers' responses as indicated above it is clear that some teachers felt their role was to teach while research and publications were not. The few who expressed interest in research and publications stated that they did not have the relevant knowledge and skills.

According to the ZECF, research has been identified as an important intervention tool at all levels of the education system as it facilitates finding out of what is obtaining, what would need to be adjusted or changed to suit the situations obtaining on the ground (MOE, 2013b). It further states that research work can contribute toward alleviating the challenges that the education system is currently facing. Despite putting an emphasis on the importance of research and research findings to the education system, it is not clearly stated what kind of support is there for teachers to be able to engage in research, beyond them doing research methods as a course component during initial teacher training.

4.2.2.13 Summary of findings and discussion

Teachers' responses show that LS was the main CPD activity. This is in line with MOE expectation and demand as aligned with some of the principles of CPD provision stated in EOF policy document (1.4). Other CPD activities that most teachers engaged in included peer observation and collaborative CPD were not recognised as CPD activities in their own right, but as viewed and discussed in the context of LS. MOE's strong emphasis on LS implicitly suggests, a 'one size fits all' approach to CPD has been adopted even though literature reviewed (2.2.4: 2.2.5) shows that it may not be sufficient in itself in addressing the various knowledge and skills needs that teachers have in order to be able to improve their practice. Teachers can acquire mathematics teaching/learning-related knowledge and skills through more ways than one. They need multiple opportunities to learn and to assist them in processes of reviewing, renewing, enhancing of thinking and practice and commitment of the mind and heart to their work and therefore an expanded array of PD activities proves necessary (Day, 1999; Timperley et al., 2007; WestEd, 2000) and differentiate PD for teachers who have different levels of experience and expertise (Taylor, Yates, Meyer, & Kinsella, 2011)

While higher academic studies allow for improvement of both teachers' academic standing as well as teacher competences and professional growth, teachers in this study perceived them simply for the purpose of upgrading their academic qualifications. This could be attributed to the fact that the MOE (2013) has been stressing the need for teachers to upgrade their

qualifications from Diploma or equivalent to Bachelor's degree if they are to qualify to teach at secondary school level.

Some teachers were not aware of alternative CPD activities while others were aware, but were not in the clear as to whether what they considered as alternative CPD activities would count and be recognised, by MOE, as CPD activities. This was partly because these activities were regarded simply as 'what teachers do' and partly because they were not formally structured as LS was, for instance. Examples of such activities were personal study and informal dialogue to improve teaching and learning. It can be deduced that raising teacher awareness of what counts as CPD activities could enhance teachers' involvement in a variety of CPD activities that could support the acquisition of the needed knowledge and development of relevant technical and soft skills.

Among the CPD activities which teachers engaged in the least were: research, publication, school-university partnership and overseas education related conferences, workshops and seminar and exchange visits. Teachers consistently regarded research, and publication as being beyond their job description. Overseas education related conferences and exchange visits were perceived as being practically impossible to pursue due to financial constraints and also deemed to be only for the privileged few.

With reference to the categorisations of CPD activities (2.2.4: 2.2.4.1: 2.4.2.2: 2.2.5) and evidence presented under Table 13 above, teachers engaged more in formal CPD activities than informal and self-directed CPD activities. As presented above, it is compulsory for teachers to engage in LS, which is formal and structured in nature. This is based on the point that it is because it is a directive from MOE that teachers should be engaging in LS process. Therefore, pointing to their CPD and participation in CPD as being dictated and restrictive. While it is acknowledged that engaging in certain PD activities can be compulsory, there is also need to consider availing opportunities for teachers to engage in recognised informal and self-directed CPD activities. This would not only enable teachers to have a variety of CPD activities to engage in, but also enable teachers to exercise their own professional judgement (2.3.4) by identifying and taking part in development activities which they would consider most beneficial in meeting their CPD needs (2.3: 2.3.1: 2.3.2: 2.3.2.1 - 2.3.2.3)

Although teachers appreciated SBCPD they also indicated a need to engage in non- SBCPD activities such as visits to other schools to share teaching experience, which also offered opportunities to reflect on their practices and contribute to their professional growth. There is a need for teachers to engage in various other CPD activities to not only increase the

opportunities for them to share teaching and learning experiences, but also encourage them to exercise their autonomy regarding CPD activities that would best meet their CPD needs and at the same time facilitate the development of a sense of ownership for their own professional and personal growth.

Collaboration is a key element to PD (2.2.5). Minimal collaboration or inability to embrace collaboration as a tool for development can have a detrimental effect on teachers' professional growth as it can hinder peer learning, reflection and re-examination of teachers' own practice and establishment of meaningful and supportive professional relationships. Therefore, personal and professional relationships should be encouraged to be developed and nurtured as this would pave way for sharing knowledge, information, experiences, good practices and values for maintaining professional standards (Boyle et al., 2005). Other benefits are as shared under section 2.2.5. For this to be achieved a broad definition of what collaborative CPD means and entails that equally considers teachers' perspective of collaboration may need to be developed (Kennedy, 2005). It should not be limited to the context of LS or LS cycle process (1.4.1: 2.2.4.1.2), but to include all other collaborative practices within the mathematics department, wider school context or with teachers in other schools, wider (teaching) community to enhance PD. While collaboration remains essential in the CPD context, it cannot be a stand-alone tool. Collaborative and Individualised CPD can both facilitate and complement each other in enhancing teachers' PD.

4.2.3 Research question three

Question three is: 'What are the perceived CPD needs of secondary school mathematics teachers in Zambia?'

Teachers had an opportunity to identify their CPD needs on the questionnaire (3.5.1) and state and discuss them during interviews and discussions. Those who completed the questionnaire had a chance to identify their CPD needs by ticking ( ) against the option representing their choice under questionnaire item C2 about CPD needs domain and also make additional comments in the space provided under the open-ended question related to CPD needs. While teachers were able to indicate by ticks ( ) to denote the option representing their choice, some were able to put accompanying notes on CPD needs and/or give additional comments during interviews such as:

I only knew mathematics knowledge and skills for teaching as areas of need. Now with guidance like there is on the questionnaire I know my list of needs is definitely longer (Interview 46). *What is on the questionnaire on CPD needs is an eye opener* (Questionnaire).

Majority of the teachers also indicated that they needed guidance in identifying their needs. Illustrative of their comments are the excerpts below:

I don't really know how to tell what my needs are exactly. If you are able to give me options of those needs like there is this and this and that the way it has been done now, then I think I can pick which ones relate to me… (Interview 5)

The ideal situation is that we should know what we need to work on as teachers, but it is not like that because we are not sure…not sure whether what we think is a need is actually a need in the real sense for a teacher and that is why there is need to have someone or something to help with crosschecking. (FGD1)

Others were as vague as: *'I need more knowledge and skills'* (Interview 25) and *'It is really difficult to say, but I can say that I need to be sufficiently equipped as a teacher'* (Interview 9) in trying to describe what their CPD needs were.

Such responses are consistent with literature that states that teachers may not know, may not be capable of recognizing or may be unaware of what their CPD needs were (Bubb & Earley, 2007; Igarashi et al., 2002).

Teachers' responses to the questionnaire, interviews and discussions on the actual CPD needs are presented below. The data is summarised and presented in Table 14 below from the closed-ended questionnaire item C2 together with detailed explanations provided as obtained from the responses from open-ended related questionnaire item, interviews and FGDs. Reference is made to relevant literature when discussing them.

Table 14 below clearly indicates that teachers in this study had CPD needs reflected in all the CPD needs domains: mathematics CK, PCK and skills, PPR, KLCN, AN domain and SD needs domain. Particularly, the teachers considered knowledge of learners and competencies to address learners' needs to be their greatest need. Specifically, 93.4% of the participants agreed or strongly agreed that knowledge of learners and their needs would meet their CPD needs. The overall percentage responses for the other CPD need domains in descending order are: 'Affective development needs-91.6%' 'Mathematics CK needs-89.5%' 'PCK and skills-88.4% 'PPR -82.6% and School development needs-80.4%. Further detailed findings and discussions on teachers' CPD needs related to CPD domain needs have been provided below.

Table 14 Overall average percentage and ranking of teachers perceived CPD needs

CPD NEEDS CATEGORY	FREQUENCY OF RESPONSES AND PERCENTAGE (%)			OVERALL AVERAGE PERCENT-AGE	RANK
	A	SA	A+SA		
KNOWLEDGE OF LEARNERS' CHARACTERISTICS AND NEEDS				**93.4**	**1**
Building trust and rapport with pupils	30(38.5)	44(56.4)	74(94.9)		
Understanding pupils' diverse (e.g personal, developmental and academic needs)	35(44.8)	42(53.8)	77(98.7)		
Understanding pupils' diverse mathematical needs	39(51.3)	36(47.4)	75(98.7)		
Adapting teaching approaches to support pupils' diverse needs	33(42.8)	38(49.4)	71(92.2)		
Collaboration in supporting pupils' diverse needs	45(58.2)	24(30.4)	69(87.3)		
Holistic (whole person) development of pupils	46(58.2)	26(32.9)	72(91.1)		
Providing pastoral care for pupils	45(58.0)	27(34.2)	72(91.1)		
AFFEECTIVE NEEDS				**91.6**	**2**
Strategies for stimulating and sustaining pupils' interest in learning mathematics	30(36.1)	39(47.0)	69(83.1)		
Awareness of and responding to pupils' beliefs about self and learning mathematics	40(49.4)	36(44.4)	76(93.8)		
Responding to pupils' attitude towards mathematics and learning mathematics	36(43.4)	42(50.6)	78(94.5)		
Building teachers' confidence	34(41.0)	40(48.2)	74(89.2)		
Maintaining and supporting teachers' positive attitude towards the teaching of mathematics	30(36.6)	50(61.0)	80(97.6)		
MATHEMATICS CONTENT KNOWLEDGE NEEDS				**89.5**	**3**
Updating and sharing new subject content knowledge	37(44.6)	41(49.4)	78(94.0)		
Dealing with difficult content areas in mathematics	38(45.8)	42(50.6)	80(96.4)		
Curriculum content implementation and improvement	19(23.8)	38(47.5)	57(71.3)		
Knowledge of mathematical concepts, representations and the interconnectedness of these concepts.	29(34.9)	48(57.8)	77(92.8)		
Knowledge of and appreciation of the value of concepts, procedures and problem solving processes in learning mathematics.	36(43.4)	38(45.8)	72(89.2)		
Linking mathematics to other school subject areas	37(46.3)	38(47.5)	75(93.8)		

Key: A- Agree, SA= Strongly Agree, A + AS = Agree+ Strongly Agree

CPD NEEDS CATEGORY	FREQUENCY OF RESPONSES AND PERCENTAGE (%)			OVERALL AVERAGE PERCENT-AGE	RANK
	A	SA	A+SA		
PEDAGOGICAL CONTENT KNOWLEDGE AND PRACTICES (PCKP)				**88.4**	**4**
Knowledge and application of various teaching strategies and skills	34(41.5)	38(46.3)	72(87.8)		
Research on mathematics teaching and (or) learning	33(42.3)	34(43.6)	67(85.9)		
Working with pupils understanding and (mis) understanding of Mathematical concepts	34(42.5)	38(47.5)	72(90.0)		
Making the learning of mathematics more meaningful and engaging learners more in their learning of mathematics	41(53.2)	34(44.2)	75(97.4)		
Expressing Mathematical ideas clearly and precisely in speech	35(44.3)	38(48.1)	73(92.4)		
Expressing Mathematical ideas clearly and precisely in writing	30(39.0)	35(45.5)	65(84.5)		
Assessment techniques, and interpretation and use of pupil assessment results to inform teaching practice	22(28.6)	38(49.5)	60(77.9)		
Knowledge of and application of various teaching strategies and skills	34(41.5)	38(46.3)	72(87.8)		
PROFESSIONAL PRACTICES AND RELATIONSHIPS(PPR)				**82.6**	**5**
Contributions to curriculum development and implementation	32(40.5)	19(24.1)	51(64.6)		
Contributing toward implementing education related policies and strategies	34(43.6)	20(25.6)	54(69.2)		
Sharing of knowledge and good practices with others in the same or different (subject) department to support personal learning	31(40.3)	41(53.2)	72(93.5)		
Interaction with the broader mathematics community	45(57.0)	33(41.8)	78(98.8)		
Interaction with the broader teaching community	56(70.9)	17(21.6)	73(92.5)		
Participation in education-related community services and voluntary work	30(38.5)	16(20.5)	46(59)		
Leadership and management skills	40(50.6)	31(39.2)	71(89.8)		
Monitoring and evaluating my own practice	30(38.0)	44(55.7)	74(93.7)		
SCHOOL DEVELOPMENT(SD) NEEDS				**80.4**	**6**
Communication with parents/guardians regarding pupil's progress	38(45.8)	39(47.0)	77(92.8)		
Engaging with parents/guardians/community for further school development	26(31.3)	36(43.4)	62(74.5)		
Adapting to the school vision and mission and realizing school goals and policies	38(46.3)	32(39.0)	70(85.4)		
Promoting the school culture and school image	41(52.6)	20(25.6)	61(78.2)		
Formulation of school plans and policies, review of procedures and practices for continuous school development.	30(38.0)	25(31.6)	55(69.6)		
Awareness of and responding to societal changes in relation to their impact on school and school values.	38(48.7)	26(33.3)	64(82.0)		

Key: A- Agree, SA= Strongly Agree, A + AS = Agree+ Strongly Agree

4.2.3.1Knowledge of learners' characteristics and needs (KLCN) domain

This is the aspect of teachers' needs that was most frequently rated as an area of high development need. There were variations in teachers' specific areas of need within this category, but overall 93.4% of the teachers in this study agreed or strongly agreed that their perceived needs lay in the area of KLCN and competences to meet the needs and thus should be the content of the CPD sessions in which they are to participate. This category of needs widely borders on an understanding of learners and their characteristics, cognition, motivation and development and how this could be used to inform mathematics teachers' teaching practices and contribution toward learners' holistic development (2.3.2.1.1.2: 2.3.5.2). One teacher's comment to this effect was:

We are here for the learners and therefore we need to know what their characteristics and learning needs are. And for us to know what their needs are and tie them to their learning of mathematics, we first need to learn how to identify the needs and then how to help meet those needs… (Interview 10)

Similarly, another teacher stated that:

Our learners are important, and we need to help them learn mathematics with understanding and appreciate it while bearing in mind their abilities, their struggles, backgrounds and their personal needs... But it seems that for our CPD we focus more on mathematics content and less about the learner him/herself who has to learn that content…I can give you an example of the famous Earth Geometry…we have had several meetings discussing what is supposed to be taught under Earth Geometry, but none of those meetings as far as I can remember, has ever focused on how well our teaching of this topic and its content can contribute to developing the personal qualities of the pupils or how learners' backgrounds hinders or helps them to learn this topic, how the pupils are going to be helped to develop their mathematical abilities in order to be creative, or knowledge creators or make a positive contribution to our society. I see a gap…a problem there… (Interview 3)

The specific strands identified under this category and on which teachers indicated they needed more support with are: understanding pupils' diverse mathematical needs and adapting teaching approaches and resources to support pupils' diverse, abilities and needs; collaboration in supporting learners' diverse needs; whole person development of learners; and providing pastoral care for pupils. These were considered as the major focus if pupils' mathematics learning abilities and performance were to be enhanced. The least needed strand in this category were 'building trust and rapport with pupils' and 'collaboration in providing pastoral care for pupils. One teacher's comment was:

Pupils are not the same and their needs in terms of learning mathematics are not the same. What I see as a problem with us teachers is too much focus on teaching a topic or a concept to pupils and not teaching pupils a topic. We teach the topic in general assuming our pupils have the same learning abilities, interests etc. Because even when you look at the classwork we prepare: whether they are examples or class exercise we don't try to differentiate in terms of such features as their learning needs or abilities. I seriously think that if we are to help our pupils learn mathematics better etc we should be able to work with and within their differences as we teach…(Interview 7)

In stating the area he needed help with, one teacher said:

I strongly agree with those who say that mathematics can contribute to the development of all rounded pupils… but I honestly don't know how this would actually work in real classroom life setting. My wish is to be helped to see…I think in a more practical sense, how mathematics or mathematics teaching can actually contribute to this. But I have not heard of any of such a thing being discussed in the 6 years that I have been serving as a teacher of Mathematics…(FGD1)

Acknowledging that learners' characteristics and/or needs can be wide and varied and that these needs can have a direct or an indirect impact on learning of mathematics, one teacher had this to say while also making reference to one of the changes that have come with the new mathematics curriculum:

…I think that learners' needs come in many different shapes, sizes and dimensions. And whichever shape or size these needs take they have great potential to affect pupils' learning of mathematics negatively or positively. I strongly feel that we should be taking care of this very important aspect of learners as teachers of mathematics even in our CPD…One example among the many that I can give here is teaching pupils at junior secondary school 'matrices' and teaching pupils at senior secondary school level 'Matrices'. It is the same content here though different depths of course, but the pupils: their characteristics, age, abilities, interests and their different Grade level here also matters and can affect their learning…(Interview 43*)*

While admitting the importance of identifying and working at meeting learners' needs, some teachers were able to share some associated challenges. For example, one teacher shared that:

…the class sizes are too big, overcrowded and with that it is not easy to work with individual pupils in order to meet their individual learning needs, interests, capabilities etc. That is why in most cases I consider them as having one and the same need and teach from that perspective…. For example, when I was teaching circle theorems…I ignored things like pupils' conduct, background, pupils' knowledge, experiences… and assumed they were all one and the same learners and ignored some could have had an understanding of the parts of a circle: chord, radius, diameter, segment and the likes So I simply went on with the actual theorems: angle in the same segment; angle at the centre twice angle at the circumference etc otherwise you can spend too much time on one topic and eventually the syllabus will not be covered…(Interview 41)

Another teacher pointed out that:

With 16 years experience in teaching mathematics, I have come to appreciate the idea of being aware of learners needs when teaching. It is only logical from a personal point of view and professional point of view that we acknowledge learners' varied characteristics, and needs as teachers for us to be more targeted in our teaching. But I also think that it is a time-consuming venture…I have more than 28 teaching periods in a week and my classes are large in numbers. Where would I get the time to identify their specific needs and target the needs when teaching?...(Interview 28)

Lack of relevant instructional resources were another challenge that some teachers made reference to. One teacher acknowledged that:

Firstly, it is the critical shortage of mathematics teachers. It is extremely difficult to focus on learners' needs when you have too many classes and overcrowded classes for that matter to

attend to. Then the resources to use to be able to guide us in implementing the new curriculum and later on in addressing the needs of the learners are simply not there. Talk of computers, Internet, textbooks… we don't have these things. And for me maybe the other problem is that I don't really know how to make good use of the few teaching resources like the textbook I have in such a way as to help pupils acquire their mathematical knowledge and also their personal qualities for example… (Interview 25)

With reference to textbook-related challenges in particular, another teacher had this to say:

…One of my main concerns is also about our textbooks. I personally think lack relevant textbooks and whatever we use is not up to date for someone who wants to use them to meet the needs of pupils who have different characteristics, learning styles, and abilities…I have problems to adapt the work or tasks in textbooks to something more interesting, and maybe more meaningful for the individual pupils in my class. So in almost all cases I use the textbook content as it is…(Interview 33*)*

This teacher's concern is in line with Banda & Baba's (2013) concern regarding the content, sequencing and arrangements of items in the textbooks in use for teaching and learning in the Zambian context. It also raises concerns on whether the need to enhance teachers' ability to assess and adapt the textbook content for suit their context is ever reflected as content of their CPD activities. Banda & Baba (2013) indicate that teachers may be lacking in their ability to adapt textbook content to learner context and also in detecting inconsistencies in textbooks. UNESCO (2012b) also state that even though teachers may be dependent on textbooks, they are not always able to detect misconceptions in them nor are they able to make relevant connections with other resources for effective content delivery. This points to an area of need that could be addressed through CPD.

Even though from the key informants' point of view the emphasis of current CPD should as is be on subject content knowledge and teaching methodology (4.2.3.3 and 4.2.3.4), majority (4 out of 6) of them were able to refer to and state the importance of exploring ways and means of meeting pupils' diverse needs. An example of an excerpt from a key informant is:

As a teacher, you are supposed to also see the differences in learners' abilities, interests and take care of that. I would be very happy to hear a teacher say "I have realised that pupils in Grade 8A class are not the same as Grade 8B pupils. And some of my pupils in each of these classes have different sets of struggles… so I need to understand my pupils and teach them according to their ability and needs". When a teacher begins to talk like that then I know they are growing professionally and whatever they have been doing to help them come to that realisation should be championed because after considering all there is to consider, the bottom line is that teaching is essentially about meeting learners' needs. (Interview 9).

A focus on KLC and development of teacher competencies to address learners' needs is fundamental in and justifiable in the context of implementing learner-centred teaching approaches (1.2.2: 2.3.2.1.1.2) which Zambia's MOE has been placing emphasis on, in the context of implementing the revised curriculum (1.2.3: 2.3.2.1.1.2) and in the quest of

meeting the demands on teachers to work toward whole-child development (2.3.2.1.1.2). However, it needs to be weighed against other evidence that could appear contradictory. For instance, how practical is it for teachers to acquire and implement knowledge of learners and their needs in resource-constrained educational environment typified by overcrowded classroom situations, lack of instructional resources, heavy workloads as result of critical shortage of mathematics teacher such as in Zambia? How feasible is it to meet this CPD need when teachers are working with time constraints, bulky syllabus and pressures derived from focus on examination-related pressures? While the argument that acquisition of KLCN and development of teacher competences to meet such needs is upheld, there may be a need to also focus on how this could be achieved in a resource-constrained educational environment with challenges being faced (1.3.3) otherwise it may remain an unrealistic need to meet.

4.2.3.2 Affective Needs (AN) domain

Following the KLCN domain was the AN domain (2.3.2.2: 2.3.5.1.3: 2.3.5.2.3). Table 14 shows that overall, 91.6% of the teachers in this study agreed or strongly agreed that they had needs in the AN domain. Teachers had AN, which were discussed from two angles: as they related to pupils and as they related to themselves. An illustrative comment is:

There are some things that affect our attitudes or emotions as teachers and they somehow end up affecting the way we teach and address our learners. I can give you an example of HIV/ AIDS and how it affects our personal and work lives in many ways... I should think the same applies with pupils: maybe this and other things affect their emotions and attitude. When their emotions are affected their concentration may be affected too. It is a pity such issues are not regarded as affecting the teaching and learning of mathematics…you never know these things- may be this could be where the answer to improving mathematics teaching and learning lies…(Interview 23)

Literature reviewed (2.3.2.2: 2.3.5.1.2: 2.3.5.2.3) relate to the teacher's comment. The components representing the AN category were: strategies for stimulating and sustaining pupils' interest in the learning of mathematics; awareness and responding to pupils' beliefs about self and about learning mathematics; responding to pupils' attitude toward mathematics as a subject; building teachers' confidence; and maintaining and supporting teachers' positive attitude toward mathematics and teaching/learning mathematics. Even though the issue of stimulating and sustaining pupils' interest in the learning of mathematics did not top the list on the questionnaire, it was expressed as a matter of concern for the majority of the teachers during interviews and FGDs. They recognised that they have a role to play in enthusing learners as they teach mathematics, but this is an issue that is not raised during their CPD. Though motivating pupils may be assumed to be a natural thing that teachers do (DeBellis & Goldin, 2006), teachers in this study indicated that it doesn't come all that naturally and thus

they needed strategies to keep the learners motivated in learning mathematics, as this still remains a challenge. An example of teachers' comments expressed during the individual interviews and discussions is:

I think that motivation issues are ignored even though most of us are fully aware that the general pupil perception of mathematics is that maths is a tough and an unfriendly subject and that if they had a choice they would avoid it or opt out. I think that there is constant need to interest pupils in learning what we intend them to learn and make maths learning a pleasurable experience. But my disappointment is that we don't talk about how we could be doing this…(Interview 26*)*

Even though some teachers openly stated that they saw the need to inspire learners to work hard to their potential, others did not and instead stated that it was learners' responsibility to do so. An example of a comment to this effect is:

…pupils should know why they are in school and particularly that they need mathematics …they have to pass Mathematics with a minimum of a credit for them to be accepted in any college or university (FGD 1).

