A TEACHER COLLECTIVE AS A PROFESSIONAL DEVELOPMENT APPROACH TO PROMOTE FOUNDATION PHASE MATHEMATICS TEACHING

T.L. HLAM

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A TEACHER COLLECTIVE AS A PROFESSIONAL DEVELOPMENT APPROACH TO PROMOTE FOUNDATION PHASE MATHEMATICS TEACHING

BY

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DECLARATION

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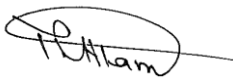 (Signature)

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TABLE OF CONTENT

Table of Contents

DECLARATION ii

TABLE OF CONTENT iii

ACKNOWLEDGEMENT vi

DEDICATION vi

ABSTRACT vii

LIST OF TABLES viii

LIST OF FIGURES viii

CHAPTER 1 1

BACKGROUND AND RATIONALE 1

1.1 INTRODUCTION 1

1.2 STATEMENT OF THE PROBLEM 2

1.3 RESEARCH AIM 4

1.4 RESEARCH QUESTIONS 4

1.5 LITERATURE REVIEW 5

1.6 LESSON STUDY 9

1.7 PEDAGOGICAL CONTENT KNOWLEDGE (PCK) AND MATHEMATICAL KNOWLEDGE FOR TEACHING (MKT) 9

1.8 NUMBER SENSE DEVELOPMENT 10

1.9 METHODOLOGY 10

1.10 OUTLINE OF THE STUDY 11

CHAPTER 2 13

LITERATURE REVIEW 13

2.1 INTRODUCTION 13

2.2 A GENERIC VIEW OF A TEACHER PROFESSIONAL DEVELOPMENT 13

2.3 TEACHER PROFESSIONAL DEVELOPMENT MODELS 14

2.4 LESSON STUDY 28

2.5 MATHEMATICAL KNOWLEDGE FOR TEACHING (MKT) 32

2.6 NUMBER SENSE DEVELOPMENT 36

2.7 ERROR ANALYSIS 38

2.8 CONCLUSION 39
CHAPTER 3 **39**
RESEARCH DESIGN AND METHODOLOGY **39**
3.1 INTRODUCTION 39
3.2 THE RESEARCH METHODOLOGY AND RATIONAL FOR ITS USE 40
3.3 DIFFERENT PARADIGMS 41
3.4 QUALITATIVE APPROACH 43
3.5 A CASE STUDY 45
3.6 SAMPLING 46
3.7 DATA COLLECTION 48
3.8 DATA ANALYSIS 54
3.9 ETHICS IN QUALITATIVE RESEARCH 56
3.10 MEASURES TO ENSURE TRUSTWORHINESS OF THE FINDINGS 57
3.11 CONCLUSION 59
CHAPTER 4 **60**
PRESENTATION AND DISCUSSION OF FINDINGS **60**
4.1 INTRODUCTION 60
4.2 DISCUSSION AND PRESENTATION OF FINDINGS 60
4.3 PRESENTATION OF THE FINDINGS FROM PERSONAL JOURNALS ... 92
4.4 CONCLUSION 95
CHAPTER 5 **96**
CONCLUSIONS AND RECOMMENDATIONS **96**
5.1 INTRODUCTION 96
5.2 OUTLINE OF THE STUDY 96
5.3 CONCLUSION DRAWN FROM THE FINDINGS 97
5.4 CONCLUDING REMARKS 105
REFERENCES **107**
APPENDIX A: PERMISSION GRANTED BY THE DEPARTMENT OF BASIC EDUCATION **110**
APPENDIX B: PERMISSION GRANTED BY NMMU FACULTY OF EDUCATION **111**
APPENDIX C: INFORMATION AND INFORMED CONSENT **112**

APPENDIX D: WRITTEN INFORMATION GIVEN TO SCHOOL PRINCIPALS PRIOR PARTICIPATION **114**

APPENDIX E: INTERVIEW SCHEDULE **115**

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Thank you Thando, Simphiwe (my children) and Xhantilomzi, my grandson for the untiring support and love you gave me, during the time of need. I love you boys.

DEDICATION

This study is dedicated to my late parents (mom Mentiwe, Ivy and daddy Thembile Freddie Mboyiya), particularly my mom who passed on 17th October 2016, when I was almost towards the end of writing my MEd dissertation. Mom you were the pillar of my strength

I will always love and cherish you in my life.

Rest in peace Jola

ABSTRACT

This qualitative study is a response to a request for help from a group of Grade 3 (year 3) teachers who were disheartened with the poor performance of their learners in Mathematics. In an attempt to address their challenge, they resolved to form a Teacher Collective (TC) amongst themselves. Their main objective was to support each other in their development of Mathematical Knowledge for Teaching (MKT).

The participants, being frustrated by what they perceived as an inefficient and unhelpful cluster approach to professional development used by the Department of Basic Education initiated their own teacher collective strategy. I was approached by this TC to assist them in developing a strategy to make this TC suit the needs of the participants. A Lesson Study (LS) approach was used as an alternative Teacher Professional Development strategy within the TC. In studies conducted by Ono and Ferreira (2010) and Jita and Mokhele (2014