Among the teachers who acknowledged that that they needed strategies to keep the learners motivated in learning mathematics was one who stated that:

I get stuck and run dry of the things to do to make pupils interested in learning or excited about learning mathematics or grow in self-confidence and confidence in their abilities to excel in mathematics…It used to be relatively easy for me to interest learners in my Geography lessons, but I must say a struggle to motivate the same pupils in a Maths lesson…(Interview 38).

A number of teachers in this study with varying qualifications and years of experiences made comments similar to the above about pupils' attitude toward mathematics while also identifying and acknowledging they had a role to play to change the status quo. Some teachers also openly acknowledged that it is not only pupils' negative attitude towards the subject that they had to deal with. They indicated that in some cases it was other issues such as pupils': poor self-concept; ability to remain focused on learning mathematics despite all the challenges they may be facing; negative attitude toward the teacher and background in mathematics, that they teachers had to deal with. This is illustrated in the following excerpts:

…some of our pupils don't believe in themselves or their ability to do well in Mathematics from way back. It is like they are already defeated. It takes a teacher who enthusiastic about mathematics to be able to take them out of their situation. But the problem is that there a very few teachers who are like that these days… (FGD1*)*

Maths is like a 'scare word' to our pupils. They fear it and generally hate it. And it is like we teachers continue instilling that fear in them as the classroom environment is characterised by fear. I don't know whether it is conscious or unconsciously done, but the thing is teachers have a lot to do with this kind of fear. Actually, some teachers don't know how to motivate learners. Let me give you a real-life example… Look at this: a pupil would ask a question during maths period and the teacher just harshly says '...hey you don't ask questions like that in Mathematics…why can't you just follow

what I have written on the board and follow what I am saying'. In a case like this the teacher not only blocks the learners' ability to inquire further, but also demotivates the learners, and instils some element of fear in them. (Interview 6)

Based on my experience I have learnt and concluded that generally, it is not only poor background in mathematics that our pupils have, it is also a negative perception…negative attitude of the subject and negative image of themselves when it comes to Mathematics learning plus other issues in their lives. These are some of the things about our learners and when it comes to dealing with such it takes a lot from the teacher: you have to know the subject content, how to deliver it and also how to motivate them and keep them motivated. But I think that most of us teachers are lacking in this area of motivating our learners even in the areas of making maths interesting to learn and dealing with their belief systems in this case…(Interview 39*)*

Teachers' responses reveal that not much consideration is given to pupils' AN (2.3.5.2.3) during CPD sessions. This is consistent with one of the findings from Mulendema's (2012) survey study already presented in chapter 1. A focus on how both cognitive and affective issues in the teaching and learning of mathematics could be addressed can contribute to teacher efficiency and improvement in pupil performance (2.4.5.1.2: 2.4.5.2).

There were some key informant participants in this study who equally identified the need for teachers to be able to work toward changing pupils' attitude and approach to learning Mathematics. One of comments presented was that: '*Our maths teachers need to market the subject and teach it to attract learners'* (Interview 10). Despite statements to this effect there was no indication about what could actually be done to change the status quo.

When it came to describing their personal teaching experiences some teachers were generally positive. For example, they made comments such as: '*I like teaching. I like teaching mathematics to be specific*' (Interview 6), *'…teaching Maths gives me a 'feel good' feeling about myself which I can't trade for anything'* (Interview 33)

Although it has its own challenges, teaching mathematics gives me a sense of fulfilment in the sense that I am helping individuals to realise or maximise their potential and prepare for a better life (Interview 22).

However, they together with those who shared some negative sentiments regarding their mathematics teaching experiences raised some concerns worth sharing here. They pointed out that their ability to remain enthusiastic and connected to their learners and to their work is not stable. The following long narrative exemplify their views and sentiments:

You find that teachers of mathematics are among the most demotivated teachers. What I mean is that the work of teaching mathematics can involve a lot…and in most cases you have more periods than the rest of the teaching staff in the school because of shortage of maths teachers then there is also the issue of pupils failing maths in large numbers and it is like you are almost blasted at during review of national exam results which make you feel like sinking into the ground because for all the other

subjects, well most of them, there are big improvements in pass rates which is not the case for maths. That is not all as this is coupled with the fact that it is not really easy to explain mathematics or mathematical concepts to pupils…so you struggle with all this as a teacher and at some point it just feels like you need some form of motivation or 'recharging' of some kind to keep you going. And even worse for those of us who have to upgrade [to degree] *in the area of specialisation. We have heard that maths at university level is complicated and most people drop out and end up changing the area of specialisation and others fail to graduate as scheduled because of repeating Maths courses…One continually struggles to stay afloat with all these pressures and demands around them and no one seems to pay attention to such things* (Interview 30)

During the first FGD one teacher ended the discussion on negative mathematics teaching experiences by stating that: *'…with unsatisfactory working conditions and without the necessary support and needed motivation especially among teachers with personal challenges like these HIV illnesses, teaching mathematics in Zambia can be a very unsatisfying work' (FGD1*). In response, another teacher added that:

…It is not simply personal health challenges like HIV/AIDS illnesses there is also a level of frustration or discouragement for us when large numbers of pupils year in year out fail mathematics. It is not easy to remain motivated in teaching a subject which pupils fail…(FGD1)

It is possible that feelings such as the above illustrated can impact on a teacher's teaching practices, which would consequently influence pupils' feelings or development of negative attitude toward Mathematics. One teacher had this to say to this effect:

Sometimes if not most of the times, I find myself weighed down by my work issues and health issues. I find myself not having the energy or the kind of enthusiasm that I think I should have and which the pupils can catch- you know where you inspire them, motivate them concerning mathematics learning… But I also know that this is not a kind of thing that people or teachers talk about as it is likely to be ignored for other more important things like challenging topics in the syllabus… so I struggle with it and just try to carry on teaching for the sake of teaching the subject. And I think this lack of enthusiasm has potential to rub off on the pupils. It is like selling a product that you are or would never be interested in yourself… (Interview 40)

The aforementioned cases show that teachers stand to benefit from CPD activities have also pays attention to affective matters affecting them and/or pupils. This is point is equally presented in other studies (Carroll, 2005; Intrator & Kunzman, 2006). For instance, Intrator & Kunzman's (2006) work even though not specifically linked to mathematics teachers and mathematics teaching argue that to be able to do teach well, one needs to possess knowledge and skills beyond the knowledge of subject content and pedagogical skill and competences to include that which would help them to remain inspired and vital even in the face of education reforms such as curriculum changes, challenges and the harsh realities of teaching in general. A point to which several other authors (Bell & Gilbert, 1996; Hatch & Lee, 2011; Pomerantz & Pomerantz, 2002; Struthers, 2007) have equally referred to. Section 2.3.5.1.2 has discussed this in further detail. In the light of the above discussed points an apt suggestion is

a consideration of CPD programmes that can help nourish teachers' 'inner lives' (Intrator & Kunzman, 2006) and include development of not only technical skills but also soft skills (Struthers, 2007; Heckman & Kautz, 2012). This strand or view of PD focus is likely to be dismissed or ignored in the face of more seemingly pressing pupil and school needs or viewed as secondary to issues such as teacher knowledge and pedagogical technique and skill, which have since taken centre stage on the CPD agenda in Zambia. However, it is worth giving attention to.

4.2.3.3 Mathematics Content Knowledge(CK)

Eighty-nine point five percent of the teachers in this study agreed/strongly agreed that their CPD needs lay in the area of mathematics CK. The need for improved mathematics CK from the literature has been discussed under 2.3.2.1.1.1., but teachers' perspectives are presented in this section. Teachers' indicated that they needed CPD that had a focus on improving CK. During FGD, for instance, one comment made to this effect and to which the other teachers were in agreement with was: '*We need to know our mathematics well for us to be able to teach it well'*(FGD1). During an interview one teacher also stated that: *What I know about our CPD is that it is about content-mathematics content. And that is what we do, it is like if you have not discussed mathematics topics to teach then you have not done anything* (Interview 41).

The strands within this domain of needs were: updating and sharing subject content; dealing with difficult or challenging content areas in mathematics; mathematics curriculum content implementation and improvement; knowledge of mathematical concepts, representations and the interconnectedness of these concepts; knowledge of and appreciation of the value of mathematical concepts, procedures and problem solving processes in learning mathematics; and linking mathematics to other subject areas.

Particularly, majority of the teachers constantly referred to the topics, which were perceived to be difficult for them to teach and to topics that have recently been added to the mathematics syllabus (1.2.3). Based on interviews and FGDs, even though the levels of difficulty and complexity varied from teacher to teacher, teachers generally indicated that they found it difficult to comprehend and to teach some topics in the syllabus and therefore needed help. These topics included: Kinematics, Trigonometry, Linear Programming, Probability and Statistics, Circle Theorem, Earth Geometry, Mensuration, Geometrical Transformation, Calculus, Graphs of functions, Geometrical Construction and Loci, Functions, Matrices and Computers. One teacher's comment in relation to difficult topics was:

I fear teaching linear programming. I have difficulties understanding it well enough to teach it. Let me share this with you…to be honest with you I have skipped it before …actually I did not teach this topic to my pupils. And the reason I was giving the pupils who approached me over the same was that the topic was not examined in their national exams therefore there was no need to waste time on it…(Interview 38)

While there might be individual teachers whose confidence levels are not negatively affected when they encounter particularly difficult topics in Mathematics, for others it is an issue of concern. A typical example is a comment from one teacher who said:

Confidence in myself and in my teaching abilities are affected when I think about teaching difficult topics like Earth Geometry. I fear my pupils can easily put me on the spot. Like what happened when I was teaching Shear Transformation, I realised then that some of them [pupils] *knew a lot about it and I felt like they wanted to expose my knowledge gaps on the topic to fellow pupils. I think that the knowledge gap between our pupils and some of us teachers on certain topics is too narrow. I am hoping that with CPD teachers like me can be helped in understanding the difficult topics and widen this knowledge gap*…(Interview 5)

Another stated that:

…with this new curriculum we are now expected to teach 'Computers' now that is a new topic in the mathematics syllabus altogether, and then we are supposed to teach Matrices, which were introduced in Grade 11 and Probability covered in Grade 12, now to Grade 8 and 9. So I have to learn the new topic then try and find a way of getting to understand Matrices and Probability for the sake of teaching at junior level. This is somewhat a challenge for me… especially that I have struggled with teaching the same topics before at Grade 11 and 12 levels…(Interview 39).

Another important point to consider is one raised by some teachers whose concern was that they have found themselves in a situation where the same mathematics syllabus topics and content are repeated unnecessarily during their CPDs. The following excerpts illustrate this point:

I like the idea that we have to discuss topics in the mathematics syllabus so that our knowledge of topics is grounded. However, the concern for me is where we have had to repeat things. Don't get me wrong here, it is good to learn and relearn, but for me it has gotten to a point where I am bored. I attended a workshop where we covered Earth Geometry and how to teach it in content in-depth, we had LS at my previous school and we covered Earth Geometry, I was transferred to this school and we have been looking at Earth Geometry…I think it is too much of the same thing. I would be better off discussing or learning something else, which I know I need help with…(Interview 43)

... I had problems with understanding and teaching Construction. I have had colleagues help me with understanding it and I think I am now okay and confident enough. I now find it a waste of time to be discussing the same topic over and over again during CPDs (Interview 31).

The above highlight how and why it is important to have differentiated CPD content to meet the various needs of different teachers. Effective approaches to PD recognises areas where teachers have strong and/or weak knowledge base. In addition, there is a need to differentiate '… between situations where new understandings and skills are needed because the existing

ones are limited, and those where teachers already have a tapestry of understandings and skills…' (Timperley et al., 2008, p.13).

Other teachers also made reference to the need for help in emphasising the interconnectedness of mathematical concepts and relating or to linking mathematics content to topics with related topics in other subjects. An Illustrative comment is:

I would like to get to a level where I confidently show pupils the interconnectedness of topics in mathematics. I am saying this because I know how I have struggled with it. The same applies with linking mathematics content to related topics in other subjects. Like you know we discuss velocity in mathematics and the same ideas are applied when discussing velocity in science…(Interview 47)

This further gives an indication of the various levels of needs in as far as mathematics content in concerned (2.3.5.1.3). The teachers' concern or areas of need also points to the need for CPD providers to find out the actual needs (2.3.1: 2.3.2.1 - 2.3.2.3: 2.3.3) of the teachers in a particular area and whenever possible adopt differentiated approaches in CPD provision.

The copies of the Mathematics Department CPD plan and in other cases minutes of departmental meetings that were made available confirm that the deliberations in the meetings were mainly to do with topics in the school mathematics syllabus that needed to be discussed or addressed. The teachers stated that it is required of them to be discussing mathematics content to teach. One teacher said:

…we have to discuss topics in the syllabus, otherwise there will be no proof of CPD going on in our department when the Standard Officers from the district or provincial office visit the school.(Interview 1)

All the key informants equally referred to difficult topics in mathematics, which the teachers needed help with. They also identified some of the topics mentioned by teachers as being challenging mathematics topics to teach. Their list of such topics was the same as that presented by teachers above, but with an addition of topics such as; Similarities and Congruency, Vectors, Algebra and Social and Commercial Arithmetic. One key informant, referring to the list of difficult topics, indicated that: *'…these are 'problem topics' for most of our teachers of mathematics and therefore CPD should focus on enhancing mathematics content knowledge.'*(Interview 14)

Other key informants expressed similar sentiments and stressed the urgent need for teachers' mathematics CK to increase to the required breadth and depth if the teachers are to be regarded as efficient and competent enough to contribute to improved mathematical literacy levels and pupil performance. This is in line with literature such as Hill et al. (2005) that state that an increase in mathematics CK can have an impact on pupil performance. The

mathematics teachers in the study held similar views with key informants in terms of the reasons for enhancing CK and added that the topics in the mathematics syllabus, which the teachers have to teach, were not taught at initial teacher training level and most them had to depend on their secondary school and in some cases 'A' level knowledge and experiences of learning Mathematics. For example, a teacher in his late career stage said:

I left secondary school a long time ago. And by the time I was in secondary school Earth Geometry was not one of the topics we did in Mathematics. Even if we did I don't think I would be able to remember all the details... To make it worse I did not learn this topic or how to teach it at undergraduate level. CPD can be helpful in this area (Interview 42)

Another teacher but in early career stage made a similar comment:

At university, we were not taught the mathematics we are to teach in secondary school per se. I only remember looking at two types of transformation: Translation Transformation and Enlargement Transformation under the secondary school taught topic 'Transformation' in the methodology course in my fourth year. This is only one topic (not even the whole topic) out the many topics we are supposed to teach at secondary school level. I mainly have had to depend on the knowledge of mathematics topics from my secondary school experience of learning mathematics… (Interview 40)

A university lecturer stated that:

…trainee teachers should not expect to learn, at university, all the topics to be taught at secondary school level as there is more mathematics than that that they need to cover and besides there isn't even enough time to do that. Maybe we can say that is why CPD is there…(Interview 11)

This comment provides another justification for CPD initiatives to focus on CK. Another contributing factor to the emphasis on CK is that there is a shortage of fully qualified mathematics teachers, which has led to the use of underqualified and unqualified teachers (1.3.2). For instance, one teacher who has a primary school teachers' certificate had this to say:

I was trained as a primary school teacher, then because of this shortage of teachers of mathematics I was seconded to teach at secondary school...All I can say is that it is challenging to teach first of all at a level you were not trained to teach and then to teach those difficult topics. Some of us are benefitting a lot from this CPD thing when we discuss the topics to teach and how they can be taught (Interview 22)

4.2.3.4 Pedagogical Content Knowledge and Practices (PCKP)

Overall, 88.4% of the teachers in this study agreed or strongly agreed that their perceived needs lay in the area of PCKP and thus should be the content of the CPD sessions in which they are to participate. PCK (2.3.2.1.1.) needs in this domain were broadly categorised under: knowledge and application of various appropriate teaching strategies; research on mathematics teaching/learning; working with pupils' (mis)understanding of mathematical concepts; engaging

learners more in their learning for effective mathematics teaching/learning; expressing mathematical ideas clearly in speech and in writing; and assessment

Most of the participant's comments were linked to the need for them to learn teaching/learning principles and strategies for effective mathematics teaching particularly those in line with making mathematics more interesting and more learner engaging. One of the teachers had this to say:

Most of the pupils in my class don't usually respond to activities I try to engage them in order to learn. Others simply don't respond when asked a question. I constantly feel under pressure to incorporate learner centred approaches in my teaching, more interactive lessons… but it simply doesn't seem to work or maybe I simply don't know how best to do it. So I am forced to just teach the traditional way. I don't know how others do it because we have never discussed things like this with fellow teachers or even in our departmental meetings. It is like what we talk about most of the time is understanding a given topic for the purpose of teaching it only…and not really in an interactive and learner engaging manner (Interview 5)

Another teacher had this to say:

I think that one way of working in making lessons more interesting, and learner engaging is when a teacher works with learners' understanding or may be misunderstanding of the concepts we are to teach them. However, this has been a very very difficult thing for me to be doing. I would appreciate if I were to be helped in this area…(Interview 19)

While acknowledging the importance of delivering more interesting and learner engaging lessons, some teachers pointed to challenges, which pose as hindrances to delivery of such lessons. A representative comment is:

…it is difficult to teach more interesting and learner-engaging lessons when the classes themselves are too big and you have to race against time to cover their bulky syllabus with no needed teaching/learning resources…(FGD1)

Other comments that were made under the PCK needs domain were in connection with technology use in teaching/learning of mathematics. During interviews and discussions majority of the teachers highlighted that they have heard of the potential benefits of integrating technologies in teaching/learning processes, but have not taken steps to use technologies in their teaching because of several challenges.

I would like to make use of technologies to enrich my teaching experiences and the learning experiences of pupils in my classes. The only problem is I do not have the skills to do so myself and there appears to be no opportunities for a person like me to learn plus we have no technologies like computers in our school. And now we have Computers as a topic for secondary school mathematics pupils I don't even know how I am going to do it…(FGD2)

Another teacher stated that:

...even though I did a course called 'Technology use in education' in college, I haven't had any hands-on experiences or activities to help with the actual technology use in class. And even if I were to share this concern here at my school, I know that nothing can be done about it because we don't have computers for examples and most, if not all of my colleagues in the department have a BBC-Born Before Computers attitude (Interview 20)

Some teachers also indicated needing help in the area of expressing mathematical ideas clearly in speech and in writing in different contexts including during questioning and class tasks or assignments and giving feedback. They acknowledged that when they are able to express mathematical concepts clearly pupils' understanding of the concepts is likely to improve. One teacher further added that:

Over the 12 years of my teaching experience I have learnt that mathematics is not just about symbols and equations…it is also about attaching meaning to them. It is about being able to find a way of communicating the meanings they carry correctly and clearly to the pupils. I find that when the mathematical concepts and ideas are well presented pupils are equally able to verbalise them and share with their friends in a way that is easy for them to understand and remember. However, I have observed that it is not easy for most of us teachers to do. I do try myself, but I must say that I still need more help in this area. Unfortunately very few if any mathematics teacher meeting cover this area of need …(Interview 34)

If teachers are to encourage learners to develop mathematical language as a means of communication they should in the first place express themselves and mathematical ideas clearly. Literature stresses the need for teachers to present mathematics ideas clearly (Cai, Perry, Wong, & Wang, 2009).

Teachers are expected to make productive use of assessment and assessment results so that they inform planning of subsequent lessons and contribute toward securing pupils' progress (Chambers & Timlin, 2013). However, based on the information provided in Table 14 above, this was the least CPD needs strand in this category of needs. Interview and discussion responses proved otherwise. Analysis of teachers' interview and discussion responses in connection to this strand, revealed that majority of the teachers' concerns, and therefore need, regarding assessment were connected to interpretation and use of pupils' assessment results to inform classroom practices. One teacher pointed out that:

Things like interpreting or using of pupils' assessment results to inform classroom practices in themselves sound like some long tedious work and I am not sure how I would manage that with the kind of workload I have. Some tips on how to do it would come in handy.(Interview 30)

One teacher's comment, though on assessment, was slightly different from the others. He in particular had this to say:

I understand the idea of using pupil assessment results to inform my practice as a teacher, but I think there is more to it that we are stating here. I think that we need to use feedback from assessment tasks we give pupils in class to inform our lesson planning…It can be involving, but it is very important.

However, we don't talk about how this can be effectively done if our lesson planning and lesson delivery can work toward improving pupils' understanding of the lessons. I also think that if the tasks for assessment are not appropriately selected to assess what is intended to be assessed then we are all missing the point…what I mean is that for instance What are the tasks in the textbooks I am using trying to assess? Is it what I also intend to assess in my classes at this particular time? I get to point where I ask myself such questions. But I don't really have any practical answers or solutions…(FGD1)

Similarly, though with a new angle to it, one teacher stated that:

I think I am quite confident with teaching most of the topics in our syllabus, but there is no harm in revising anyway. I am equally ok with using assessment to improve my practice as a teacher. My main concern is that I would like to discuss something else too that can inform classroom practice. Look at this, what we do most, if not all the time, is looking at topics to teach…at some point it gets boring for me. Issues of research for me would be more exciting. I have always desired to engage in research in some way …I am very interested, but I seem to be lost in terms of where to start from, how to start, where to get the resources for research from or the guidance one needs. I am not sure whether such things would even be talked about as attention in our department is on dealing with challenging topics in Mathematics (Interview 40)

The above-presented points raised by the teachers to qualify their PCK needs vary not only in nature, but dimension. They illustrate and confirm the point from literature that teachers perceived needs vary from teacher to teacher and from groups of teachers to the other (2.3; 2.3.1; 2.3.2). Teachers' perceived needs, though different, need to be accommodated and reflected in the content of CPD sessions in which the teachers participate if the teachers' work is to be fully supported.

4.2.3.5Professional Practices and Relationships(PPR)

Overall, 82.6% of the teachers in this study agreed/strongly agreed that their perceived needs lay in the category of PPR. The specific CPD needs strands within this category of needs where teachers have the highest need is in the areas of; monitoring and evaluating my own practice; interaction with fellow teachers in and outside the Mathematics Department and broader mathematics teachers' community; and the least areas to satisfy their CPD needs were: interaction with the broader community; making contributions to curriculum development and participation in education-related community services and voluntary work.

Most teachers' responses constantly referred to the point linked to monitoring and evaluating their practice and being able to identify areas they needed to work on. The following excerpts illustrate this:

I know we have Standards Officers not forgetting the HOD and other school administrators to monitor and evaluate our work. But I think there should be a way of doing it myself which I need to grow in myself. Because I think this can lead to helping me identify critical areas I need to work on to improve my teaching. (Interview 37)

Another teacher mentioned:

I hear of teachers who are critical reviewers and evaluators of their own work. How does one become a critical evaluator of one's own work? I think for me it should start from there…because what I simply do is fill up the space for lesson evaluation on the lesson plan template with comments like: lesson successfully taught or lesson not taught and sometimes I don't even put any comment…(Interview 40)

It can be deduced from the responses above that teachers need to be empowered to identify their own needs in as far as their CPD is concerned (2.3.3; 2.3.4.). Further, during the interviews and FGDs, teachers pointed out that it is important for members of the mathematics department to get along if they are to support each other with their work and their professional growth.

One teacher specifically stated that:

…there is no unity in our department. Teachers don't get along, worse with the HOD. It is like there are separate and opposing camps. Maybe it is something to do with the differences in qualifications because I know some of our colleagues are more qualified than some of us. It is even worse when the teachers do not want to listen to or receive instruction from their HOD. I think is not reasonable: it is not healthy for a department. It is one reason why I am suggesting that for CPD in departments to work out, issues of respect for authority, some level of trust, communication, working together as a team are important and should be addressed (Interview 5)

One HOD confirmed that issues of inappropriate teacher social conduct are a concern for some HODs.

The teachers in my department choose to do their own things without consulting me. There is no collaborative culture and even things like departmental meetings, or planning lessons together can't work for us. You know people need to know that we need to lay aside our individual differences when it comes to carrying out our professional work…but this is not the case. We are told to plan lessons together, but this is not practical in my department…(Interview 21)

The above illustrates some factors that can hinder collaboration in the context of teachers' PD: lack of collaborative culture; lack of or limited leadership skills to foster good professional relationships (section 2.2.5).

Teachers' comments were not only related to improving working relations and interactions within the Mathematics Department, but also referred to: having increased opportunities for interaction with the broader mathematics teachers' community; finding ways of networking with teachers from other departments; and getting expert advice from experts, outside school setting, in the field of Mathematics. These are illustrated by the following comments:

…There is also this aspect of interdepartmental interactions that we need to work on. For example, I am teaching travel graphs I go to physics they call it Kinematics… We have Social and Commercial Arithmetic there is also investment, shares, dividends, and interest rates under Business Studies. There

is Earth Geometry in Mathematics and something like that in Geography. I think that working together at inter-departmental levels should be taken seriously and cultivated. We need to learn to share ideas for our own benefit and for the good of the learners- so that we help learners see how concepts in maths are interconnected, how maths is so applicable in other subject areas and contexts… (Interview 41)

Such comments illustrate the point that supports the argument that teachers of mathematics need to be aware of the different concept representations within mathematics and the links to other subjects, in the school curriculum, where mathematics plays a role. Academics such as Cai et al. (2009) attest to this.

While interaction with the broader community was among the least rated CPD strand in this category of needs some teachers, through the discussions, expressed the need to engage the wider community goals linked to improving mathematics teaching and learning. For example, one teacher commented that: '*While teachers have a responsibility to teach pupils mathematics, stakeholder involvement in supporting pupils' learning cannot be ignored.'* (FGD2). This point was qualified by another teacher who stated that: *'…community members and relevant stakeholders such as parents/guardians, motivation speakers in education, men and women in Maths-related careers can also contribute towards raising awareness of the value of mathematics* (FGD2). Similar comments were made during the individual interviews. For instance:

My secondary school maths teacher was very good at teaching us maths. But sometimes he would not be alone when teaching us. He would invite someone before or after we learn some concepts in Mathematics to talk to us about how what we have learnt could be applied in real life and work world. Like I remember this one time in Grade 9, he invited someone from the water company to discuss with us water bills, water meter reading and other things like that. The person helped us to cement our understanding of this part of the topic…It is one of the lessons that I have never forgotten…I think we need to be doing more of this (Interview 6)

Some illustrative comments from teachers who made reference to the point on making contributions to curriculum development and participation in education-related community services and voluntary work include the following: *'I do not see how I can contribute to the development of the curriculum when I don't even know what is involved in this process. Let's just say I don't have the capacity to do it'* (Interview 30). This could be attributed to the point that Curriculum Development studies is not a course that is offered in most universities in the country and the ones that offer it offer it as an optional or elective course partly due to shortage of lecturers in the area.

Teachers who made reference to participation in education-related community services and voluntary work stated that they had too much work to do to even consider voluntary work. Others stated that it was not rewarding in any way so one could do without it.

4.2.3.6 School development (SD) needs

CPD with focus on SD needs was the least category of needs among all the CPD needs categories with 80.4% overall responses. This category includes: communicating with parents/guardians regarding engaging with parents/guardians for SD; realizing school goals and adapting to school vision and mission; promoting school culture and school image; formulation of school plans for continuous SD; and awareness of societal changes in relation to their impact on the school. Among these strands, teachers' questionnaire responses show that communicating with parents/guardians regarding pupil progress topped the list of teachers' perceived needs while formulation of school plans for continuous SD was the least needed CPD focus.

The view on the need to improve on communicating with parents/guardians regarding pupil progress was confirmed during the interviews and discussions. An example of a teacher's comment during the FGD was:

…I don't see myself working with parents/guardians beyond the level of informing them about their child's progress in maths during open day…we teachers need the skills for reporting this well...(FGD1)

With reference to engaging parents/guardians for SD**,** teachers' responses during the discussions and interviews showed that this had little to do with them and confirmed that their engagement with parents bordered on pupil performance. For instance, one teacher stated that:

I think that engaging parents in school development is a responsibility of only a selected few like the HODs, Deputy Head or the Head teacher…the rest of us basically have to engage with parents at the level of communicating pupil progress (Interview 39)

On the issue of realizing school goals and promoting school culture and school image, most teachers indicated that to start with, they didn't know what the mission statement for their school was. Only a few admitted having read through their school mission statements, but even in such circumstances, they still acknowledged they did not really understand the mission statement or they were not in a position to even recall. One teacher stated:

…I know the school has a mission statement…it is written somewhere I am sure, but to be honest I can't remember what it is all about…In fact it seems that it is not even as important to understand or

state the school's mission statement. What really matters is that I am able to teach the maths that I am expected to teach (Interview 1)

Regarding the CPD strand on formulation of school plans for continuous SD which was the least rated CPD focus under this category of need, teachers responded that they were not involved in the formulation of SD plans.

Things like making school development plans are for school administrators. We rarely discuss or take part in making school plans as teachers. We are just informed about the plans sometimes and the school administration team does the rest ... I guess it doesn't matter much to me…as long as I am able to do my work. (Interview 36)

Teachers have a role to play, at different levels, in SD (2.3.2.3: 2.3.5.3) and should be informed of and empowered to take on such roles and responsibilities for the same purpose. This is consistent with the literature (Gray, 2005; Loucks-Horsley et al., 1996) which states that teachers should be encouraged to take on roles beyond the roles they play in the classroom setting and play roles in SD and beyond.

4.2.3.7 Other findings

Any relationships between teacher characteristics and teachers' perceived needs?

Even though there are no significant differences based on statistical analysis of data, it is interesting to notice from the responses given by interviewed key participants and those in FGDs that there were some differences between teacher characteristics (such as gender, age, years of teaching experience, academic qualifications, grade level teacher teaching and level of responsibilities) and teachers' perceived needs. Details are provided in the next text.

(a) Gender and perceived CPD needs: All female mathematics teachers, but not all male teachers, expressed a need for needs related to knowledge of learners' characteristics and AN domains to be addressed through CPD as a priority. This could suggest that female teachers (whether by nature or nurture) are more likely to express a need for CPD linked to knowledge of learners' characteristics and AN. Illustrative comments from female teachers were:

…these pupils are like our children. It is important that we find ways of understanding them and then make an effort to help them grow into children with good knowledge of mathematics and also grow into responsible people and citizens (Interview 6)

Other comments include the following:

We are second parents to our pupils here at school and therefore we should be able to support and motivate pupils most importantly in their learning of Mathematics and also in becoming better adults. We cannot do everything, but there is a lot we can do for them and with them… (Interview 17)

I think that these pupils spend most of their time during school term here at school and it is only right that we get to know them, their characteristics and help them not only with their learning of mathematics, but also shaping the overall behaviour, prepare and inspire them to live better lives in future (Interview 31)

The findings of this study show that CPD needs can vary in the light of teachers' gender among other teacher demographics or characteristic factors (2.3.5.1.4). Based on teachers' responses it can be concluded that female teachers are more likely to express a need for CPD linked to knowledge of learners' characteristics and AN. Results from Singer's (1996) study shows that females are more likely than males to use motivation in their teaching and a comparably more recent study by Kuh, Laird and Umbach (2004) shows that female faculty members are more likely than males to value and use instructional styles and practices that enrich educational experiences. Hustler et al.'s (2003) study also shows that female teachers were more likely, than their male counterparts, to state that successful INSET was that which provided them with information that could be applied practically. CPD with a focus on knowledge of learners' characteristics and AN and developing competences to meet these needs can enrich learners' educational experiences and could be considered to have practical applications and can enrich learners' educational experiences as such knowledge could, for instance, contribute to pupils developing more positive self-image, believe in their potential, to being more involved in the lessons and apply themselves more to learning. However, how such information could be applied practically also depends on whether the teachers are aware of pupils' actual needs or levels of needs and the extent to which the structural elements of their sociocultural work context such as class sizes, lack of resources, time constraints support or hinder application of information obtained.

Despite not having established the exact reasons why differences in CPD needs based on gender as illustrated above exist, the findings of this study can be used as a springboard to further explore how and why the CPD needs differ and how best CPDs could be avenue for meeting the different needs that teachers have.

(**b)Age and perceived CPD needs:** A larger number of teachers in the young age groups conveyed concerns and needs linked to the knowledge of learners and their characteristics and PCK and practices domains compared to those in the older age groups.

For instance, one teacher in the young age group of 20-25 stated that:

…what topic to teach is not a problem of concern for me. What is of concern for me is knowing and understanding the learners and having the knowledge and what it takes to teach the topics to my pupils well. I need to know my pupils well enough including what they need to learn their

mathematics and how to manage them so that I could teach them well enough with strategies that would work for them and so they could start taking me seriously (Interview 3)

Another young teacher in the 26-30 age group had this to say:

…I think that it is important to know what the learners need to be able to learn mathematics well and develop and increase some level of enjoyment of and even engagement in the lessons (Interview 6)

Teachers' responses were indicative of the point of view that learners' needs have potential to influence learners' behaviour, attitude, response and ability to learn mathematics therefore, suggesting that knowledge of learners would have an influence on a teacher's choice of instructional practices. This is consistent with literature such as Kilpatrick et al. (2001) that states that understanding of learners and their cognition, motivation and development can inform, and contribute to specialise and/or adjust instruction. This point has been discussed further under sections 2.3.2.1.1.2 and 2.3.5.2.1 of this thesis. Knowing where pupils are whether in terms of mathematics CK or their social, physical or emotional development is imperative in knowing what steps or strategies to take to take them further in their knowledge, skills and understanding levels. CPD with a focus on areas such as identified by the teachers in this case may equip the teachers with competences to be able to help learners acquire the needed mathematical knowledge, understanding and skills. This further indicates that there is a need that the knowledge and skills teachers obtain through CPD programmes relate closely to teachers' work practices, experiences and contexts.

(c) Years of teaching experience and perceived CPD needs: Majority of teachers with more years of teaching experience especially in the late career stage compared to teachers with less teaching experience expressed high selectivity of CPD focus especially as related to mathematics CK and PCK. This was especially accentuated among older teachers. For instance, most of the teachers with more years of teaching experience expressed reluctance to engage in CPD with a focus on what were generally considered as 'difficult topics' in mathematics (4.2.3.3) or a focus on use of technology to enhance teaching/learning (4.2.3.4) areas of CPD focus which teachers with less teaching experience were generally enthusiastic about.

Illustrative of teachers' comments included the following:

…I have been teaching for a long time and with several years of teaching one gets to know a lot of things. I know the content of secondary school mathematics in and out and with a lot of practice over the years learnt several ways of teaching the topics. I don't really see a need to be going over things I already know how to teach…I can do my teaching job well even without this these technologies. We can leave them to those who are new to the teaching field (Interview 17)

There are very few things, if any, related to mathematics content and pedagogy that one can say they can teach me now. This is why I find CPD where we focus on what is considered as difficult topics and how to teach them a waste of time for me. Teaching can be demanding and exhausting and for me something to keep me a little more motivated, and able to handle well increasing administrator and government interference and culture of controlling on the job would be appreciated…(Interview 26)

The above could signify that years of teaching experience, and to a certain extent age, potentially have an influence on what teachers would prefer as focus of their PD (2.3.5.1.1; 2.3.5.1.2; 2.3.5.1.4). This is similar to findings by Richter et al.'s (2011)'s study discussed under section 2.3.5.1.4 that older teachers showed high selectivity of CPD focus. With more years of teaching teachers can have a rich content and pedagogical knowledge base, be able to make sound judgment on teaching practices based on past experience, be able to solve a wide range of teaching problems, and have better understanding of learners' needs and learner learning compared to newly qualified teachers (Mahmoudi & Özkan, 2015; Richards & Farrell, 2005). It can be argued here that high selective of CPD focus can be a sign that teachers can identify their needs and are expressing a need to engage more deeply in identified, and not dictated to, areas than those areas they feel they are already competent in. However, in light of changing times, learner needs and expectations and changes within the education system such as introduction of a new curriculum, teachers may at the same time have to demonstrate some willingness, openness and commitment to lifelong learning and improvement and avoid overconfidence and complacency as a result of their years of teaching experience. Critical self-reflection could enable the teachers to identify and better understand the discrepancy between the knowledge and skills, in relation to mathematics CK and PCK in this case, which they already possess and the new. The point that is standing out is that already raised in literature (Bubb & Earley 2007; Muijs *et al.,* 2004) that teachers' CPD needs vary and CPD should be closely tied to teachers' identified needs. If teachers identify the area they are deficient in and need help or support with and specifically attend CPD activity or activities based on this, it may draw them closer to not only valuing CPD, but also to ensuring competence and improving their practise.

(d)Academic qualifications and perceived CPD needs: Majority of the teachers with higher academic qualifications expressed a need for CPD with a focus on PPR and SD needs. This was especially emphasised among those who also had several years of teaching experience. One teacher with a Bachelors' degree and within the 16-23 years of experience had this to say:

With a degree, the more CPD I attend the more the chances are that I would be promoted to a higher position. The chances are even higher if I learn more about things like leadership and people-management issues, policy formulation matters… (Interview 23)

Another teacher who was the only one with a Masters' degree qualification among the teacher participants and had years of teaching experience within the 24-30 stated that:

I can't retire a secondary school teacher. I have a masters' now, I have lot of experience and I will do everything else possible including a short course like monitoring and evaluation course or education leadership and management course to get myself to a position such as a lecturer or as an administrator… (Interview 19)

Teachers' responses as illustrated above indicated that an increase in knowledge and skills as related to the two categories of needs (PPR and SD needs) coupled with their qualifications and experience would increase chances of being promoted to higher positions within the school or beyond. This could be attributed to the point that CPD can prepare individual teachers for promotion to higher positions (2.2.2). It can not only help them to become better candidates for the future positions, but also prepare them to lead and manage others effectively. However, as already mentioned under section 2.2.2 and highlighted in section and 4.2.1.5, while it is true that CPD supports career aspirations and progression of participating teachers, it is not the only focus of CPD. CPD can also influence teachers' satisfaction and their subsequent plans to remain in the teaching field (Parkes, & Stevens, 2000). It can help keep teachers interested and interesting in their work, improve teachers' teaching practices and advance pupil achievement and therefore teachers should commit to seeing how the knowledge and skills obtained could be translated to meet this cause too.

(e) Grade level taught and perceived needs: Most of the teachers who taught all secondary school grade levels expressed a need for CPD with focus on instructional practices or pedagogy fitting the different grade levels being taught, with marked differences between junior secondary school grades (8-9) and senior secondary school grades (10-12).

Teaching mathematics becomes more challenging as you teacher older pupils. This is because apart from helping them with maths related problems they face including the fear of mathematics itself…, one has to deal with behavioural and attitude related problems which can affect their learning of mathematics if not properly managed (Interview 7).

Another teacher stated that:

… each grade level has its own unique challenges at varying levels. Their learning styles are different too. A teacher has to be at least mentally prepared and equipped to deal with challenges they could face as they teach the different grade levels. This is because there is nothing like strategies one can use to help the Grade 9s for example to learn mathematics well will work for the Grade 11s or 12s…(Interview 33)

Teachers comments identify the point that while there is common core mathematical content and expected common core mathematics teaching strategies and practices such as identified in

literature (Hall et al., 2015: Isac et al., 2015) and discussed under section 2.3.5.1.5, which teachers need to be aware of, there is a need for teachers to also be aware of and employ teaching strategies fitting the different grade level(s) they are teaching. This is because there are some differences between junior and secondary school learners of mathematics. The results of a comparative study by Mohammed & Tarmizi (2010) in Tanzania and Malaysia for instance shows that senior students showed high levels of anxiety or feared mathematics more than the junior students. This implies that teachers of such students not only need to be aware of this and other differences, but also be equipped with strategies to use to enable learners in the different levels realise their potential, learn mathematics well and achieve highly. Instructional strategies differ within and across grade levels (Vartuli, 1999). Even though this is an area that may need further study, it can be concluded that differentiated teaching approaches not only applies to pupils in a particular grade, but also can apply across grade levels.

(f) Teacher's additional responsibilities and perceived CPD needs: Nearly all teachers with additional responsibilities (that is, HOD and/or school CPD Coordinator) communicated a need for CPD with a focus on PPR and SD needs. An example of an excerpt to this effect is:

Those of us who have responsibilities other than teaching need learning opportunities that focuses on preparing and empowering us to execute our duties effectively. I can give you an example to explain my point. I have not been in leadership like HOD and CPD Coordinator before. It is a demanding role and I think that I should have opportunities to learn strategies to increase my personal effectiveness, lead members of the department effectively for the purpose of improving teaching and learning of mathematics and also being able to develop contacts and networks with other professionals… (Interview 32).

Another HOD had this to say.

As HOD I have to perform my duties as a teacher and HOD. As a teacher, I have my own unique set of challenges and areas I need to improve on as I teach. As HOD I have a unique set of areas I need to improve on too as I lead and manage the department and sometimes a school. I would say that attention should also be paid to supporting us HODs with our multiple responsibilities to help us not only improve our practice, but also lead and manage the team effectively (Interview 8)

Teachers' responses correspond with Schibeci & Hickey's (2003) point that teachers should be involved in CPD related to their diverse roles. This point has been discussed further under section 2.3.5.1.2. This would facilitate gaining knowledge and developing skills to enable them develop and maintain professional working relations with teachers and other stakeholders and fulfil their several roles and responsibilities. A neglect of CPD for teachers with additional responsibilities such as HOD especially focussing on areas of identified needs

would not only deny them opportunities for enhancing their effectiveness in their work as leaders and managers, but also to an extent limit their ability to improve and support the quality of CPD for teachers under their leadership and across the school.

4.2.3.8 Summary of findings and discussions

There are several findings of this study as linked to research question three on secondary school mathematics teachers' perceived CPD needs. This section only gives a summary of the main findings. In presenting the findings taken together different subheading have been used as it has been considered that presenting the summary following the headings above would be restrictive in nature.

Teachers' highest category of CPD needs

Teachers' CPD needs were reflected in six main categories or domains namely KLCN, AN, Mathematics CK, PCK and practices, professional relationships and practices and SD needs. Teachers in this study consistently rated KLCN and developing their competences in meeting learners' needs as an area of highest development need and SD needs as the least area of needs. This, to an extent, contradicts EOF principle of CPD provision (1.4) which stresses a focus on school needs. Overall, teachers' responses as linked to KLC and competencies for addressing learners' needs indicated that this is a category of needs that CPD has not paid much attention to and yet it is an important area to address if pupils' performance and attainment in mathematics is to improve. Having a solid knowledge of learners and their characteristics is justified as partly illustrated under section 2.3.2.1.1.2. To add on, knowledge of learners and their characteristics and development of teacher competencies to address the learner needs is essentially justified in the context of implementing learner-centred teaching approaches (MOE, 1996, 2013b; Mtika & Gates, 2010; O'Sullivan, 2004; Schweisfurth, 2011; Sugrue & Fentiman, 2012; UNESCO, 2011) which have taken centre stage in education systems in many countries in the world including Zambia (see section 1.2.2). As already stated, learner-centred teaching approaches generally call for teachers to facilitate learners' learning than transmit knowledge to learners. A focus on teaching as a facilitating process demands insight into knowledge of learners: knowledge of where a learner is at a particular learning point, their stage or level of knowledge of a particular learning material, their characteristics, motivations, needs and how they (learners) perceive learning in order to effectively facilitate their learning (Gow & Kember, 1993; Powell & Kalina, 2009; Rahman et al., 2010). This can facilitate the development of the individual learner's mathematical abilities and improve mastery of mathematical content.

Also, a focus on learners and their characteristics and development of teacher competencies to address the learner needs is equally justified in the context where there are demands on teachers, irrespective of their teaching subject, to focus on 'holistic development' of school-going pupils. Holistic development of learners, also called 'whole child' development though a complex and controversial notion, is basically development beyond the teaching of traditional academic subjects and encompasses social, moral, emotional and affective development of learners (Miller, 2010; Sanderse, Walker, & Jones, 2015; UNESCO, 2011). Based on a qualitative study involving 102 teachers in 33 secondary schools in the UK, there is evidence that, while it can be a challenge to achieve in assessment-focused school systems, 'developing the whole child' was personally important to teachers (Sanderse et al., 2015). Even though leaners' personal and holistic development is generally considered a responsibility of some and not all teachers, it is a responsibility of every teacher, mathematics teachers inclusive and as such, mathematics teachers' role extends beyond developing pupils' mathematical knowledge and skills to include whole pupil development (Westwell & Lee, 2011).

However, despite having a solid knowledge of learners and their characteristics being acceptable there are some challenges that come with its realisation and implementation. As illustrated under section 4.2.3.1, teachers acknowledged some of the accompanying challenges in addressing this area of need (4.2.3.1). Some of the factors that can potentially working against teachers in this quest are linked to the elements of their sociocultural context such as: lack of instructional resources, the overcrowded classes they handle and their heavy workloads coupled with the immanent time constraints and externally mandated policies (1.3.3).

Broad nature of CPD needs

Teachers' responses to the questionnaire item C2, interviews and discussion show that no one teacher identified only one single area of need or CPD needs from any one single category of CPD needs. This confirms that teachers have several and varied needs and thus need to possess knowledge and skills of different broad dimensions to enable them cope (2.3.2.1: 2.3.2.1.1: 2.3.2.1.1.1: 2.3.2.1.1.2: 2.3.2.1: 2.3.2.3: 2.3.5.1.3). Teaching is a complex activity (Mishra & Koehler, 2006; Timperley et al., 2008; Vartuli, 1999). Mishra & Koehler (2006) state that teaching is '…a highly complex activity that draws on many kinds of knowledge'(p. 1020). Teaching requires that one possess a broad knowledge base and capabilities, that include both technical and soft skills, to be able to fully engage in. This suggests that CPD needs are broad and so should the focus of CPD be if it is to enhance teachers' professional,

personal and social growth (2.3.2: 2.3.2.1 - 2.3.2.3). Broad content of CPD activities would equip teachers with knowledge and further development of relevant skills to enable them not only fulfil their teaching tasks (Westwell & Lee, 2011) but also their wider professional responsibilities (Chambers & Timlin, 2013). In addition, provision of a broad CPD content can contribute toward addressing and catering for the diverse needs of teachers a point further discussed in the next section.

Diverse nature of teachers' CPD needs

Even though majority of the teachers rated knowledge of learners and learners' needs highly, they were able to point to different strands within this category of needs as being the areas they needed most support with. This is illustrated under 4.2.3.1. This trend repeats itself within all the other categories of needs identified (4.2.3.2 - 4.2.3.6) which is an indication that apart from areas of CPD needs being broad they are also varied and they vary from teacher to teacher, from category of need to another and even within the categories of needs. This point is consistent with literature such as Muijs *et al.* (2004). Apart from varying from teacher to teacher the needs are also in various combinations due to several factors including gender (2.3.5.1). For instance, some teachers stressed the need for attention to be paid to AN because of their gender and/or because of their personal circumstances relating to being affected and/or infected by HIV/AIDS which spelt short career life span while others did not. PD needs can change according to current circumstances, personal and professional backgrounds and experiences (Goodall et al., 2005; Rogers et al., 2006). Needs vary in priority and complexity too. Some teachers can have more varied and complex needs than others (Reviere, Berkowitz, Carter, & Ferguson, 1996). Hurrell's (2013) comment even though referring to Ball et al.(2008)'s Mathematics Knowledge for Teaching model that '…until a specific circumstance has been determined no domain is fundamentally more important than any other domain' (Hurrell, 2013, p. 59) all applies here. Therefore, it can be deduced that teachers' personal and/or circumstances and experiences are likely to determine which needs or category of CPD have priority at any one point in time. Therein lies the significance of ascertaining teachers' actual needs based on needs assessment (2.3.3), than depending on assumptions of the needs.

Teachers' view of teaching

The findings show that overall, with an exception of teachers with additional responsibilities, teachers have a narrow view of mathematics teaching and their roles and responsibilities.

They were aware of and in recognition of their role of teaching, but this is restricted to teaching mathematics. Mathematics teachers' role also extends beyond contributing towards developing the mathematical knowledge and skills in learners and includes whole-pupil development (2.3.2.1.1.2).

Further, even though teachers are aware of their role of teaching they did not recognise that their role extended beyond teaching to include wider professional responsibilities. For instance, they expressed reluctance to engage in education-related community and voluntary services. In addition, they singled out the point that they did not see the need for their engagement in formulation of school plans and policies. They stated that such are roles and responsibilities of those in the school administration and management team including HODs. This further confirmed that teachers' perception of the notion of CPD is narrow (4.1.2) and that their perception of their involvement in decision-making within the CPD context and on education matters in general is also limited.

Teacher empowerment

For teachers' needs to be known, teachers' voices concerning CPD preferences and needs, which should be heard and supported, should be heard and supported. This would help in understanding what teachers regard as important for their CPD. If teachers' ability to identify their needs is enhanced and opportunities for them to identify their CPD focus are increased, then teachers will be able to speak out and focus on issues which are important to them (Cordingley et al., 2003). Therefore, teachers may need to be empowered to identify their CPD needs. They might, at the same time also, need to be guided to identify their needs whenever necessary as they may not always have the ability to or may not be fully equipped to identify their own needs or may simply need to feel supported in this way in their quest for professional, social and personal development (2.3.3: 2.3.4). Additionally, since there are some differences between teacher characteristics (such as gender, age, years of teaching experience, academic qualifications, grade level teacher teaching and level of responsibilities) and teachers' perceived needs, there is a need for CPD to be closely linked to teachers needs if teachers are to be empowered with the knowledge skills and competences for their practise. If this is not done teachers may end up not appreciating the value of and benefiting from CPD. As Dillon (2010) states, teacher professional development can meet teachers' needs or it can frustrate teachers and prevent them from realising their full potential.

4.2.4 Research question four

Research question 4 is: What are secondary school mathematics teachers' perspectives on

what makes CPD activities (non)effective? What are their perceptions of the (non)effectiveness of current CPD activities in meeting their perceived CPD needs?

Teachers' responses, from the questionnaire item under Part B, interview and discussion questions, reveal their perceptions of what they regarded as pointers to what makes CPD (non)effective in general and their opinions of the (non)effectiveness of current CPD in meeting their CPD needs in particular. The emerging themes from teachers' responses to what makes CPD activities (non)effective have been presented under the following headings: CPD content relevant to addressing teachers' needs; teachers having a say in their own CPD; focused with clear goals; appropriate mode of delivery and use of instructional materials; quality of facilitators; structure for feedback and follow-up; and timing. Each of these themes have been discussed and analysed in the context of relevant literature.

4.2.4.1 CPD content relevant to addressing teachers' needs

Majority of the teachers' responses deliberated on the point that CPD is effective when it is designed to address teachers' needs. However, based on teachers' responses presented under section 4.2.3 above teachers', CPD needs, and hence envisioned CPD content, vary from one teacher to another as depending on the influence of several factors such as teacher motivation, and aspirations(Dillon, Osborne, Fairbrother & Kurina, 2000; Hustler et al., 2003; Kennedy & McKay, 2011; Thakrar et al., 2009) and others such as discussed (2.3.5), and can be in different combinations. Examples of comments from teachers as influenced by some of these factors are:

As someone new in the system there are obviously a lot of things that I need to learn compared to the teachers who have a lot of teaching experience. Look at this: I am concerned about how I am going to manage my classes, I am worried about how to carry myself around as a teacher…I don't think experienced teachers have such concerns or maybe they could have, but I don't think they affect them as much they affect me who is new (Interview 1)

An example of a comment that emanated from a teacher with teaching experiences of many years was:

Teaching for over twenty years is not a joke…my teaching experiences have taught me a lot about pupils, about teaching mathematics and about myself as a teacher. What I consider as my learning needs are different from the new teachers, but in reality, our CPD has no regard for this fact at all and we are treated as if our needs are the same…and for me this is frustrating and discourages me from attending these CPDs (Interview 42)

The above point to the need to consider differentiated approaches in CPD provision to meet the various needs of the teachers concerned. It implies that the content of any CPD should be broad enough to cover target teachers' diverse professional, personal and social needs

(2.3.2.1: 2.3.2.2: 2.3.2.3: 2.4.1)

Another comment by one teacher' that could fall under this theme is that:

...it is difficult to apply some of the things discussed…I can give you an example of this idea of active learning as it is talked about in learner-centred teaching contexts during CPD…we don't even consider how this could be done practically in a large class like the 80 pupils some of us have to teach (Interview 46)

The above comment suggest that what is relevant to teachers' needs also relates to how CPD content closely reflects teachers' real life classroom experience. The content of CPD activities should be contextualised and reflect the practical classroom and school realities within which teachers' work (Ottevanger et al., 2007). Examples of typical classroom realities in the Zambian context include large class sizes, overcrowded classroom and others as presented under section 1.3. If the focus of CPD is to be contextualised, then it would mean that teachers' voices in a given context would have to be accommodated in the planning and implementation of CPD. The above fits in with the principles of adult learning that adult learners are relevancy orientated and practical as they relate learning to their real-life situations (1.7.2).

4.2.4.2Teachers having a say in their CPD

Even though the respondents received their initial teacher training at different times, had different levels of teaching experience and taught in different schools, they consistently referred to the point that effective CPD considers teachers' views and concerns. One teacher's comment to this effect was:

…There was this one time when my concerns and views in terms of the way we teach mathematics without sharing with the pupils why they are learning a certain concept or topic like matrices and how the concept can be applied in real life contexts, were addressed during CPD. It felt good in that someone paid attention to my concerns, but I am afraid this rarely happen (Interview 23)

Another teacher commented that:

CPD is real when it addresses the real issues that we teachers face. This to me means that I should, at some point have a say, regarding CPD I engage in. Otherwise it remains 'superficial' and 'mechanical' (Interview 44).

Teachers' comments such as illustrated above are suggestive of the point that their voices concerning CPD preferences and needs should be heard and accommodated. They also signify that teachers are expected to be a part of CPD that has been chosen for them without them getting involved in neither the selection nor planning of the same CPD activities. These views correspond with Colbert et al.'s (2008) observation that '…while teachers are

required to participate in PD activities, it is often the case that they are not involved in selecting and planning those activities…' (p. 135). Even if individual teachers' perceived needs, views, preferences can change, teachers' voice regarding their CPD, CPD focus should be heard, considered, accommodated in all the stages of planning, designing and implementing of CPD programmes (2.41). As Hustler et al. (2003) state, '…in some part at least teachers [should] have a say in their own professional development'(p. 142). Involving teachers in their own learning and development is consistent with principles of constructivism and adult learning theories (1.7.1: 1.7.2).

4.2.4.3Focused and with clear goals

Teachers' responses and comments showed that CPD is effective when the focus or goal for CPD is clear for and to the participating teachers**.** Some comments to this effect include the following:

The HOD sometimes prepares a CPD plan per term. But you find that the goal for CPD for that particular term is not known or not shared with the rest of the members in the department… And you find that at one time you discuss teaching of a particular topic like Trigonometry the next time around you move on to something else regardless of whether you concluded the discussion during the previous meetings or whether there are some concerns from the teachers after having learnt and tried to teach Trigonometry in class... (Interview 20)

Other teachers' comments show that they are ignorant of CPD policies and/or implementation guidelines. An illustrative comment in this regard include the one below:

CPD is effective when we have clear goal to work toward. It would help if we even knew what policies, at notional and school level, guide our CPD and CPD implementation. I am personally not aware of any of such. Being aware of such could help the teachers or relevant stakeholders to align our work and CPD activities to the policy guidelines…(Interview 21)

Lack of awareness of national and school CPD-related policy and policy implementation guidelines has negative implications on teachers' commitment to CPD and if left unattended would further constrain teachers from seizing opportunities to being committed to CPD initiatives for their professional growth. An excerpt illustrative of teachers' need to be aware of the CPD goals as derived from the CPD policy guidelines include the following:

…CPD would make more sense if we had this broad clear picture of teachers professional growth path of some kind which would involve helping us knowing where one is in terms of their growth and what one needs to know and the skills they need to develop in order to get better at one's work and get to the next higher level…(Interview 7)

Teachers' concerns are consistent with the principle of adult learning which indicates that adult learners need to know the reason(s) for learning what they are required to learn (Knowles et al., 1998) which in one way or another helps to keep them focused and motivated

to achieve the set goal(s) (1.7.2: 2.4.2). It can be inferred from the above comments that there are generally no clear goals for teacher' CPD and that there is lack of consistent CPD focus. King (2002) makes similar observation that generally CPD activities tend to lack consistent focus either for individual teachers or for a school'(p. 244). Teachers' responses in this study appear to be drawn from their experiences with regard to attending formal structured CPD where they have little or no say concerning their CPD. It remains to be determined whether the case could be the same or different if and when informal and/or self-directed CPD were to be considered.

4.2.4.4 Mode of delivery and instructional resources

Many teacher respondents alluded to or confirmed the point that they were learners and that how they learnt mattered. *'…We are learners too. The idea of CPD is for us teachers to be able to learn…Effective CPD is one where we as teachers are to be viewed as adults who are learners …*' (Interview 19).

Teachers' view that they are learners is in line with Zambia's MOE statement that 'Teaching is a learned and learning profession, and every teacher should also be a learner' (MOE, 2010, p. 1). In other CPD literature, learning is considered an important component of CPD (Mahmoudi & Özkan, 2015; WestEd, 2000). It is therefore imperative that a conducive learning environment for teachers is considered.

…it is possible to teach the right thing the wrong way...and unfortunately this makes everything wrong… So for me how the things I need to learn are taught matters a lot when I consider whether CPD is effective or not…(Interview 3)

It can be inferred from the above comment that the mode of delivery is one of the determining factors for effective CPD. With regard to what teachers perceived as appropriate mode of delivery one teacher mentioned that:

Effective CPD is engaging…the methods of presentation involve engaging learners, and I mean us teachers, in the learning that is taking place…where I and others can share experiences related to the subject and learn from it…where I am prompted to reflect on my practices (Interview 40)

The teacher's comment above with reference to reflection is justified in the context of professional growth as teachers are expected to be reflecting more on their practice. Hamilton (2013)cited earlier in chapter 2 refers to this point too. Unfortunately, as Helsby (2000) observes, teacher confidence, which can facilitate such kind of reflection on and in one's practice, is often weakened with top-down forms of accountability and inspection and by increased managerialism. The additional point being that the '…intensification of working

life and resource constraints place severe limits upon the possibility of finding time for reflection and practice'(Helsby, 2000, p. 104). This relates and applies to the working experiences and realities of teachers in Zambia with the heavy workloads, arguably limited time within which to cover the bulky syllabus and pressure to prepare the pupils for national examinations (1.3.3). It appears that not much can be done regarding the work place realities and context and this forces teachers to teach without focusing on the individual needs of the learners and simply not engage in reflective practices for their own and learners' benefit.

Among several other comments that respondents made regarding what they perceived as appropriate mode of delivery are the following:

I expect to be practically involved in some way during CPD, or at least some information to make it more practical in my classroom setting otherwise to me without such it would remain ineffective. I remember when we took a walk around the school premises pointing out some real-life examples that can help us relate the topic 'Bearing to real life…it was very engaging…(Interview 41)

There are times when it is hard to imagine how what CPD presenters are talking about could be put into practice. So the best is for them to be able to demonstrate some of these things. For example, it would make sense to me if they could demonstrate how circle theorems can be taught in such a way that it promotes critical thinking among the pupils, or how to make the teaching of graphs of functions, to a large group of pupils who have consistently expressed dislike for maths, fun and interesting, how I could use two textbooks against 80 pupils to teach Matrices, how I can teach 'Computers' when there are no computers in the school…(Interview 19)

Teachers' view concerning active learning or active engagement in the learning process during CPD is supported in literature (Borko et al., 2004; Day, 1999; Garet et al., 2001; King, 2002; Ottevanger et al., 2007; Riding, 2001; Timperley et al., 2008) and fits in with the principles of constructivism and adult learning. The use of effective modes of delivery can enable and support learning. However, note should be made here that to some extent teachers' active engagement in CPD depends on teachers' willingness and commitment to learning and participating.

My participation depends on my needs and interest. If I know I need help or advice then I am active, otherwise I do not participate. It makes more sense for me to participate more if I am interested in the topic being discussed (Interview 2)

This is consistent with one of the findings of Steyn's (2013) qualitative study, aiming to explain South African educators' perception of CPD, that when teachers are willing and committed to learning they are likely to actively engage in CPD.

Teachers' responses on the use of appropriate methodology were give alongside views that CPD is effective when appropriate teaching/learning resources are used and they presented as such here. An example one teacher had this to say:

I know that it is not easy to find or organise teaching/learning resources in our setup compared to fellow teachers in other countries especially the developed countries. However, during CPD is an opportunity for the presenters to be able to use instructional practices we can identify with here in Zambia and show that improvising teaching/learning resources is a possibility even here in Zambia...Because there is no use for a presenter to keep saying "…if we were in Japan we could have used this and that…" They should ensure the knowledge they acquired during the visit to Japan is applied in the Zambian set-up where there are no resources as compared to Japan(Interview 20)

4.2.4.5Quality facilitators

The other characteristic of effective CPD that teachers identified was the quality of the CPD presenters or facilitators. Some of the excerpts from teachers' responses, such as the one below, illustrate this point:

I think one element of effective CPD is having enthusiastic, inspiring presenters with relevant experience to share. It is like they inspire you to do better even within the context of the challenges we face as teachers of Mathematics. They inspire you to inspire pupils too (FGD1)

The presenter was very good. He knew his mathematics very well. He was able to share brilliant ideas … while also accommodating teachers' perspectives and experiences in teaching as well as pupils' perspective on the topic. Some presenters present theories only, but not him. They have no relevant experience to draw practical examples from. But he had. They have no idea of what the classrooms realities are like…but he had (FGD1)

There was one CPD I attended which I considered ineffective: The presenter didn't seem to know what she was talking about. She was sharing on Circle Theorems-she struggled even with explaining the theorem about the angle at the centre being twice the angle at the circumference… her knowledge of the content was too shallow (Interview 31).

…how the presenter presented himself-he was well -prepared of course-he had worksheets, he had a model of the earth as a teaching aid. So when you talk about the shortest distance he was able to show us from the model. I can actually call him an expert in the area. (Interview 47)

It is not just about being knowledgeable; a presenter should also be approachable too (Questionnaire).

Even though in their responses teachers did not specify whom they preferred as presenter/facilitator whether CPD coordinator; or fellow teacher; or university lecturer, their comments are indicative of the qualities of a good CPD facilitator. Based on the comments above, it can be deduced that the CPD presenters/facilitators should have good command of the content to be delivered; should be aware of the specific needs of the teachers to whom the presentation is to be made; and also possess excellent presentation skills (2.4.3). Teachers' views concerning having quality presenters with relevant knowledge and experience for CPD are consistent with MOE expectation of CPD facilitators (MOE, 2014) and other literature, which state that CPD is dependent on the quality of presenters, as reviewed under section 2.4.3.

4.2.4.6 Structure for feedback and follow-up

Teachers' responses reflected the point that with effective CPD comes opportunity for giving and receiving feedback and making follow-up on teachers. Illustrative of teachers' responses to this effect are the following excerpts:

CPD is effective when I am able to get some kind of support, after a CPD session, regarding where I am in the process of implementing what I had learnt…(Interview 2*)*

I can sit and listen to how I am to teach 'Stretch Transformation', but have I actually learnt or have I actually been empowered to put acquired knowledge into practice in my teaching? This is where I think follow-up comes in. There is no such follow-up at the moment, but it needs to be there (FGD 2)

Another teacher, who was also in agreement with the point on 'follow-up' being an element of effective CPD, mentioned some of the benefits that come with follow-up:

… following-up can bring about ideas on how to further support teachers who could be struggling with implementing ideas learnt and on how to simply keep those who are doing fine, motivated…(Questionnaire)

Even though teachers were of the view that feedback and/or follow-up were important characteristics of effective CPD, they were also quick to point out that with financial and human resource constraints this may not be realised. A representative comment made by the teachers is given below:

The issues of feedback or follow-up are just dreams and will remain dreams for as long we have no provision or facilities for such in our system…Seriously take a look at this: first there are time constraints, then lack of funding coupled with lack of the kind of people who could be considered as trustworthy and qualified enough to do following up…(FGD 1)

Another teacher added:

…there is no proper structure for such follow-up business in our education system and there is lack of commitment to doing such things partly because it seems there are other more pressing demands on our time and there are also limited finances available…(FGD1)

The teachers' response in this case mainly point to the existence of time, financial and human resource constraints in the context of making follow-up on CPD. However, it can also be deduced from the literature (Bubb & Earley, 2007) that when CPD activities in the first place are loosely matched to teachers' CPD needs and not related to teachers' classroom realities follow-up becomes impractical.

All things considered, the importance of follow-up and feedback in the CPD context cannot be overemphasised (2.4.4). It provides opportunities to give and for teachers to receive formal or informal feedback. Feedback allows teachers opportunities to continually reflect on their learning and their practice and exposes teachers to more (new) ideas to help them in

improving their teaching practices (Bechtel & O'Sullivan, 2006; Cordingley et al., 2003; Steyn, 2011). However, since teachers are different and implement learnt material, change or improve their practices at different rates, a one-size fits all kind of follow-up and feedback giving for all teachers may not work.

4.2.4.7Timing of CPD

Teachers made reference to the timing of CPD sessions in their comments and discussion regarding effective CPD. Their comments were mainly related to SBCPD.

Effective CPD takes place at appropriate time(s). The time we have our CPD is not all that appropriate. We have CPD after classes, and by which time I am too tired and drained to concentrate on whatever we need to learn and just look forward to going back home…(Interview 5)

In our school, CPDs are held during teaching time. This ends up disrupting lessons, which is not fair on the part of the pupils who are supposed to be learning at the time. If CPD is to be considered effective, then it should not be taking away valuable teaching time…(Interview 40)

The above comments suggest that there are variations regarding the timing for SBCPD. It can be deduced that even though SBCPD through LS is the main CPD activity for teachers in Zambia (1.4: 2.2.2: 4.2.2.1), there is no specific time set for teachers to engage in it. Despite raising their concerns regarding timing for CPD, no specific comments were made regarding the best time for effective CPD. No teacher made reference to the number of CPD days or hours that a teacher is supposed to take over a period of time such as per year. This could be attributed to the point that there is no such thing as number of CPD days or hours that a teacher is supposed to take in a specified period of time annually in their context or that if this exists it is not reinforced.

Some teachers' responses such as: *'...Sometimes we meet for two hours and at other times longer than that. It is not clear how long these CPD sessions should be for...*(Interview 37), indicate that there was need to consider the duration of CPD sessions in the CPD plans. No teacher however stated what they perceived the optimal duration: *'...I don't know what the ideal duration for CPDs should be...'*(Interview 20). Even though time to meet and for how long to meet is an important issue to consider in regard to CPD, it is not enough on its own in the quest to improve teachers' learning through planned CPD sessions. Reviewed literature (Kennedy, 1998) shows that there is no significant relationship between time spent on PD and teacher learning. Boyle, et al.(2005) equally adds that there may not be link with ideas that that the longer a professional activity is the better the results and Desimone (2009) appears to have concluded that there is no clear guidance in literature on the duration of effective CPD. However, literature (Bubb & Earley, 2007; Timperley et al., 2008; Villegas-Reimers, 2003)

has made general comments regarding duration of CPD. Bubb & Earley (2007) for example state that teachers need adequate time during and after CPD to reflect on their newly acquired knowledge and to explore ways in which such knowledge could fit in their context. Effective CPD is long enough for teacher learning to take place (Timperley et al., 2008; Villegas-Reimers, 2003) and 'deep learning takes time, and takes place over time' (Loucks-Horsley et al., 1996, p. 2). However, as earlier stated, these remain as 'general' comments because terms such as 'adequate time' or 'long enough' are relative terms.

In response to the question **'What are secondary school mathematics teachers' perceptions of the (non) effectiveness of current CPD activities in meeting their perceived CPD needs'?** which is part of research question 4, the points in the next paragraphs were considered.

The first point to note here is that teachers' consideration of whether CPD was (non)effective in meeting their needs varied according to their circumstances and their needs and this also largely depended on whether teachers were able to identify their needs or not. After analysis of their responses it is concluded that some teachers struggled to comprehend the concept of CPD needs and with identifying their individual CPD needs in particular (4.2.3). This is consolidated by more differing reactions that included statements such as: *'I am not sure about what my real needs are…' (Interview 1)* and *'I don't think I can say that I know my needs per se…even if I knew am not sure it matters to any one because we look at what has been planned for us…'*(Interview 23).

Secondly, teachers' responses indicated that current CPD has contributed toward meeting some, but not all of their perceived needs. Their responses point out that their current CPD content was predominantly defined by mathematics CK and pedagogy (4.2.3.3: 4.3.3.4). Therefore, even though teachers' responses stem from different perspectives and experiences that can be attributed to their teaching experience or level of expertise**,** current CPD has to some extent contributed to meeting some of their needs in these two categories of need. One representative comment is: *My knowledge of some of the topics in mathematics has improved and so has my approach to teaching and my actual teaching practices*…(Interview 2). However, it is inferred from teachers' responses that CPD content needs to be broadened to cover other concerns and needs that they had. An illustrative comment was:

CPD is effective if its focus has content that teachers need to learn about to help them become better in their work. And for me this can't always definitely be about mathematics content knowledge and pedagogy like it currently is.... (Interview 5)

Another teacher had this to say:

CPD should not only concentrate on mathematics content and teaching skills, but also go beyond that…. to help us cope with the challenges we face in teaching mathematics and in our education system in general…(FGD1)

And another mentioned that*: 'Mathematics content is important, but we need to be looking at other real issues… during our CPD otherwise the focus will be too narrow…'*(FGD 1)

In general, while it was acknowledged that CPD was limited to mathematics content and pedagogical knowledge and practices, teachers were not definite as to what else would be considered relevant to the CPD agenda nor the basis for their choice of CPD focus. After analysis of their responses and relevant MOE documentation it is concluded that: **(a)** apart from some teachers facing difficulties with identifying their individual CPD needs, teachers were not aware of the policy statement in the EOF pointing to some of the areas they needed to gain in-depth knowledge in and develop their competence in areas which are highlighted under section 2.3.1 and repeated under the next point; and **(b)** teachers' responses point to a mismatch between government' implied focus of CPD and actual CPD focus. To reiterate, teachers' responses point out that their current CPD content was predominantly defined by mathematics CK and pedagogy (4.2.3.3: 4.2.3.4). However, based on the EOF policy document, CPD should help in updating pedagogical approaches, pastoral care for learners, assessment procedures, school organisation and management, and relationship with parents/guardians and the community (MOE, 1996). Despite such statements, CPD content predominantly remains defined by mathematics CK and pedagogy. In addition, based on analysis of other literature as reviewed in this study (2.3.1; 2.3.2) it can be deduced that current CPD content was not broad enough to facilitate teachers' professional, social and personal needs (2.3.2: 2.3.2.1 - 2.3.2.3). A predominant focus on mathematics content and pedagogical knowledge could be interpreted as significant but at the same time limiting and limited compared to what teachers expressed as their needs (section 4.2.3; 4.2.3.1-4.2.3.6) in terms of the knowledge, understanding, skills and values to enable them develop and improve their practice.

Thirdly, teachers' responses and comments pointed to the lack of consideration of what individual teachers perceived as important for their CPD. They referred to the inability to accommodate their' different needs and levels of needs during CPD sessions. A comment to illustrate this is one from one of the teachers interviewed:

We teachers are different in so many ways: our knowledge levels, our experiences…so it is only natural that, to some extent, our differences are considered and accommodated in our CPDs…Don't

get me wrong here…I will give you an example to clarify my point… I mean 'accommodated' in a positive sense. I have had several chances to look at Earth Geometry I consider it inappropriate to treat me like one who has no knowledge of Earth Geometry just because for this particular CPD session we are looking at Earth Geometry. Our levels are different …(Interview 7)

Analysis of teachers' responses such as the above reveals that teachers' CPD needs, whether professional or social or personal needs vary widely in nature, intensity and complexity depending on factors such as teachers' level of expertise, years of experience, academic qualifications and current grade level teaching among other factors. The variation in needs was evident even among teachers with for instance, the same qualifications and years of experience (4.2.3.1 - 4.2.3.6). Despite teachers' diverse and wide-ranging levels of needs, current CPD has been insufficiently differentiated.

CPD is a waste of time because we look at the same things even when you feel positively confident in a particular area. A classic example is just from the last departmental meeting we had. We were made to look at aspects of Matrices, which I have had no problems with understanding or teaching, but we were all treated like we all were coming across Matrices for the first time… I wish I had spent my precious time doing something more important…(Interview 43*)*

It is concluded that there is need for the adoption of differentiated approaches within CPD in addressing teachers' different needs. Literature such as Goodall et al.(2005) state that greater differentiation of provision is necessary to ensure that the varying needs of teachers are met. Teachers are not a homogeneous group, and they bring in to CPD activity different experiences, attitudes, values, knowledge and skills- a point which the ALT acknowledges. For this reason, CPD that does not put into consideration teachers as a heterogeneous group and does not provide opportunities for differentiation in learning risks being distanced by some teachers (Timperley et al., 2007). However, opportunities for differentiation can only flourish in circumstances where teachers' voices concerning CPD preferences and needs are heard, supported and considered in CPD programmes (Guskey, 2002). While recognising that teachers have varying needs, efforts at balancing the individual and group needs of secondary school teachers of mathematics may also need to be made. To this point (Wermke, 2013) adds that 'the balance of group and individual needs should be taken into consideration continually'(p. 34). An example of this is drawn from Timperley et al.'s (2007) work in which they explain that there should be opportunities for individual differentiation in PD for groups of teachers.

Fourthly, teachers' responses and comments (4.2.1: 4.2.2) confirm that there is too much emphasis on one form of CPD- SBCPD through LS. While this form of CPD fits in the principles governing CPD (1.4) and is considered cost effective among other benefits (1.4.1: 2.2.3: 2.2.4) emphasis on one form of CPD can be can be interpreted and considered narrow

and limiting. Based on literature reviewed (2.2.3; 2.2.4) and responses from teachers analysed (4.2.1; 4.2.2), it cannot be sufficient in itself in addressing all the various knowledge and skills needs (2.3: 2.3.2: 2.3.2.1 - 2.3.2.3: 4.2.3.1 - 4.2.3.6) that teachers have in order to be able to improve their practice. Teachers can acquire mathematics teaching/learning-related knowledge and skills and broad educational knowledge and skills through more ways than one (2.2.4: 2.2.4.1: 2.2.4.1.1: 2.2.4.1.2: 2.2.4.2).

The fifth point is that majority of the teachers in this study communicated that the decisions regarding their CPD such as decision of what should be addressed during CPD was not made by them. A representative comment of this is:

I cannot remember being asked what I felt needed to be discussed when we met for such CPD things. Our HOD is the one decides on what should be discussed when we meet. He almost always appears to have a plan…From experience I know that even if I were to be asked we would still go ahead with what he has already planned for our CPD (Interview 20)

This is an indication that teachers do not always have a say in decisions regarding the focus of CPD. Other teachers' responses and comments point to their inability to identify their own needs and also indicating they needed some form of support to identify their needs. An illustrative comment is presented below:

I don't really know how to tell what my needs are exactly. If you are able to give me options of those needs like there is this and this and that, then that way maybe I can pick which ones relate to me… (Interview 5)

With reference to such a comment, it can be assumed that teachers have not been empowered to and have not had chances to exercise their professional autonomy in identifying their CPD needs and making decisions regarding which CPD would best meet their identified needs. They therefore need to be empowered with the necessary knowledge and skills to be able to take or exercise some degree of professional judgment regarding their CPD and taking responsibility for their CPD.

4.2.4.8 Summary of findings and discussions

This section has presented what secondary school mathematics teachers perceived to be the characteristics of (non) effective CPD. There was no one single measure of what made CPD effective. This is probably because individuals are likely to have different understanding and interpretation of what constitutes effectiveness. This noted, teachers' responses on what made CPD effective have been presented and discussed under the following subheadings: CPD content relevant to addressing teachers' needs, teachers having a say in their own CPD, focused with clear goals, appropriate mode of delivery and use of teaching/learning materials,

quality of facilitators, structure for feedback and follow-up and timing. Reference has been made to some of these points in trying to illustrate how and whether current CPD has contributed to meeting secondary school mathematics teachers' CPD needs.

Secondary school mathematics teachers' responses indicate that their CPD focus is predominantly mathematics content and pedagogy (2.3.2.1.1.1: 4.2.3). Teachers in this study consistently referred to the point that whilst it is important to enhance their mathematics CK and PCK and practices, as is currently the case, they would prefer that there be, at the same time, opportunities for them to discuss something else of relevance to their teaching practice. Though there were instances where teachers were not specific about that 'something else' analysis of their responses and narratives indicated that this was linked to acquiring and updating knowledge and developing skills in all other areas of their work and professional, personal and social development. Margo et al.'s (2008) comment that in the present age teachers need much more than deep and thorough subject knowledge and PCK, but knowledge to enable them be life coaches for the learners, to implement and make curriculum relevant to the learners and remain dedicated to their teaching work and fulfilling wider professional responsibilities and interested in life-long learning, aptly applies to the teachers in this study.

Teachers' responses indicate that there is insufficient consideration of their views regarding CPD: CPD activities or the focus of CPD sessions. The analysis of their responses in this regard with reference to relevant literature suggest that their voices (2.3.4) regarding CPD in general, and their conceptions of effective CPD, CPD activities and CPD content are worthy considering in the context of determining their real needs and improving their CPD experience.

Further analysis of teachers' responses reveals that discussion on CPD and the effectiveness of CPD is incomplete without reference to prevalent resource constraints and contextual challenge (1.3.3-1.3.4: 1.4: 1.4.1). In resource constrained (educational) environments, valuable resources for CPD such as time, finances, instructional resources and human resources are limited and prone to be 'misdirected' or 'redirected' due to poor management or mismanagement and/or competing demands within the education system. It is also worth stating that based on analysis of data, teachers' perceived effectiveness of CPD is also influenced by kinds of CPD activities teachers engage in and several other factors such as the influence of teachers' motivations, aspirations and needs among other factors.

4.3 Chapter summary

This chapter has presented and discussed considerable qualitative and quantitative data collected on how secondary school mathematics teachers in this study perceived CPD: how they perceived the notion of CPD and it value; the CPD activities that they engaged in; their perceived CPD needs; and perceived (non)effectiveness of CPD. The presentation of the findings and the discussion of findings were structured into three main headings. The first main heading presents information about the participating teachers. In summary, a large number of the secondary school mathematics teachers that participated in this study were male representing typical trends in terms of the gender of mathematics teachers in the country. The teachers in the study had different academic qualifications, belonged to different age groups, taught different grade levels and had varying years of teaching experience.

The second main heading presents and discusses the research findings. It has been subdivided into four subheadings following the four research questions for this study: (1) How do secondary school mathematics teachers perceive CPD and its value? (2) What CPD activities are secondary school mathematics teachers in Zambia currently engaged in? What are their perceptions of these CPD activities? How do the teachers perceive these CPD activities? (3) What are the perceived CPD needs of secondary school mathematics teachers in Zambia?; And (4) What are secondary school mathematics teachers' perspectives on what makes CPD activities (non)effective? What are their perceptions of the (non)effectiveness of current CPD activities in meeting their perceived CPD needs? Further relevant third level subheadings were identified and created under each second level subheading. The findings were presented and discussed accordingly under each of the identified subheadings. This last main heading provides the chapter summary.

The next chapter provides a proposed framework for teachers' CPD needs identification to possibly guide teachers in identifying their CPD needs and possible CPD activities that could meet their CPD needs.

Chapter 5: Suggested needs identification and analysis model

Chapter four presented the research findings and discussion. This chapter presents the proposed generic framework of mathematics teachers' CPD needs. Section 5.1 discusses the rationale for the proposed generic framework of teachers' CPD needs which is followed by section 5.2 the structure of the proposed generic framework of teachers' CPD needs. The chapter ends with a chapter summary under section 5.3.

5.1 Rationale for the proposed generic framework of teachers' CPD needs analysis model

As has been presented in the previous chapter, the MOE in Zambia expects teachers to engage in SBCPD through LS for their PD. This is the main CPD activity with a predominant focus on Mathematics CK. The rationale behind the framework of teachers' needs is to empower teachers to be able to identify their own CPD needs to support their professional, social and personal development and thus to an extent take responsibility of their CPD. Based on the qualitative and quantitative data collected for this research, some teachers expressed lack of awareness of their needs; with some stating that it was not for them to identify their CPD needs but the responsibility of their superiors including the HOD, CPD coordinators or MOE officials; and with others recognising that they could play a role in identifying their CPD needs, but that they were not sure how to go about it and what would count as acceptable teachers' needs. Based on this, this proposed framework would not only contribute to raising awareness of teachers possible CPD needs, but also guide and contribute to empowering teachers to identify their CPD needs.

In addition, literature shows that teaching work is broad, complex and demanding by nature, and becoming increasingly so in the face of societal changes, requiring teachers to have vast not only subject-specific knowledge and pedagogical skills, but also broader educational knowledge and skills (2.3.2.1.). Literature also shows that teachers' needs are wide, varied, in different combinations and increasing levels of complexity and changing over time (2.3; 2.3.1; 2.3.2.1; 2.3.2.2; 2.3.2.3). As highlighted in this study, teachers' needs can be mediated by several factors such as identified in section 2.3.5 coupled with the structural elements of their sociocultural contexts (1.3; 1.4; 1.7.3). These needs in teachers' professional, personal and social contexts may need to be identified, recognised and teachers supported in meeting

them thus enabling them to continue developing and becoming proficient in their work. A starting point could be through using a framework of teachers' CPD needs as it would help individual mathematics teachers to make meaningful self-evaluations of their own individual CPD needs. It can facilitate and provide opportunities for teachers' continuous reflection on their teaching practices and keep teachers from making vague statements regarding their CPD needs which would be difficult to make sense of. Familiarity with and effective use of this framework would, to use Hurrell's (2013) ideas, enable teachers to reflect on the various domains of CPD needs or areas or any areas in which they may feel they are deficient or areas that require development to foster professional growth. It will also be one of the viable means by which teachers could identify and analyse their learning needs and thereby exercise some degree of teacher autonomy in their CPD (2.3.4). Note should be made here that for this to work, government support in the form of, for instance, policy provisions, more CPD opportunities and freedom for teachers to participate in would equally be needed

Further, among the government official documents with information on teachers' CPD that were reviewed there is no such framework in place in Zambia that presents teachers' needs and competences, including possible CPD activities, that teachers might ideally consider through their career and which in some ways, could be seen to be a benchmark against which teachers can measure their personal PD. In fact, the EOF national policy document states that:

No master plan exists to show …the nature of their [teachers'] *training needs, the needs of the education system, and the types of programmes that would best meet these needs (MOE, 1996: 116).*

The proposed framework would help in showing the generic nature of the CPD needs of teachers and therefore guide teachers in identifying their specific needs. This framework would also contribute to making the EOF guiding principle of CPD provision stated earlier in chapter 1 more clearer. This would be that it is not only school needs that CPD should focus on, but also teachers' individual needs and that teachers have a significant role to play in identifying their needs a point which is evident in literature reviewed in chapter 2 and which is drawn from study findings presented in chapter 4.

Furthermore, the needs identification framework can enable school administrators and other relevant stakeholders to be targeted in addressing the PD of teachers. Supervisors including HOD, CPD Coordinator MOE officials or officials from the recently established Teaching Council of Zambia (TCZ) can use it to effectively play their role in supporting teachers' PD as they would be aware of teachers' actual needs. This could be through widely

disseminating information about CPD and contribute toward appropriately directing available resources for the success of CPD. The MOE and TCZ officials can use it to be aware of and understand the knowledge and skills needs of the teachers in the education system.

5.2 The proposed generic framework of teachers' CPD needs analysis model

5.2.1 Background information

The framework is a synthesis of ideas extended in the works of various authors (ACTEQ, 2003; Ball & Even, 2009; Bell & Gilbert, 1996; Hustler et al., 2003; Kilpatrick et al., 2001; Krauss et al., 2008; MOE, 1996; Smith, 2004; UOR, 2016; Vitae, 2011). It has also made a consideration of some of the findings as presented in chapter 4. The framework serves to illustrate what knowledge, competencies and values, teachers could broadly embrace and grow in during the different stages of their professional growth and development.

The framework is in line with the principle of constructivism theory where individuals are more actively engaged in and have a greater sense of ownership in their learning and in their PD in this case and also the principle of adult learning that adults are autonomous and self-directed and goal oriented (1.7.1: 1.7.2). The use of the proposed framework could be a start or a boost to teachers taking responsibility of their own learning and development. The framework is meant to be flexible enough to allow teachers to state and clarify their needs and allow for engagement in both formally structured and self-directed PD in order to meet the identified needs.

5.2.2 The structure of the generic framework of mathematics teachers' CPD needs analysis model

The generic framework of mathematics teachers' CPD needs is structured into three main domains A, B and C with domain A representing professional knowledge and skills needs, domain B representing personal needs and C social development needs. Each main domain is divided into subdomains covering teachers' potential needs in terms of knowledge, skills, values, behaviours as well professional standards for teaching and exercising their wider professional responsibilities.

Reference is made to Table 15 below: Column one indicates the CPD needs domain and subdomains, while column two teachers' needs under which teachers would be expected to state the identified need(s) including the learning objective associated with the identified

needs. The accompanying information for each of the subdomains under column one are given below:

A1: Mathematics CK which includes areas of needs such as those related to:

- Mathematics as a subject-that is the nature of the subject, norms and standards of evidence in mathematics;
- Mathematics specific knowledge-mathematical facts, concepts and procedures and the relationships among them, together with the conceptual basis for that knowledge with respect to the different topics in the school mathematics curriculum;
- Links between mathematics to other school subject areas etc

A2: Mathematics PCK and practices which includes areas of needs such as those related to:

- Knowledge of the curriculum and its core values and principles;
- Knowledge of teaching in general;
- Knowledge of classroom practices that support the development of mathematical competence;
- Knowledge of tasks and tools that can be used for teaching mathematical ideas;
- Communicating mathematical knowledge precisely in writing and speech;
- Working with pupils understanding and misunderstanding of Mathematical concepts;
- Making the learning of mathematics more meaningful and engaging learners more in their learning of mathematics;
- Assessment techniques, and interpretation and use of pupil assessment results to inform teaching practice;
- Knowledge of technology and technology use in teaching and learning etc

A3: Knowledge of learners which includes areas of needs such as those related to:

- How learners learn mathematics
- Knowledge of how various mathematical ideas develop in learners;
- Knowledge of learning mathematics and the approaches that influence learners' thinking and learning;
- Knowledge of common difficulties that learners experience with certain mathematical concepts and procedures;
- Knowledge of how to determine the level where a child is in terms of processing mathematical concepts and how to help them proceed/Progress: Holistic (whole person) development of pupils;
- Providing pastoral care for pupils;
- Understanding pupils' diverse personal, developmental and academic needs (such as personal, developmental and academic needs);
- Adapting teaching approaches to support pupils' diverse needs;
- Responding to pupils' attitude towards mathematics and learning Mathematics;
- Awareness of and responding to pupils' beliefs about self and learning Mathematics;
- Strategies for stimulating and sustaining pupils' interest in learning Mathematics etc

B1 Personal effectiveness which includes areas of needs such as those related to:

- Self-confidence
- Enthusiasm e.g strategies for surviving and coping with pressures within the teaching practice

- Managing feelings and attitudes such as those associated with changing teachers' attitudes and beliefs about mathematics teaching and learning;
- Perseverance- being able to survive and cope with pressures within the teaching practice;
- Self-reflection;
- Maintaining and supporting teachers' positive attitude towards mathematics and the teaching of Mathematics etc

B2 Self-management which includes areas of needs such as those related to:

- Metacognition and self-regulatory approaches (such as strategies to set their own learning or development goals, monitor and evaluate their own development);
- Work-life balance;
- Time- management etc

C1Working with others within the school which includes areas of needs such as those related to:

- Developing ways of working with others in the department or different school department;
- Sharing of knowledge and good practices with others in the same or different (subject) department to support personal learning;
- Commitment to SD (such as adapting to the school vision and mission and realizing school goals)

C2 Engaging with the broader teaching community areas of needs such as those related to:

- Interaction with the broader mathematics community
- Interaction with the broader teaching community

C3 Engagement in wider community includes areas of needs such as those related to:

- Engaging with parents/guardians/community for further SD
- Participation in education-related community services and voluntary work

Teachers would have to take responsibility and identify the area of need to be addressed. Deciding what knowledge, skills and values one intends to acquire and develop through/during CPD activity can inform decisions regarding the appropriate CPD activity to engage in to meet one's needs (Taylor, 2013).

Table 15 Generic framework for teachers' CPD needs analysis model

Needs Domain	**Teacher's needs (**as identified by the teacher and/or with the support of the supervisor e.g HOD**) and learning objective(s)**	**Formal and/or informal CPD activity/activities teacher engages in to meet identified need(s)**	**Date(s) CPD attended**	**Learning outcome**
DOMAIN A: Professional knowledge and skills needs domain: The knowledge, intellectual abilities and techniques for teaching mathematics				
A1: Mathematics CK Includes Mathematics as a subject-that is the nature of the subject, norms and standards of evidence in mathematics etc				
A2: Mathematics PCK Includes knowledge of classroom practices that support the development of mathematical competence etc				
A3: Knowledge of learners Includes how learners learn mathematics in general and specific aspects of mathematics etc				

DOMAIN B: Personal development needs: the development of personal qualities and skills for self-understanding and self-development-with an awareness of prevailing societal cultural values				
B1 Personal effectiveness includes managing feelings and attitudes such as associated with changing teachers' activities and beliefs about mathematics teaching and learning etc				
B2 Self-management includes metacognition and self-regulatory approaches (e.g strategies to set their own learning or development goals, monitor and evaluate their own development) etc				
DOMAIN C: Social development needs: Leading to acquisition of knowledge and development of skills for establishing and maintaining meaningful relationships for fulfilment of teachers' professional roles				
C1: Working with others within the school Includes developing ways of working with others in the department or different school department etc				

C2: Engaging with the broader teaching community Includes interaction with the broader mathematics community Interaction with the broader teaching community etc				
C3 Engagement in wider community Includes engaging with parents/guardians/community for further SD etc				
Additional CPD needs not covered above				

In the third column, that is, formal and informal CPD activities column, teachers should be able to state the CPD activities: formal or informal that they would have engaged in in order to meet their identified needs. These CPD activities should have clear learning goals and outcomes and related to teachers' (professional) role and area of specialisation. Examples of formal CPD activities include professional courses, seminars, conferences, departmental (in-house) trainings, higher academic qualifications and informal CPD activities include personal or private study, informal dialogue to improve teaching and learning. Those in charge of teachers' CPD may have to ascertain which CPD activities are considered formal and those informal and communicate these clearly to teachers concerned. Teachers would be expected to consistently document and update the learning/CPD activities they would engage in. They should be able to record any CPD activity as planned or completed once undertaken. When CPD activities are recorded as 'planned' it would show a teacher's development plan for a given period of time. Supporting documentation for formal learning activities undertaken may have to be provided. These could include certificate of participation or achievement for courses attended.

The fourth column in Table 15 above is meant for indicating the date CPD was attended and the last column in is meant for recording the learning outcomes from the CPD activities engaged in. Recording the (key) learning outcome(s) of the CPD undertaken is not only a

way of encouraging teachers to reflect upon and evaluate what they have learnt, but also to a way to facilitate identification of future CPD and learning needs.

A copy of the completed framework of teachers' needs form should be kept in each teacher's teaching file and other copies shared with supervisors such as the HOD. From the evidence provided in Chapter 4 the whole process of completing a form of this nature could be highly regarded as an additional responsibility by the teachers who already have heavy workloads. However, it should be considered necessary if teachers are to exercise some degree of autonomy in, have a say in, and take responsibility of their CPD based on what the evidence provided in the previous chapter suggested.

Note should be made here that the proposed generic framework of teachers' CPD needs can be supplemented by other methods for identifying CPD needs such as the SWOT analysis presented (2.3.3).

5.3 Chapter summary

CPD process becomes meaningful and relevant when needs are appropriately researched, identified and targeted within sessions of CPD activities. This chapter has presented the proposed generic framework of teachers' CPD needs analysis model which could guide and support teachers in identifying their CPD needs and CPD activities that could meet the identified needs thus empower teachers to have a say in their own CPD. The framework may work well with changes in elements of teachers' sociocultural contexts which could allow teachers flexibility and opportunity to identify their CPD needs and have multiple opportunities through which such needs could be met. The next chapter provides a general overview of this study, summary of key findings and conclusions. It also presents recommendations based on its key findings; limitations of the study and possible areas for further research.

Chapter 6: Conclusions and Recommendations

The previous chapter presented the proposed generic framework of teachers' CPD needs that could guide teachers in identifying their CPD needs together with possible CPD activities to meet their CPD needs. This chapter presents a general overview of thesis chapters 1 through to chapter 5 under section 6.1 followed by a summary the key findings and conclusions in relation to the research aim and research questions guiding this study under section 6.2. Section 6.3 provides recommendations of the study, 6.4 the limitations of the study and 6.5 possible areas for future research.

6.1 General overview of thesis chapters

Of the six chapters, Chapter 1 provides the context for this study which is subdivided into nine sections: background information about Zambia (1.1); Zambian education system and structure (1.2); mathematics teaching and learning in Zambia (1.3); teachers' CPD (1.4); the focus of the study described in terms of the aim and research questions (1.5); the significance of the study (1.6); the theoretical framework (1.7); an overview of the thesis chapters (1.8) and, finally a chapter summary (1.9).

Chapter 2 is where relevant existing literature is explored and presented. The first section of the chapter gives the introduction followed by section 2.1, which presents the purpose of the literature review. Section 2.2 discusses teachers' CPD by looking at conceptualisation of the notion of CPD 2.2.1, the value of CPD 2.2.2, agents in CPD provision 2.2.3, CPD activities 2.2.4. Section 2.3 highlights teachers' CPD needs followed by section 2.4 which focuses on effective CPD and section 2.5 provides the chapter summary

Chapter 3 presents the methodological approach undertaken in the collection of data for this study. Section 3.1 gives a recap of the research aim and research questions guiding the study. The theoretical framework underpinning this study is constructivism as presented under section 3.2 and the research is broadly qualitative in nature (section 3.3). This study followed a case study research design (3.3) and adopted mixed data collection methods (section 3.5) to allow for collection of both qualitative and quantitative data needed to address the research questions. The pilot study information is presented under section 3.4. Section 3.6 focuses on the order of data collection followed by data analysis procedures under section 3.7. Section 3.8 presents reliability and validity issues and section 3.9 addresses ethical considerations. Section 3.10 summarises the chapter.

The focus of Chapter 4 is the presentation and discussion of findings. Section 4.1 gives an overview of participants in the study. The presentation and discussion of the findings are structured around the research questions while at the same time also capturing the emergent issues under section 4.2. Section 4.2.1 presents the findings attached to addressing research question one relating to how teachers conceptualise CPD and its value; section 4.2.2 presents findings on CPD activities teachers engaged in and their perceptions of the CPD activities; section 4.2.3 the findings on the secondary school mathematics teachers' perceived CPD needs; section 4.2.4 addresses the findings connected to teachers' perceptions of what makes CPD (non)effective and the (non)effectiveness of current CPD in contributing to addressing secondary school mathematics teachers' CPD needs. Section 4.3 provides the chapter summary.

Chapter 5 presents the suggested generic framework of teachers' CPD needs which can be used by teachers in identifying their needs and CPD activities that could contribute toward meeting teachers' identified CPD needs. The first part of the chapter gives the introduction to the chapter, section 5.1 the rationale for the proposed generic framework of teachers' CPD needs. This is followed by section 5.2 with the background information regarding the suggested framework and also its structure. Section 5.3 is the chapter summary.

Chapter 6 focuses on the key findings and conclusions of the study as drawn from findings of the study and consideration of relevant literature pertaining to the study.

6.2 Summary of key findings, conclusions and implications

With the use of questionnaire, face-to-face in-depth interviews, FGDs and documents for analysis this study collected quantitative and qualitative data from secondary school mathematics teachers in Zambia on their perspectives on CPD. The data collected was analysed with reference to relevant CPD literature, literature in the field of mathematics education and beyond. The literature review was conducted to map existing studies that investigate discussions of CPD and CPD needs in general, mathematics teachers in general, mathematics teachers' CPD and CPD needs. Considerable literature review was done before going for data collection so as to inform the fieldwork.

This study focused on investigating secondary school mathematics teachers' perspectives on CPD with the aim of finding out whether and how current CPD meets their CPD needs and to what extent. The interrelated research questions guiding the study were: (1) how do

secondary school mathematics teachers perceive CPD and its value?; (2) what CPD activities are secondary school mathematics teachers in Zambia currently engaged in?; how do the teachers perceive these CPD activities?; (3) what are the perceived CPD needs of secondary school mathematics teachers in Zambia?; and (4) what are secondary school mathematics teachers' perspectives on what makes CPD activities (non)effective? and what are their perceptions of the (non)effectiveness of current CPD activities in meeting their perceived CPD needs?

To address the above stated research questions, the key findings of the research are presented and discussed in turn.

The findings of this study show that secondary school mathematics teachers' conceptualisation of the notion of CPD differed from teacher to teacher and so was the value they attached to CPD. Specifically, CPD was perceived to be: 'an event', 'a collective activity', 'about learning and developing', 'a directive from government' and 'a ladder to promotion' (4.2.1.1 to 4.2.1.5). How committed teachers are to CPD, to an extent depends on their conception of CPD. For CPD initiatives to be successful they have to convey an understanding of the personal meaning that the participating teachers attach to CPD (Mokhele & Jita, 2010). Considering the different notions of CPD, it can be construed that there is a need to provide a broad and holistic view of CPD, which advances the differing notions, and purposes of teachers' CPD. By implication, the differing, and seemingly, conflicting perspectives of CPD can be brought together for a broad and all-inclusive shared understanding of CPD which would not only be essential for teachers, but also for all the providers of CPD (2.2.3). CPD is a collective responsibility (Bubb & Earley, 2007). Having a shared understanding of what CPD is could pave way for meaningful cooperation between and among relevant stakeholders in CPD provision and more opportunities for widening the content of CPD sessions so as to meet teachers' various and diverse CPD needs (2.3).

The Literature (Bell & Gilbert, 1996; Bubb & Earley, 2007; Fraser et al., 2007; Robertson & Murrihy, 2006; Struthers, 2007) shows that teacher development encompasses professional, personal and social development (2.3.1 - 2.3.2.3). At the heart of CPD is self-improvement of professional, personal and social qualities not only for its own sake, but with a view to ensure improvement in the quality of the teaching and learning process so that pupils and other beneficiaries are provided with the best service possible (Bubb & Earley, 2007). The findings of the study (4.2.1 - 4.2.4) show that even though professional, personal and social development aspects are intertwined and crucial for having 'whole' teacher development,

teachers' CPD focus was mainly for PD and little on considering knowledge, skills, competencies and values pertaining to the social and personal development. It is concluded that teachers' perceptions demonstrate that they have a narrow and limited view of what constitutes their development. The need for a broad view of CPD that encompasses professional, personal and social development applies.

The other point concerns CPD activities that secondary school mathematics teachers engaged in. The findings of this study (4.2.1: 4.2.2) show that teachers mainly engaged in formal structured SBCPD through LS chiefly for the purpose of complying with government demand and less out of teachers' ability to exercise autonomy (2.3.4) with regard to their CPD. Teachers' responses also indicated that there are some forms of CPD, which are (teacher) self –directed and some informal in nature which are not recognised as CPD, but simply as 'what teachers do' (4.2.2). By deduction, there is a need to embrace the kind of CPD that comprises and accommodates many different activities: formal or informal in nature, school-based as well as non-school-based, that allow for teacher learning and professional growth. The whole picture of teachers' continuing PD is to cover the point that teacher development or growth can take place in multiple contexts (Borko et al., 2004) taking into consideration the individual teacher as a learner (Mansour et al., 2014). Further, emphasis should go beyond the CPD activities themselves and include the purpose of and realisation of the purpose of the CPD activities.

Regarding teachers' perceived CPD needs, it is important to note first that based on the data collected for this research and presented in chapter 4 (4.2 - 4.2.4) some of the secondary school mathematics teachers expressed that it was not for them to identify their CPD needs but the responsibility of their superiors (including the HOD, CPD coordinators or MOE officials), with others recognising that they had a role to play in identifying their CPD needs, but were not sure of how to go about it and what would count as acceptable teachers' needs. This implies that there is a need to raise awareness and empower teachers to identify their CPD needs and take responsibility of their CPD. This is not without recognising that teachers cannot do it alone as government responsibility and '…support in the form of policy provisions, resources, incentives, freedom and opportunities are crucial for CPD' (Padwad & Dixit, 2014, p. 13) too.

With respect to teachers' perceived CPD needs as organised in the six main domains (4.2.3.1 - 4.2.3.6): mathematics CK, PCK and skills, PPR, KLCN and skills to meet learners' needs, AN and SD needs, teachers' responses show that they had the highest CPD need in the KLCN

needs domain as tied to raising the standard, attainment and learning experiences of mathematics. Teachers' lowest CPD needs lie in the SD needs domain. However, it was also observed that there were variations in terms of what teachers perceived to be their needs across a whole range of variables that were organised under each of the six main domains. The aforementioned implies that CPD needs of secondary school mathematics teachers vary from teacher to teacher, from category of need to another and even within the categories of needs. Teachers have diverse needs (2.3.2.1 - 2.3.2.3) and in various combinations due to various factors such as described in sections 2.3.5.1 - 2.3.5.3.2. Even though there are no significant differences based on statistical analysis of data, it is interesting to note, from the responses given by interviewed teachers and those who participated in FGDs that there were some differences between teacher characteristics (such as: gender; age; years of teaching experience; academic qualifications; grade level teacher teaching; and level of responsibilities) and teachers' perceived needs (4.2.3). Overall teachers' responses show that while their needs differ, differentiated CPD approaches designed to meet the different needs teachers had have not been sufficiently considered with respect to the CPD activities they attended and the content of CPD. The impact of CPD on teachers remains limited when CPD does not address teachers' needs effectively. Therefore, there is a need for teachers' needs to be ascertained so that CPD activities and CPD content are closely matched to the teachers' identified needs (Bubb & Earley, 2007) and linked to realities or practicalities in existence in mathematics teachers' lives and work contexts (Christie et al., 2004; Mansour, 2015) such as illustrated in chapter 1.

The findings of this research (4.2.4) show that teachers' consideration of whether CPD was effective in meeting their needs varied according to their circumstances and their needs and this also largely depended on whether teachers were able to identify their needs. Overall, an analysis of teachers' responses indicates that: (a) current CPD has a predominant focus on mathematics-specific knowledge and pedagogical skills. Inference is made that while mathematics-specific knowledge and pedagogical knowledge and skills are of significant importance teachers also need broader educational knowledge and skills especially considering their social-economic context. This broader CPD content is central for meeting teachers' professional, social and personal development; (b) as already stated above, there was insufficient differentiation of CPD provision which is necessary to ensure that the varying needs of teachers are met; (c) teacher involvement in decision making linked to their CPD and focus of CPD was limited. This suggests that teachers need to be empowered to take responsibility of their CPD and to engage in decision-making regarding it (2.3.4).

Teachers' perceptions of CPD in general, their conceptions of effective CPD (CPD activities and CPD content) are worth considering in the context of improving their CPD experience. Otherwise CPDs might end up not meeting teachers' needs and prevent them from realising their full potential.

One other important point to note here is that: with reference to background information provided in chapter 1 which illustrates not only the challenges mathematics teachers face, but also broad socio-economic challenges in the country and reference to responses from teachers in this study regarding their personal and work experiences as related to CPD(chapter 4), this study resonates with academics (Christie, et al., 2004; Wheeler, 2001; Bolam & McMahon, 2004: Weber, 2007; Mansour, 2015) who have concluded that CPD cannot have an impact if it is not carefully designed to respond to teachers personal, work and the country's prevailing contextual demands or forces. Effective CPD is a multifaceted kind of CPD that would empower teachers with the knowledge, skills, competencies, values and personal qualities that would enable them not only to improve their teaching practice, but also to continually cope with the demands, challenges, pressures and expectations within a disadvantaged educational system and broad socio-economic environment such as obtaining in Zambia.

6.3 Recommendations

Considering that teachers possessed a narrow view of CPD, it is considered appropriate to recommend that teachers be sensitised on the broader all-encompassing picture or conception of CPD that embraces professional, social and personal development (2.2.1). In addition, based on teachers' responses related to CPD activities which show that there is too much emphasis on one form of CPD and teachers' responses demonstrating a lack of awareness of the wide range of CPD opportunities available, it is considered fitting to recommend that what counts as CPD, its purpose including CPD activities be ascertained as this would make teachers aware of the various aspects of CPD and CPD activities. There is a need to increase awareness of CPD opportunities by actively promoting them.

As already identified in the literature such as Bell & Gilbert, (1996) and discussed at length (2.3 - 2.3.2.3), secondary school mathematics teachers have diverse professional, social and personal development needs, which are influenced by several factors (2.3.5.1 - 2.3.5.3.2) that need to be addressed for teachers to be proficient, effective and efficient in the execution of their work. Thus, CPD provision needs to increasingly adopt differentiation approaches to meet these diverse needs and also match their various learning styles.

Teachers' CPD should be closely matched with the teachers' actual CPD needs and not based on assumptions about what teachers' CPD needs should or could be. This aspect is not clearly expressed in the guiding principles of CPD provision. It is thus recommended that regular and systematic assessment of teachers' CPD needs be conducted at different levels: national level, organisation/school level and individual teacher level for the purpose of addressing the limitations of any one method used in assessing needs and for the purpose of having a comprehensive picture of what teachers' actual CPD needs are.

Decisions on CPD content should not simply reflect the agenda of those hoping that teachers' teaching practices can change or improve, but also the agenda of the participating teachers. This study recommends that teachers should play a significant and active role in identifying their needs while also being supported by their immediate supervisors. The generic framework of teachers' CPD needs analysis proposed and presented under chapter 5 of this thesis can be used in this case, on its own or supplemented by other methods such as the SWOT analysis (2.3.3). This can strengthen the quality of the needs identification and analysis process.

CPD designers, providers and supporters need to consider the extent to which teachers are able to or are being given opportunities to take charge of their personal CPD agenda. Teachers need to be empowered to exercise some degree of autonomy in their continuing professional development (2.3.4) through for instance identifying their professional needs and being a part in deciding CPD to meet their needs. In this case, teacher autonomy is not to be viewed from the angle of undermining school authority but about maximizing opportunities for teachers to take responsibility for their PD. They should be able to take responsibility for their own skills, knowledge and values development. One viable means of achieving this is through the use of the proposed generic framework of teachers' CPD needs analysis model proposed in Chapter 5 of this thesis.

The focus of CPD is not only on teachers changing their practice but extended to improving pupil attainment. Mathematics teaching and learning must be made more relevant to the needs of the pupils (2.3.2.1.2; 2.4.5.2). In particular, mathematics should not remain for academic purposes only; pupils should have increased opportunities to relate mathematics to real life in a meaningful way. In addition, both the cognitive and non-cognitive (affective) issues relating to teachers' teaching and pupils' learning of mathematics should be reflected in the content of CPD sessions and addressed accordingly. The performance of pupils in

Mathematics is highly likely to improve when interventions target both cognitive and affective issues affecting their learning of mathematics (2.4.5.1.2; 2.4.5.2).

There are several CPD providers (2.2.3). On this basis, it is argued that with clear CPD goals, MOE, which oversees teacher development, should recognise the contribution of potential agents in CPD provision (2.2.3) and work together with them to meet the diverse CPD needs of teachers. Among these are HEIs which should be involved in order to provide, in addition to academic courses, a range of PD courses, which could target meeting teachers' identified professional, social and personal needs that would be carried out in the context of lecturers' workloads and availability of resources. Others include professional associations (2.2.3) such as ZAME, which need to be encouraged to offer varying and unique PD services to its members depending on the size of the association, its resources and the needs and interests of its members.

Academic research about education is regarded as an important analytical and intervention tool at all levels of the education system in that it facilitates finding out of what is obtaining, what works or needs to be adjusted or changed to suit the situations obtaining on the ground (4.2). However, findings from this study show that 'research' is among the least CPD activity that teachers engage in. A strong commitment to and a support structure for research is needed in Zambia's education system, especially among teachers, as it can contribute toward informing policy formulation and facilitate policy implementation. One practical way could be through teachers engaging with researchers at university level.

6.4 Limitations of the study

As already acknowledged, the current study investigates secondary school mathematics teachers' perceptions and so the results may reveal more about their opinions, which may prove to be underestimates or overestimates of their actual experience in relation to CPD. No observations of their engagement in CPD activities were carried out to confirm or contradict their perspectives. Despite this limitation, it can be stated that teachers' perceptions provide an opportunity for teachers to express their views of their CPD experiences and also gives a fuller understanding of what it means to experience CPD in a context such as Zambia.

It is worth mentioning that the findings of this study could be considered provisional or not being fixed**.** The views of the teachers in this study are bound to be specific to their circumstances, place and time. Due to time and financial resource constraints, the study was limited to one district in Zambia. The participants in this study were mathematics teachers in

one district out of a total of eleven districts in the central province of Zambia. The findings therefore, even though illuminating, are limited to secondary school mathematics teachers in this district. The views of the participants obtained through interviews, discussions and the questionnaire, presented in this thesis are true for the participants at the time of data collection (April to August 2015) and in their particular context. While the findings and recommendations have wider implications to secondary school mathematics teachers' CPD, the above-mentioned factors can act as limitations to the generalisability of the findings and the recommendations. However, Marshall & Rossman (2011) state that although qualitative studies such as this one cannot be generalised in a statistical sense, the findings can be transferable. Based on this argument, the findings of this study not only informs practice at a local level but can also inform others at national or global level or be used in similar other settings and contexts.

There is a scarcity of literature on the specific needs of secondary school mathematics teachers in Zambia. Consequently, the ideas and the needs of secondary school mathematics teachers have been developed, adopted from sources from other countries and been adapted to the Zambian context. The scarcity of data on specific needs of the teachers potentially affected the quality of findings and reporting of findings, as majority of the data collected in this study could not be verified with other relevant documented evidence.

Despite the above stated limitations, the findings of this study have illuminated secondary school mathematics teachers' perceptions regarding CPD practices that they are involved in and whether they have contributed to meeting their CPD needs and to what extent, which would not otherwise have been possible. The use of literature sources from other countries has revealed the CPD practices for mathematics teachers in other countries that could have remained uncovered if not for this study. The information obtained however had to be weighed against the practical realities and experiences associated with the difficulties mathematics teachers experience in their work and educational contexts, some of which are due to economic hardships in the country.

6.5 Possible future research areas

This research has, to a great extent, achieved the aim set out in chapter 1 and other chapters of the thesis. However, further research would still be needed to unintentional or unplanned oversights of the study and thereby contribute toward strengthening the provision of CPD that is closely matched with secondary school mathematics teachers' perceived and identified CPD needs. Further research can be taken in the following four areas:

1. A study of this nature could be extended to other parts of the country and thereby include a larger population than the present study had.

2. CPD needs to equip teachers with a broad and solid teacher knowledge base which goes beyond mathematics CK and PCK, competences and values to enable them to teach effectively and meet learners' needs (2.3.5.2; 2.3.5.2.1 - 2.3.5.2.3). There is a need to ascertain the mathematical needs of learners in Zambia. This should entail identifying factors that affect learners' learning of mathematics and what learners need to learn mathematics well, engage in mathematics lessons and to be competent in mathematics. Findings of such a research would inform the content of CPD and thus contribute to enabling teachers to be fully equipped to target their efforts at ensuring that learners cope with the demands of learning mathematics and they leave the school system with the necessary mathematical knowledge and skills for coping with real life demands, for the workplace or further study.

3. Collaboration is an essential element in supporting teachers' professional growth (2.2; 2.2.5). A study could be undertaken to explore ways of strengthening collaboration within the context of LS, which is currently the main form of CPD in the country, and of developing or extending it to contexts beyond LS. Research could also be undertaken to find out how and the extent to which secondary school mathematics teachers collaborate in situations where topics in mathematics are somewhat dependent on topics in other subject areas such as Science and Geography. Collaboration and networking is equally important among the providers of CPD (2.2.3) in order to maximise efforts at broadening CPD opportunities for teachers and also raising the quality of CPD provided. Undertaking a research of this type could help to establish how other CPD providers such as HEIs, professional association-ZAME, the newly created National Science Learning Centre in Zambia could meaningfully collaborate and contribute toward designing and delivering PD courses for secondary school mathematics teachers.

4. Literature such as Bubb & Earley (2007) shows that apart from Initial Teacher Training being valuable in its own right it can also be viewed as providing a platform on which continuing PD can be erected (2.2.2: 2.2.3.5). Research can be carried out to establish how and to what extent Initial Mathematics Teacher Training has contributed toward the development of an acceptable conceptualisation of CPD and development of important competences and habits and the attitudes that can serve as the basis for CPD. This is needed in order to help teachers develop a positive attitude toward CPD right from initial training time..

6.6 Conclusion

The focus of this research was to investigate secondary school mathematics teachers' perceptions of their CPD with the aim of finding out whether and how current CPD meets their CPD needs and to what extent. This aim was adequately achieved. Overall the findings of the study show that teachers' consideration of whether current CPD meets their CPD needs varied according to their circumstances and their needs and this largely depended on whether teachers were able to identify their CPD needs. The proposed framework for teachers' CPD needs identification and analysis can serve as a guide for teachers in identifying their CPD needs and possible CPD activities that could meet their CPD needs. CPD provision should not simply target meeting the demands of those responsible for the overall quality of the teaching workforce, but also the demands and needs of the participating teachers themselves. In addition, teachers' CPD in a low-income and developing country such as Zambia requires a consideration of the specific local context including the elements of the sociocultural contexts within which the teachers work and the demands of the education and school system which press upon their CPD. Without accommodating teachers' CPD needs, CPD can be poorly directed or inadequate for the teachers whom it intends to serve. It is hoped that the findings of this study, and its recommendations will inform secondary school mathematics teachers' CPD practices in the local context and similar other contexts.

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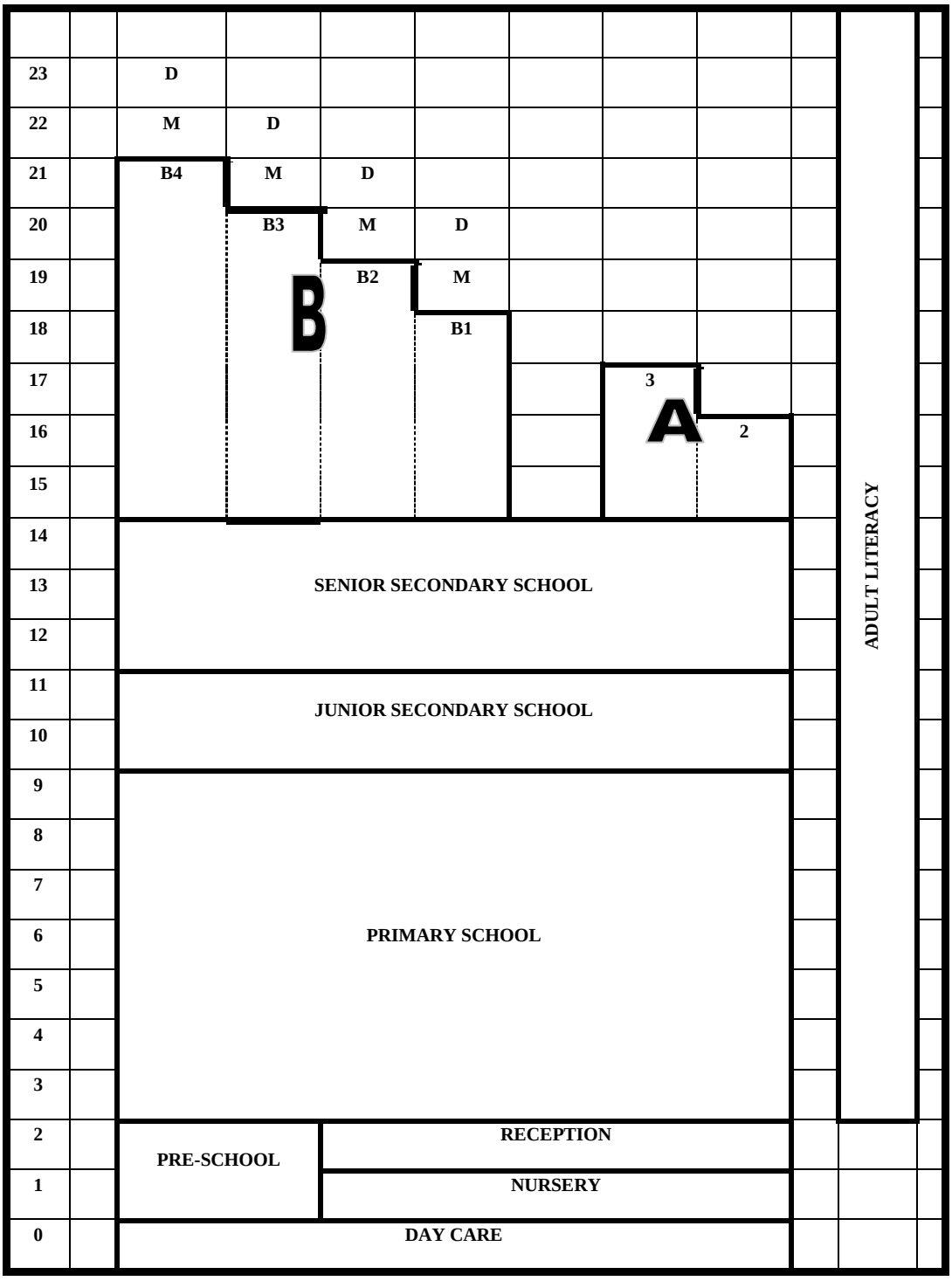
Appendices

Appendix A Number of years learners spend schooling



A=Various vocational programmes. E.g. trades, nursing, teaching, agriculture leading to certificate or diploma.
B = University degree
D = Doctorate, M = Masters, B = Bachelor
4 Years Ordinary degree
5 Years Engineering, Agriculture, Pharmacy etc.
6 Years Veterinary Medicine
7 Years Medicine

NB: In A and B there are also some courses which take less than 2 years. From Primary to Senior Secondary education year represents a grade.

Appendix B (1) Participation Permission

All Communications should be addressed to
The Provincial Education Officer
Telephone 05 222535/8

In reply please quote
No.

PEOC/101/1/1

REPUBLIC OF ZAMBIA
MINISTRY OF EDUCATION,
SCIENCE ,VOCATIONAL TRAINING AND EARLY EDUCATION
REGIONAL HEADQUARTERS
P.O BOX 80197
KABWE

24th April, 2015

To: All District Education Board Secretaries
All Headteachers - Secondary Schools
CENTRAL PROVINCE

RE: INTRODUCTION – MAUREEN KABWE KANCHEBELE SINYANGWE

I write to introduce the above named officer who is carrying out a study on **'MATHEMATICS TEACHERS' PERCEPTIONS OF THEIR CONTINUING PROFESSIONAL DEVELOPMENT'** for her PhD.

Kindly assist her in any way possible.

PP Jennipher Chishimba Banda
Provincial Education Officer
CENTRAL PROVINCE

/ym

Appendix B (2) Participation Permission

All Correspondence should be addressed to
The District Education Board Secretary – Kabwe District
Tel/fax: 05 – 224702 01

In reply please quote
No.....

DEBSK/

REPUBLIC OF ZAMBIA
MINISTRY OF EDUCATION,
SCIENCE ,VOCATIONAL TRAINING AND EARLY EDUCATION
DISTRICT EDUCATION BOARD
P.O BOX 80423
KABWE

April 24, 2015

To: All Headteachers
Secondary Schools
KABWE

RE: INTRODUCTION - MAUREEN KABWE KANCHEBELE SINYANGWE

I write to introduce the above named officer who is carrying out a study on '***Mathematics Teachers' perceptions of their continuing professional development***' for her Phd.

Kindly assist her in any way possible.

Mwape Sunday
DISTRICT EDUCATION BOARD SECRETARY
KABWE DISTRICT

/amm*...

Appendix C Questionnaire

MATHEMATICS TEACHERS' PERSPECTIVES OF CONTINUING PROFESSIONAL DEVELOPMENT

This questionnaire aims to look at your CPD activities, needs and experiences from your perspective. All responses will be in complete confidence. No school or individual will be identified in any report of published findings. The questionnaire consists of 6 parts (A-F). If you wish to add further comments, then kindly write your response/comment in the space provided or next to each questionnaire item or at the back of the page. Thank you for your participation.

Part A: CPD activities

A1: What is your understanding of CPD?

A2: CPD activities I have been involved in (Please **tick** ( ) where appropriate)

CPD activities	I am involved in ---------			
	Never	Rarely	Often	Always
Visits to other schools to share teaching experiences				
Collaborative teaching				
Local/regional/national Education-related Conferences, Workshops, Seminars				
Overseas Education-related Conferences, Workshops, Seminars,				
Peer class observation (Observing colleagues teach)				
Demonstration lessons by CPD providers				
School-university partnerships				
Higher academic qualification study (e.g attending courses at college or University)				
Lesson study				
Research (e.g Action Research or individual or collaborative research etc)				
Publications				
Online learning				
Mentoring (as mentee or as mentor)				
Personal study (e.g reading subject related or education related literature)				
Informal networking with colleagues (informal dialogue to improve teaching and learning)				
Departmental meetings				
Others (Please specify)				

Which, from the above mentioned, in your opinion was the most useful for your personal continuing professional development. Please give reasons for your answer.

Part B: Effectiveness of CPD

In your opinion, what makes CPD effective?

Part C: Participation in CPD and CPD needs

C1: Opportunities/Barriers to CPD

Please tick ( ) in the spaces provided for the choice that best describes your personal opinion regarding the following statements.

Factors that can affect participation in CPD	**I think that---------affects my participation in CPD**			
	Never	**Rarely**	**Often**	**Always**
Attitude toward CPD				
Lack of awareness of CPD opportunities				
Workload				
Incentives for participation				
School culture/management				
Financial costs (e.g too expensive)				
No Suitable CPD programme provided				
Availability or lack of staff				
Personal circumstances or commitments (e.g family commitments)				
Timing (conflict with work schedule)				
Location				
Appraisal Performance Assessment System (APAS)				
Others (Please specify)				

C2: CPD needs domain

Please **tick** ( ) the spaces provided for the choice that best describes your personal opinion regarding the following statements.

I participate in CPD on---------				**CPD needs domain** **C2.1 Content Knowledge domain**	**I think that CPD on----------can satisfy my needs.**			
Never	**Rarely**	**Often**	**Always**		**Strongly disagree**	**Disagree**	**Agree**	**Strongly agreed**
				Updating and sharing new subject content knowledge				
				Dealing with difficult content areas in mathematics				
				Curriculum content implementation and improvement				
				Knowledge of and appreciation of the value of concepts, procedures and problem solving processes in learning Mathematics.				
				Knowledge of Mathematical concepts, representations and the interconnectedness of these concepts.				
				Linking mathematics to other school subject areas				
I participate in CPD on----------				**C2.2 Pedagogical content knowledge and practices**	**I participate in CPD on----------**			
Never	**Rarely**	**Often**	**Always**		**Strongly disagree**	**Disagree**	**Agree**	**Strongly Agree**
				Knowledge of and application of various teaching strategies and skills				
				Research on mathematics teaching and (or) learning				
				Ways of teaching difficult topics in mathematics				
				Working with pupils understanding and (mis)understanding of Mathematical concepts				
				Making the learning of mathematics more meaningful and engaging learners more in their learning of mathematics				
				Expressing Mathematical ideas clearly and precisely in speech and in writing				
				Assessment techniques, and interpretation and use of pupil assessment results to inform teaching practice				
				Knowledge on Technology and technology use in teaching and learning				

I participate in CPD on----------				C2.3 Professional practices and relationships domain	I participate in CPD on----------			
Never	**Rarely**	**Often**	**Always**		**Strongly disagree**	**Disagree**	**Agree**	**Strongly agree**
				Contributions to curriculum development				
				Awareness of and contributing toward implementing education related policies and strategies				
				Sharing of knowledge and good practices with others in the same or different (subject) department to support personal learning				
				Interaction with the broader mathematics community				
				Interaction with the broader teaching community				
				Participation in education-related community services and voluntary work				
				Leadership and management skills				
				Identifying my own professional development needs as one way of monitoring and evaluating my own practice				
I participate in CPD on----------				**C2.4 Pupil development needs domain/knowledge of learners' needs**	**I think that CPD on----------can satisfy my needs.**			
Never	**Rarely**	**Often**	**Always**		**Strongly disagree**	**Disagree**	**Agree**	**Strongly agree**
				Building trust and rapport with pupils				
				Understanding pupils' diverse personal, developmental and academic needs (e.g personal, developmental and academic needs)				
				Understanding pupils' diverse mathematical needs				
				Adapting teaching approaches to support pupils' diverse needs				
				Collaboration in supporting pupils' diverse needs				
				Holistic (whole person) development of pupils				
				Providing pastoral care for pupils				

I participate in CPD on----------				C2.5: Affective development needs domain	I think that CPD on----------can satisfy my needs.			
Never	**Rarely**	**Often**	**Always**		**Strongly disagree**	**Disagree**	**Agree**	**Strongly agree**
				Strategies for stimulating and sustaining pupils interest in learning Mathematics				
				Awareness of and responding to pupils beliefs about self and learning Mathematics				
				Responding to pupils' attitude towards mathematics and learning Mathematics				
				Building teachers' confidence				
				Maintaining and supporting teachers' positive attitude towards the teaching of Mathematics				
I participate in CPD on----------				**C2.6: School development needs domain**	**I think that CPD on----------can satisfy my needs.**			
Never	**Rarely**	**Often**	**Always**		**Strongly disagree**	**Disagree**	**Agree**	**Strongly agree**
				Communication with parents/guardians regarding pupil's progress				
				Engaging with parents/guardians/community for further school development				
				Adapting to the school vision and mission and realizing school goals and policies				
				Promoting the school culture and school image				
				Formulation of school plans and policies, review of procedures and practices for continuous school development.				
				Awareness of and responding to societal changes in relation to their impact on school and school values.				

Which of the above do you think is most needed by mathematics teachers at your school or in your district? Explain why

Please use this space to add any further comments that you would wish to make about professional development generally or about professional development in Mathematics specifically.

Part D: Career and professional plans

What are your career plans for the next 5 years?

What level of qualification would you like to have? (Tick as appropriate)
Diploma in Education (Dip. Ed.)
Bachelor of Arts in Education (B.Ed.) or equivalent
Master of Science (MSc.) or equivalent
Doctor of Philosophy (PhD) or equivalent)

Where would you hope to be in five years' time? (Rank your choices according to your aspirations by placing numbers against each choice to indicate the order of your choice: 1 = highest priority, 2 the second highest and so on)
Remain a class teacher
Become a Head of Department
Become Deputy Head
Become Head teacher
Become a lecturer in a College or University
Become an administrator (at District, provincial or national level)
Leave teaching all together for another job
Retire
Please comment on why you have the above ranking.

What can facilitate/hinder you from achieving your ambition(s)

What would you like your CPD to be like in the future?

Part E: Personal Background Information

Please provide answers to each of the following (tick wherever appropriate).

1. Gender: Male Female

2. Age

20–25 26–30 31–35 36–40 41 – 45 46 – 50 Above 50

3. Highest Educational Level

Certificate of Education (or equivalent)
Diploma in Education
Bachelor's Degree
Master's Degree
Doctoral Degree
Others (please specify): _____

4. Teaching Experience

0-3 years 4–7years 8–15years 16–23years 24 – 30 years 31^{+} years

5. Which grade level(s) are you currently teaching? Grade 8 Grade 9 Grade 10 Grade 11 Grade 12

6. My current position(s) is (are)

Head of Department
Class teacher
Others (please specify)

7. The subject(s) I am teaching is (are): _____

Part F

I would like to participate in a follow up interview. **Yes:** _____ **No:** _____ If YES, please write your name and your email address and/or phone number.
Name: _____ Email: _____ Phone number: _____

Thank you for completing this questionnaire

Appendix D Information sheet

Researcher: Maureen K. K. Sinyangwe
Phone: +260976027911/+44(0)7448727379
Email: k.m.k.sinyangwe@pgr.reading.ac.uk

Teacher information sheet

Research Project: **An investigation into secondary school mathematics teachers' perspectives of Continuing Professional Development (CPD)**

Researcher: Maureen Kabwe Kanchebele Sinyangwe

I would like to invite you to take part in a research study about teachers' Continuing Professional Development (CPD).

What is the study?
This study is being conducted by Maureen K. K. Sinyangwe a student at the University of Reading. The aim of this study is to investigate the extent to which teachers' Continuing Professional Development (CPD) needs are met by current CPD. It is hoped that the findings of the study will help CPD providers in the selection and design of CPD that will not only meet national and school needs but also teachers' development needs. The findings will help inform future CPD strategy, investment, provision and the support system to sustain the process.

The study will involve Mathematics teachers at secondary school level. They will be interviewed and audio recorded as they respond to the interview questions. The recordings will be transcribed and anonymised before being analysed.

Why have I been chosen to take part?
You have been invited to take part in the research because you are a teacher of mathematics and you are expected to participate in Continuing Professional Development programmes as may be arranged by the school. Your knowledge and experience(s), in this area, as a teacher of Mathematics would be valuable to this study.

Do I have to take part?
It is entirely up to you whether to participate. You may also withdraw your consent to participating at any time during the research, without any repercussions to you. In such a case

Researcher: Maureen K. K. Sinyangwe
Phone: +260976027911/+44(0)7448727379
Email: k.m.k.sinyangwe@pgr.reading.ac.uk

you may contact me on Phone No: +44(0)7448727379 (UK) or +260 976027911(Zambia), email: k.m.k.sinyangwe@pgr.reading.ac.uk

University of Reading

What will happen if I take part?
You will be asked to take part in a one-to-one interview and answer some questions based on current CPD and your CPD needs. This should take about 15 - 30 minutes. The interview will enable me to get details about your understanding of CPD, your CPD

experiences, your CPD needs and the extent to which your CPD needs are being met by the CPD you have been engaging in.

What are the risks and benefits of taking part?
The information you will provide will remain confidential and will only be seen by me the researcher and my supervisors. The information you will provide will not be with the school administration or any other person within or outside the school. You will not be identified in the report based on this study.

It is hoped that you will be able to participate, as the findings of this study will be useful in the provision of meaningful and relevant CPD for teachers and Mathematics teachers in particular.

What will happen to the data?
The data provided is strictly confidential and no real names will be used in this study or the study report that will be written afterwards. The records from this study will be private and stored securely on a password-protected computer and data destroyed after a period of five years. A written report based on the findings of this study will be presented to my supervisors. A copy of the report can be sent to you electronically or by post if you would like to have one.

What happens if I change my mind?
You can change your mind at any time without any consequences. During the research, you can stop completing the interviews at any time. If you change your mind after data collection has ended, your data will be discarded.

Who has reviewed the study?

Researcher: Maureen K. K. Sinyangwe
Phone: +260976027911/+44(0)7448727379
Email: k.m.k.sinyangwe@pgr.reading.ac.uk

This project has been reviewed following the procedures of the University Research Ethics Committee and has been given a favourable ethical opinion for conduct. The University has the appropriate insurances in place. Full details are available on request.

What happens if something goes wrong?

In the unlikely case of concern or complaint, you can contact my supervisors, Dr Berry Billingsley, University of Reading; Tel: +44 (0) 118 378 2655 Email:

b.billingsley@reading.ac.uk or Dr Yota Dimitriadi, University of Reading: Tel: +44 (0) 118 378 2688. Email: Y.Dimitriadi@reading.ac.uk

Where can I get more information?

If you will need more information, please contact me on Tel: +44(0)7448727379 (UK) or +260 976027911 (Zambia), email: k.m.k.sinyangwe@pgr.reading.ac.uk or my supervisors, Dr Berry Billingsley, Tel: +44 (0) 118 378 2655 Email: b.billingsley@reading.ac.uk or Dr Yota Dimitriadi, University of Reading: Tel: +44 (0) 118 378 2688. Email: Y.Dimitriadi@reading.ac.uk

I sincerely hope you will agree to participate in the study. If you do, please complete the consent form that has been attached.

Thank you for your time.

Appendix E (1) Research participant's consent form

Researcher: Maureen K. K. Sinyangwe
Phone: +260976027911/+44(0)7448727379
Email: k.m.k.sinyangwe@pgr.reading.ac.uk

Research Project: **An investigation into secondary school mathematics teachers' perspectives of Continuing Professional Development (CPD)**

Teacher's Consent Form

I have read the Information Sheet about the project and received a copy of it.

I understand what the purpose of the project is and what is required of me. All my questions have been answered.

Name of teacher: _____

Name of secondary school: _____

Please tick as appropriate:

I agree to complete a questionnaire ☐

I consent to being interviewed ☐

I agree to this interview being recorded ☐

I agree to the use of anonymised quotes in subsequent publications ☐

I agree to take part in a focus group which will be recorded ☐

Signed: _____

Date: _____

Appendix E (2) Research participant's consent form

Researcher: Maureen K. K. Sinyangwe
Phone: +260976027911/+44(0)7448727379
Email: k.m.k.sinyangwe@pgr.reading.ac.uk

Research Project: **An investigation into secondary school mathematics teachers' perspectives of Continuing Professional Development (CPD)**

Head Teacher Consent Form

I have read the Information Sheet about the project and received a copy of it.

I understand what the purpose of the research is and what is required of me. All my questions have been answered.

Name of Head Teacher: _____

Name of secondary school: _____

Please tick as appropriate:

I consent to the involvement of my school in the project as outlined in the Information Sheet ☐

I consent to being interviewed ☐

I agree to this interview being recorded ☐

I agree to the use of anonymised quotes in subsequent publications ☐

I agree to provide any relevant documentation on CPD ☐

Signed: _____

Date: _____

Appendix E (3) Research participant's consent form

Researcher: Maureen K. K. Sinyangwe
Phone: +260976027911/+44(0)7448727379
Email: k.m.k.sinyangwe@pgr.reading.ac.uk

Research Project: **An investigation into secondary school mathematics teachers' perspectives of Continuing Professional Development (CPD)**

Senior Education Standards Officer (Mathematics) Consent Form

I have read the Information Sheet about the project and received a copy of it.

I understand what the purpose of the research is and what is required of me. All my questions have been answered.

Name of Officer: _____

Name of Station: _____

Please tick as appropriate:

I consent to being interviewed ☐

I agree to this interview being recorded ☐

I agree to the use of anonymised quotes in subsequent publications ☐

I agree to provide any relevant documentation on CPD ☐

Signed: _____

Date: _____

Appendix E (4) Research participant's consent form

Researcher: Maureen K. K. Sinyangwe
Phone: +260976027911/+44(0)7448727379
Email: k.m.k.sinyangwe@pgr.reading.ac.uk

Research Project: **An investigation into secondary school mathematics teachers' perspectives of Continuing Professional Development (CPD)**

University lecturer's Consent Form

I have read the Information Sheet about the project and received a copy of it.

I understand what the purpose of the research is and what is required of me. All my questions have been answered.

Name of Officer: _____

Name of Station: _____

Please tick as appropriate:

I consent to being interviewed ☐

I agree to this interview being recorded ☐

I agree to the use of anonymised quotes in subsequent publications ☐

I agree to provide any relevant documentation ☐

Signed: _____

Date: _____

Appendix F (1) Interview Schedule

Interview questions for mathematics teachers.

I would like you to tell me your views of teachers' Continuing Professional Development (CPD) and how CPD meets your CPD needs. However, I have some key issues that I hope we will cover during the interview, so I may have to check my prompts occasionally to make sure we are on track.

1. **Background information-about your professional self**

   Before we get into the main discussion, please tell me about your career history…

   May need to probe to ensure that the following are considered

   - Academic background as far as mathematics is concerned

2. **Understanding of and attitude towards Continuing Professional Development (CPD)**

   To confirm understanding right from the start, share with me your understanding of CPD.

   May need to probe to ensure that the following are considered

   - Your understanding/description of CPD?
   - Why do you think you should/should not have CPD? Give me reasons.
   - Relate to answers provided on questionnaire completed by respondent: You indicated on the questionnaire that you preferred …kindly tell me why.

3. **Content and Effectiveness of CPD**

   I'd like you to focus on your perceptions about your experiences, with any examples that have been memorable, related to your CPD?

   May need to probe to ensure that the following are considered

   - What CPD content would you prefer? Why and when?
   - Who decides on the focus of CPD?
   - Your view on what makes effective CPD.

4. **Teachers' CPD needs**

   We can now move on and talk about your needs in the context of professional development. Have you ever felt there is/was a tension between what you would like or need to do and what your school (your head)/the government needs you to do in relation to CPD?

   May need to probe to ensure that the following are considered

   - Please give me examples?
   - What would you say has largely driven your CPD activities? Is it you/ the school/ the government
   - Have you ever been involved in CPD in which you have initiated (alone or in collaboration with other teachers)? Has the school supported this?
   - Who identifies CPD activities for you to participate in?

- How do you identify (your) CPD needs?
- Over the next few years what do you see as your key CPD needs?

5. **Opportunities/Barriers to CPD**

   I am interested to know more about your views on what influences your approach/access/ participation in CPD

   <u>May need to probe to ensure that the following are considered</u>

   You stated on the questionnaire that…influences your approach/access/ participation in CPD.

   Kindly tell me more about it.

6. Finally, it is my belief that CPD providers should listen to teachers' perceptions about CPD. From your point of view, what is the main message that you would want CPD providers to be aware of and what would you like to see in the future in relation to teachers' CPD.

Thank you for your help and time

If you think of anything else, or have any queries, please contact me on: +44(0)7448727379 (UK); or +260 976027911(Zambia); or email: k.m.k.sinyangwe@pgr.reading.ac.uk

Appendix F (2) Interview Schedule

Interview questions for the Head teacher/CPD coordinator

1. **About teachers' Continuing Professional Development (CPD)**
   Please tell me about your understanding of Continuing Professional Development (CPD) and its role?
   Does the school have an agreed understanding of what is meant by CPD? If so, what and where is it?
   May need to probe to ensure that the following are considered

   - Is there an overall theme underpinning CPD in the school?
   - How does this theme relate to the national approach to teaching and learning?
   - Aim of CPD for teachers
   - Types of CPD currently available for teachers
   - Focus of teachers' CPD
2. **School response to national CPD initiatives**
   In what way(s) is the school response to CPD driven by national initiatives?
   May need to probe to ensure that the following are considered

   - Funding
   - National policy/priorities/initiatives
3. **About your role**
   How would you describe your role in the school in relation to CPD?
   May need to probe to ensure that the following are considered

   How do you see your role and teachers' role in CPD?

   - How are CPD programmes selected/determined? Who participates in the selection and design of CPD programmes? What do you consider when planning for teachers CPD?
   - What do you see as teachers' role in the planning or organisation of CPD?
   - Share with me how information on teachers CPD needs is collected and how the information is used to identify the priorities of CPD
   - What are the general views and attitude of teachers towards CPD?
   - How are teachers kept motivated to participate in CPD
4. **Assessment of CPD**
   Tell me about the most effective/least effective CPD programmes you have attended? Why was it the most effective/least effective CPD?
   May need to probe to ensure that the following are considered
   - What processes are there in the school to monitor CPD?
   - How do you evaluate the success of CPD programmes?
   - In what ways do you benefit from the evaluation of CPD?

Thank you for your help and time

If you think of anything else, or have any queries, please contact me on: +44(0)7448727379 (UK); or +260 976027911(Zambia); or email: k.m.k.sinyangwe@pgr.reading.ac.uk

Appendix F (3) Interview Schedule

Interview questions for CPD (course) providers at Higher Education Institutions

1. **CPD courses**
   What courses are available, at the institution, for in-service teachers of Mathematics? Please tell me
   May need to probe to ensure that the following are considered
   - Why are the courses are important.
   - What do you consider when advertising and selecting course participants?
2. **Teachers' CPD needs**
   Tell me what you think the needs of in-service teachers of Mathematics are?
   May need to probe to ensure that the following are considered
   - How do you find out the needs of course participants? E.g before the course and during the course?
   - How do you address the identified needs?

3. **Assessment of CPD**
   Share with me how you assess the impact of CPD courses undertaken by teachers of Mathematics?

4. **Course related documentation**
   May I have a look at any kind of documentation, which I can access, about the CPD course?
   May need to probe to ensure that necessary documentation is considered
   For example:
   - Course outline(s)
   - Pre-course questionnaire, if any
   - After course questionnaire or course evaluation form, if any.

Thank you for your help and time

If you think of anything else, or have any queries, please contact me on: +44(0)7448727379 (UK); or +260 976027911(Zambia); or email: k.m.k.sinyangwe@pgr.reading.ac.uk

Appendix F (4) Interview Schedule

Interview questions for MOE representative at the National/Provincial/District office

1. **Understanding of Continuing Professional Development (CPD)**
   What is your understanding of Continuing Professional Development (CPD)?
   What is the Ministry of Education Science, Vocational training and Early Education stand on CPD?
   May need to probe to ensure that the following are considered
   - What is (are) the national approach to teaching and learning?
   - How does this approach fit into the Zambian cultural context?
   - In what ways is CPD driven by factors such as national approach to teaching and learning, cultural context, Donor funding, etc. Please give some examples
2. **Planning and provision for CPD**
   Share with me the procedure for planning the activities for teachers' CPD?
   May need to probe to ensure that the following are considered
   - What are some of the things you take into consideration when planning for teachers' CPD?
   - How are CPD programmes selected? Who participates in the selection and design of CPD programmes?
   - What do you see as teachers' role in CPD?
   - Share with me how information on teachers' CPD needs is collected and how the information is used to identify the priorities of CPD
3. **CPD delivery**
   - What are the types of CPD that are organised for Mathematics teachers?
   - Give me examples of the content of some of the CPD programmes provided to teachers of Mathematics
   - What are the general views and attitude of Mathematics teachers towards CPD?

4. **Assessment of CPD**
   Tell me about the most effective/least effective CPD programmes you have attended? Why was it the most effective/least effective CPD?
   May need to probe to ensure that the following are considered
   - How do you evaluate the success of CPD programmes?
   - In what ways do you benefit from the evaluation of CPD?

Thank you for your help and time

If you think of anything else, or have any queries, please contact me on: +44(0)7448727379 (UK); or +260 976027911(Zambia); or email: k.m.k.sinyangwe@pgr.reading.ac.uk

Appendix G Focus Group Discussion guide

I would like you to tell me your views of teachers' Continuing Professional Development (CPD) and how CPD meets your CPD needs. However, I have some key issues that I hope we will cover during the interview, so I may have to check my prompts occasionally to make sure we are on track.

1. **Understanding of and attitude towards Continuing Professional Development (CPD)**

   To confirm understanding right from the start, share with me your understanding of CPD.

   May need to probe to ensure that the following are considered

   - Understanding/description of CPD
   - Reasons for or importance of CPD
   - Views on/attitude toward CPD. Why
   - What influences your participation in CPD

2. **Content and Effectiveness of CPD**

   I'd like you to focus on your perceptions about your experiences, with any examples that have been memorable, related to your CPD?

   May need to probe to ensure that the following are considered

   - CPD content or focus preferred? Why and when?
   - Who decides on the content or focus of CPD?
   - How do you identify (your) CPD needs?
   - Over the next few years what do you see as your key CPD needs?
   - Who identifies CPD activities for you to participate in?
   - Have you ever been involved in CPD in which you have initiated (alone or in collaboration with other teachers)? Has the school supported this?
   - Your view on what makes effective CPD.
   -

3. **Teachers' CPD needs and school development needs**

   We can now move on and talk about your needs in the context of professional development. Have you ever felt there is/was a tension between what you would like or need to do and what your school (your head)/the government needs you to do in relation to CPD? Please give me examples?

4. Finally, it is my belief that CPD providers should listen to teachers' perceptions about CPD. From your point of view, what is the main message that you would want CPD providers to be aware of and what would you like to see in the future in relation to teachers' CPD.

Thank you for your help and time

If you think of anything else, or have any queries, please contact me on: +44(0)7448727379 (UK); or +260 976027911(Zambia); or email: k.m.k.sinyangwe@pgr.reading.ac.uk

Appendix H Sample of transcribed interview

Interviewer: Before we get into the main discussion, please tell me about your academic background as far as mathematics is concerned

Respondent:...I went to COSETCO and got my Diploma and then went to UNZA afterwards to get my degree... You know maths courses there are tough and we have those tough lecturers there at UNZA, but with the background that I had, it wasn't too much of a problem. Besides I was generally good in Mathematics. I had done Additional Mathematics at secondary school then at college and I think this was good preparation for me. So 1st and 2nd years Mathematics courses there at UNZA were not seriously challenging. In fact, even this Additional Mathematics that pupils run away from at secondary school level, it is very helpful when you move on to doing 'A' level courses. Because these...most of the things you do in 1st and 2nd year are just purely Additional Mathematics as presented at secondary school using the same CORE Course textbook book [showing a copy of an Additional Mathematics text book-CORE Course...] I must say 3rd and 4th year courses at UNZA were a bit challenging, but I still pulled through. ...here we have we have one Additional Math Class per stream: one G10 class, one G11 and one G12 class. I am the one handling two Additional Maths class and the other colleague is handling the other class. This in addition to the other Ordinary Maths classes that I have to teach-so you can imagine the heavy workload I have. It is very unfortunate that some of our colleagues in the department shy away from taking Additional Mathematics classes... I have done some other jobs before, but I only have 3 years teaching experience. My plans are that I should go back to school and do my masters' course, refresh my mind through studying and hopefully become a lecturer like you or may be have a different higher position or a better job after graduating. The biggest hindrance is funds. Money is not easy to come by.

Interviewer: To confirm understanding right from the start, share with me your understanding of CPD.

Respondent: When the Ministry introduced CPD here in Kabwe, it appeared to be a good programme, but with some limitations due to other factors. I can explain what I mean here. This CPD thing I mean the Lesson Study means that classes are affected because there are no teachers to attend to them. This is because as teachers we have to plan for a lesson, you go in one class and observe a colleague teach that lesson, you sit, you review, again you reteach- all that takes up a lot of time actually teaching time and our other pupils end up missing out on time with their teacher. You need to be aware that this is what the Ministry wants us to be doing-I mean having the Lesson Study cycles. They actually want us to be having three Lesson Study Cycles in a year. It is not practical to be honest. These Lesson Study cycle things takes up a lot of time and as I have shared our pupils are somehow affected. It is practically impossible to do.

The good things I can say that come out of these Lesson Study if you do it well is that it gives an opportunity for you as colleagues to interact and share a lot of ideas concerning teaching. So with these CPDs you can share, you interact because you do the plans together so you find people ask questions and observe one another in the department so from there you are able to learn one or two things. The only problem is that it only works well when you are somehow able to get along as members of the department.

Interviewer: Are you saying CPD is when you have Lesson Study?
Respondent: Yes, largely that is what it means. In fact, I think that is what the Ministry has communicated to us. However, when you come to think of it seriously even when you visit other schools you can consider that can be considered as CPD because you share ideas. Even when you attend workshops you share ideas there. There are presentations there on different topics so you share knowledge. There are people who have had a chance to go to other countries. Like our colleague who went on a government-sponsored trip to Kenya and also Japan to learn more about lesson study and I think something to do with problem solving
Interviewer: What CPD content or focus would you prefer?
Respondent: Basically when you look at the mathematics syllabus there are those topics that are proven to be challenging to learners, not only learners, but even some teachers. You even discuss the challenges that pupils face and how to overcome them. So those are the topics that we can be looking at. Even though generally for us degree holders I think that most of these topics are a walk over. This is may be why we don't need these CPDs as much. If we are to be having them maybe when the focus goes beyond difficult topics to teach may be then we would be motivated to attend.
Interviewer: You have said 'when focus goes beyond difficult topics to teach...' Please give me some details and examples to clarify the point.
Respondent: What I mean is that difficult topics should not be the only focus of CPD or Lesson study. Not all of us find difficulties in understanding or teaching certain topics for example. Even if we well to find difficulties, these difficulties are at different levels. We all can't have deep understanding of all the topics in maths, but for some teachers it is worse... they even fear some classes, like someone fearing to take on a G11 or G12 class. The situation is even worse when it comes to Additional Mathematics classes-very few teachers are willing to take them on. So you find that some of us are given G11, G12 classes and Additional Math classes and we have more classes than others because as I said our colleagues have this fear or lack the confidence, but we all claim and boast to be maths teachers. I tend to think there are so many half-baked mathematics teachers in the system who need to be helped in different areas if we are going to see increase in the pass rate in Mathematics.
I am not sure if this would be acceptable, but other things I think we could look at can be issues of motivation, maintaining interest in teaching despite the challenges we face at different levels. You know for us mathematics teachers to be effective, we need to have interest and show interest in our subject. We need to have interest in the subject to start with ...otherwise everything else like the teaching won't be making sense at all -it will be a serious struggle through and through...I would like to get to a level where I confidently show pupils the interconnectedness of topics in mathematics. I am saying this because I know how I have struggled with it. The same applies with linking mathematics content to related topics in other subjects. Like you know we discuss velocity in mathematics and the same ideas are applied when discussing velocity in science...Plus there are probably other areas which are there to discuss and maybe I just don't know them. The only problem is when you have to follow orders it becomes very difficult to fuse in what you as an individual think should be done. We have been told that we should focus on difficult topics to teach so we follow the orders. Even if you were to look at these other things like I have

shared with you I don't think even the HOD would accept or even come to your defence when the MOE officials visit the school and ask about what you have done for your CPD. So may be simply leaving it at difficult topics to teach is safer.

Interviewer: In your view what makes CPD effective? Give me an example of CPD that you consider effective.

Respondent: There was this one CPD when we invited a teacher from C* secondary school, he is now at B* Secondary School-Mr M*- to share on Earth Geometry. It was a well-planned and well-presented CPD. ...how the presenter presented himself-he was well prepared of course-he had worksheets, he had a model of the earth as a teaching aid... So when you talk about the shortest distance he was able to show us from the model. I can actually call him an expert in the area. It was very effective. Those of us who did not learn Earth Geometry at secondary school as it wasn't in the syllabus or even at college and University learnt a lot. Then I also think that CPD is effective when teachers' minds are refreshed in relation to things that they the teachers feel or think they need to have their minds refreshed on.

Then there was this one I consider the least effective CPD. It was on lesson planning for shear transformation. There was this focal person concerning these lesson-planning issues...she was one of the first people to be invited to Japan to see how they teach there. It is like she didn't understand the rationale part of the lesson planning itself and rationale for the topic she was trying to plan for. The presentation was not up to expected standards. We gave out our views concerning the presentation and mentioned that we didn't understand, but then ....you know you can't attack a colleague to say: this is not right. Even if you were to say this and that is not right they would still end up thinking or feeling attacked so we left it at that.

Interviewer: Who decides on the CPD you engage in or the focus of CPD you engage in?

Respondent: The ideal situation is where we teachers identify the topics we think we should look at. The role of teachers in CPD should be to share ideas, share knowledge, share experiences on issues that are affecting them and relevant at a particular point in time. But in reality in one way or another there are certain things that are just imposed on us. We are not really for the idea. Because, for example we are trained right, we are professionals so to speak, but we are made to do all these unnecessary things: they make us sit down and observe one teacher. Don't get me wrong here-there is nothing wrong with doing that once in a while, but they make you do this and then they make you again to reteach the same thing 2 or 3 times...so it becomes boring. And you know, we had a chance to talk to one of the facilitators from Japan who visited K* secondary school as volunteer teachers. The volunteers shared their teaching experience in Japan. The difference is that that side, Lesson Study is and has been part of their culture and there are very few pupils in classes, say 15 or 20 pupils or far less than that so it is very easy for you to interact...because according to them this CPD even involves pupils: participation from pupils and the teacher also learning from or is it with the pupils. Now look at us here we have 70, 80, 90 and sometimes 100 pupils in a class it is a great challenge to fully engage pupils in the lesson...And where do you even get the time to commit to

lesson study when you have teach and mark the pupils' work considering these big numbers?

Maybe we are still trying to find our foot, but what I have seen is that it is a good thing if you know the context where the idea you are imposing on people is coming from. They impose this Lesson Study on us and they are not even interested in seeing how we are faring. May be if the, the people who initiated the CPD in central province were still around may be things could have been different. They are all gone. So it like it is now slowly dying a natural death too. It is like we no longer have a resource person, so to speak, one to spearhead that programme.

Interviewer: Before we end this interview, from your point of view, what is the main message that you would want CPD providers to be aware of and what would you like to see in the future in relation to teachers' CPD.

Respondent: Our view of CPD should change. Our view should be that CPD is about sharing ideas, helping each other learner improve our skills so that we could help the pupils achieve more in mathematics. These days we look at CPD as a way of way of gaining some incentives; making money especially through attending workshops or visiting other countries like those who have been to Japan or Kenya or Malaysia. Some of us teachers are thinking CPD is for those who have benefitted through making money and visiting other countries and since the chances of benefit this way are zero the CPD is not our thing. So if our view of CPD can change to CPD being a programme that could help us as teachers to become better teachers then maybe we would be committed to it.

CPD coordinators should also take CPD more as a voluntary work and not as something that they can earn or make a living from ~~though~~ the incentives or monies.

Then, like I have said earlier, there should be some sense of ownership on our part as teachers. Yes, the initiators or those spearheading this Lesson Study thing have moved out of our district, but we can make it as a part of us and make it work for us. If we are to get there then I think that it should start with teachers being sensitised or maybe say re-sensitised concerning the whole CPD thing including its importance.

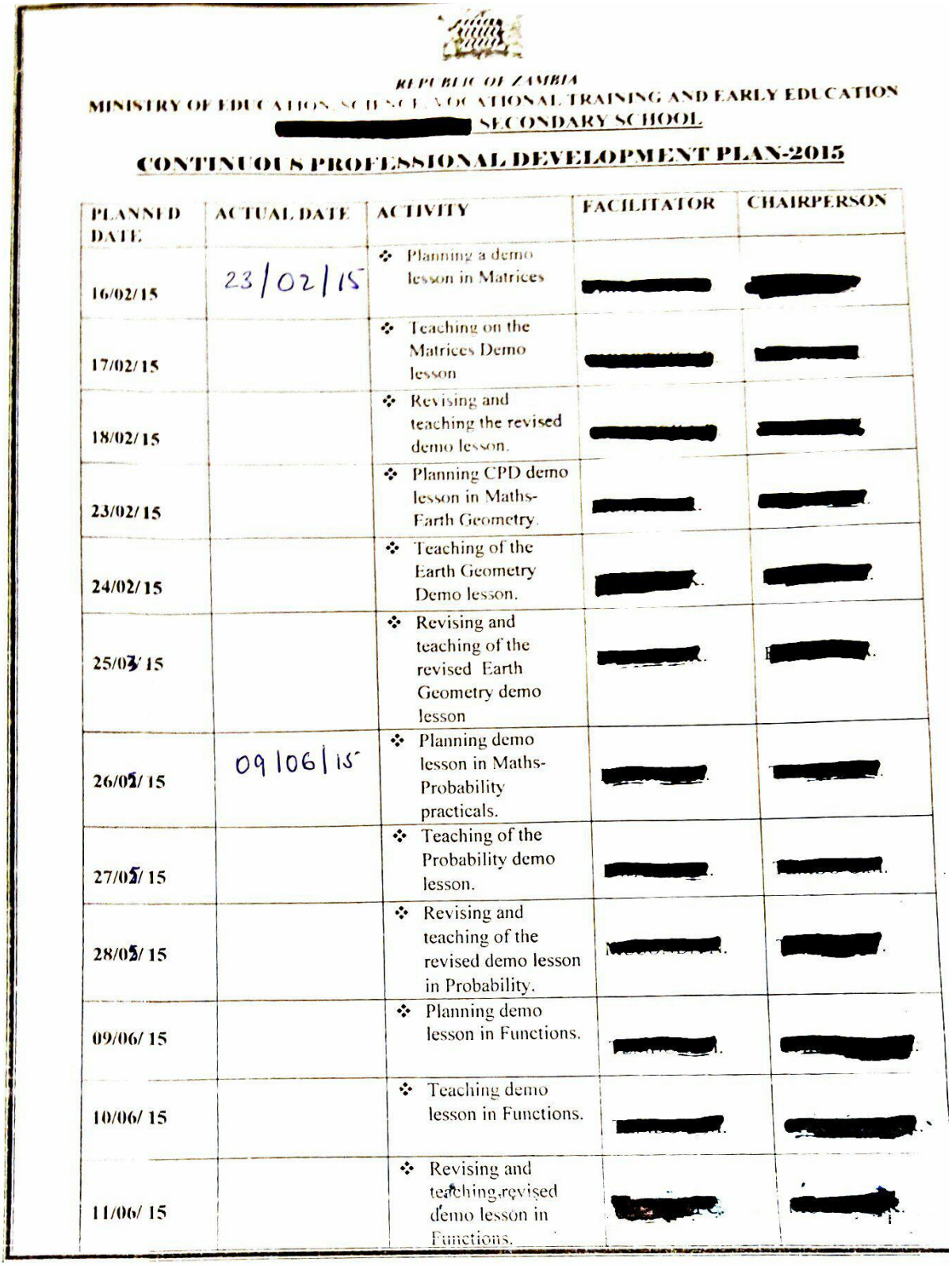
Appendix I Participants in the interviews and FGDs

SNo	Interviewee	Sex	Years of teaching experience	Date of interview	Length of interview
1	Maths teacher	M	4 - 7	01/05/2015	39min
2	Maths teacher	M	8 - 15	01/05/2015	22min
3	Maths teacher	M	0 - 3	01/05/2015	12min
4	Maths teacher	M	0 - 3	01/05/2015	22min
5	Maths teacher	M	8 - 15	06/05/2015	13min
6	Maths teacher	F	4 - 7	18/05/2015	22min
7	Maths teacher	M	8 - 15	19/05/2015	25min
8	Maths teacher/HOD	M	16-23	29/05/2015	16min
9	MOE officer-Curriculum Development specialist	F	-	01/06/2015	24min
10	MOE officer Maths/Science specialist-national level	F	-	01/06/2015	23min
11	University Lecturer	M	-	01/06/2015	65min
12	Maths teacher/ School CPD coordinator	M	8 - 15	03/06/2015	11min
13	Maths teacher/HOD	M	8 - 15	03/06/2015	18min
14	MOE officer –Teacher Education	M	-	04/06/2015	36min
15	MOE officer -standards officer -national level	M	-	04/06/2015	67min
16	Maths teacher/ HOD/School CPD coordinator	M	24 - 30	09/06/2015	22min
17	Maths teacher/ HOD	F	16 - 23	09/06/2015	15min
18	MOE Officer-Maths specialist-provincial level	M	-	12/06/2015	20min
19	Maths teacher	M	8 - 15	16/06/2015	21min
20	Maths teacher	M	24 - 30	18/06/2015	23min
21	Maths teacher/Sch CPD coordinator	M	8 - 15	18/06/2015	21 min
22	Maths teacher	M	0 - 3	18/06/2015	25min
23	Maths teacher	M	16 - 23	30/06/2015	21min
24	Maths teacher	M	8 - 15	01/07/2015	35min
25	Maths teacher	M	8 – 15	10/07/2015	22min
26	Maths teacher	M	30^{+}	10/07/2015	18min
27	Maths teacher/HOD	M	24-30	10/07/2015	22 min
28	Maths teacher	M	16-23	14/07/2015	36 min
29	Maths teacher/ HOD	M	8 - 15	14/07/2015	21 min
30	Maths teacher	M	8 - 15	14/07/2015	11 min
31	Maths teacher	F	4 - 7	15/07/2015	13 min
32	Maths HOD/ Sch CPD coordinator	M	30^{+}	15/07/2015	30 min
33	Maths teacher	M	24 - 30	16/07/2015	28 min

34	Maths teacher	M	8 - 15	21/07/2015	36 min
35	Maths teacher/ HOD	F	24 - 30	23/07/2015	61 min
36	Maths teacher	M	0 - 3	25/07/2015	24 min
37	Maths teacher	M	8 - 15	24/07/2015	21 min
38	Maths teacher	M	30^{+}	28/07/2015	40 min
39	Maths teacher	M	24 - 30	29/07/2015	36 min
40	Maths teacher	M	4 - 7	29/07/2015	27 min
41	Maths teacher	M	8 - 15	29/07/2015	18 min
42	Maths teacher	M	24 - 30	30/07/2015	36 min
43	Maths teacher	M	8 - 15	30/07/2015	17 min
44	Maths teacher	M	0 - 3	30/07/2015	24 min
45	Maths teacher	M	8 - 15	31/07/2015	20 min
46	Maths teacher	M	4 - 7	31/07/2015	13 min
47	Maths teacher	M	0 -3	31/07/2015	21 min

SNo	**Focus Group Discussants/participants**	**Years of teaching experience**	**Date**	**Length of discussion**
1	5 (1 female and 4 male) Maths teachers	0 – 3 (1) 4 – 7 (2) 8 – 15(1) 16 – 23 (1)	13/06/2015	25min
2	6 (1 female and 5 male) Maths teachers	0 – 3 (1) 4 – 7 (1) 8 – 15 (1) 16 – 23 (1) 24 – 30 (1) 30^{+} (1)	30/07/2015	37min

Appendix J Copy of CPD plan



REPUBLIC OF ZAMBIA

MINISTRY OF EDUCATION, SCIENCE, VOCATIONAL TRAINING AND EARLY EDUCATION

[redacted] SECONDARY SCHOOL

CONTINUOUS PROFESSIONAL DEVELOPMENT PLAN-2015

PLANNED DATE	ACTUAL DATE	ACTIVITY	FACILITATOR	CHAIRPERSON
16/02/15	23/02/15	❖ Planning a demo lesson in Matrices	[redacted]	[redacted]
17/02/15		❖ Teaching on the Matrices Demo lesson	[redacted]	[redacted]
18/02/15		❖ Revising and teaching the revised demo lesson.	[redacted]	[redacted]
23/02/15		❖ Planning CPD demo lesson in Maths-Earth Geometry.	[redacted]	[redacted]
24/02/15		❖ Teaching of the Earth Geometry Demo lesson.	[redacted]	[redacted]
25/02/15		❖ Revising and teaching of the revised Earth Geometry demo lesson	[redacted]	[redacted]
26/02/15	09/06/15	❖ Planning demo lesson in Maths-Probability practicals.	[redacted]	[redacted]
27/02/15		❖ Teaching of the Probability demo lesson.	[redacted]	[redacted]
28/02/15		❖ Revising and teaching of the revised demo lesson in Probability.	[redacted]	[redacted]
09/06/15		❖ Planning demo lesson in Functions.	[redacted]	[redacted]
10/06/15		❖ Teaching demo lesson in Functions.	[redacted]	[redacted]
11/06/15		❖ Revising and teaching revised demo lesson in Functions.	[redacted]	[redacted]

Appendix K Minutes of Departmental meeting

[redacted] SECONDARY SCHOOL

MATHEMATICS DEPARTMENT

MINUTES FOR CPD MEETING – TRAVEL GRAPHS (Kinematics / Velocity or Speed–Time graph)

Venue: Maths Departmental office

Date: 18/02/14

Time: 1400hrs.

Agenda:

1. Opening Prayer
2. Opening Remarks
3. Objectives
4. Common [redacted] on Speed–Time Graph
5. Closing Remarks
6. Closing Prayer

Attendance

1. [redacted]
2. [redacted]
3. [redacted]
4. [redacted]
5. [redacted]

Opening Prayer

[redacted] gave an opening prayer to mark the beginning of the meeting

Opening Remarks [redacted]

The chairperson (HOD) welcomed the members to the meeting and encouraged them to be fully involved in the discussions so that a good lesson plan would be formulated. He declared the meeting open.

Objectives: [redacted]

The main objective was to share ideas on the best approach to teaching Travel Graphs (Kinematics) to pupils.

The facilitator, [redacted], referred the members to Maths grade 12 and some questions from past exam. papers as the best references for teaching Kinematics. She also said there was need to contact the Natural Sciences Department to emphasize on the use of the formulae: $V = u + at$, $S = \frac{1}{2}ut + at^2$ and $V = u + 2as$ which can be used in place of Mathematical formulae: Use of area of a trapezium, Gradient $\left(\frac{y}{x}\right)$ and $S = \frac{D}{T}$. [redacted]

The Common lesson plan was formulated on speed-time graphs with questions from grade 12 Maths and grade 12 past papers: P1 (2009) and P1 (2008). The members agreed to attend during demonstration with 12B on 20th Feb. 2014 at 0850hrs.

Closing Remarks and Prayer.

The HOD thanked the members for their presence and full participation. He urged them to witness the lesson presentation to the pupils on 20th Feb. 2014 so that they take note of weaknesses embedded in the lesson plan ~~that~~ could help revise the lesson plan for perfection. He closed the meeting with a prayer. The meeting ended at 1550hours.

[redacted]

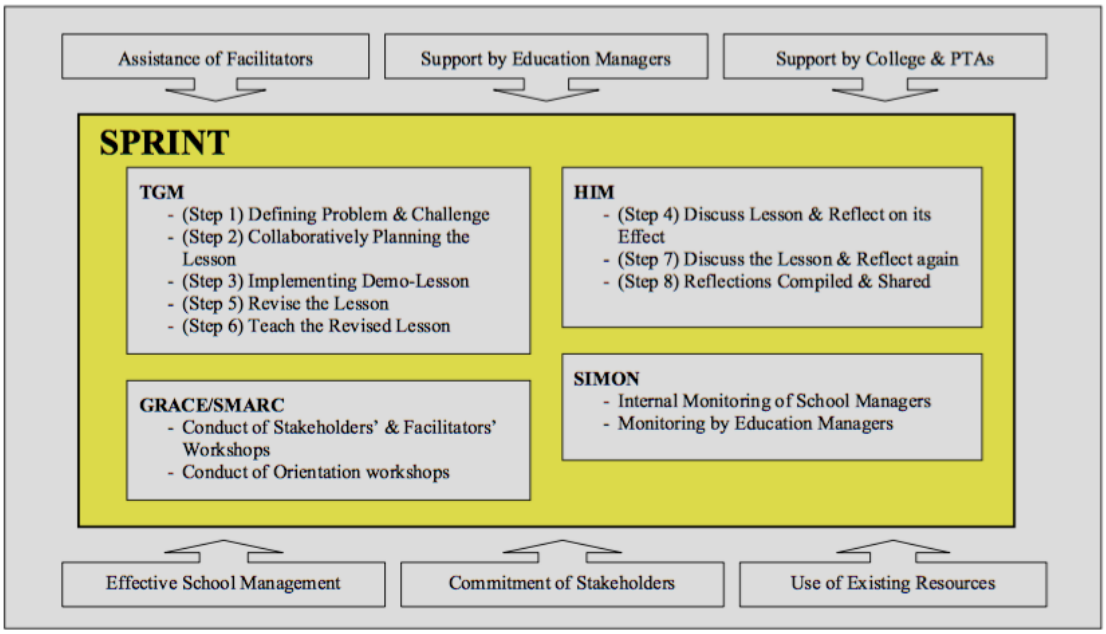
[redacted]

CHAIRPERSON

[redacted]

SECRETARY

Appendix L Framework of SBCPD through LS



Source: MOE (2010, p.6)

Key

SPRINT-School programme of In-Service for the term

TGM-Teachers Group Meeting

HIM-Head teachers' In-service Meeting

GRACE-Grade Meeting at Resource Centre

SMARC-Subject Meeting at Resource Centre

SIMON-School In-service and Monitoring

NOTE: 'School-Based CPD uses Teachers Group Meeting (TGM) and Head teachers' In-service Meeting (HIM) in SPRINT as a venue of learning of teachers. Grade Meeting at Resource Centre (GRACE) and Subject Meeting at Resource Centre (SMARC) are also considered as venues of workshops for stakeholders and facilitators. These types of meetings take place regularly throughout a year and monitored by School In-service and Monitoring (SIMON) programme '(MOE, 2010, p. 2)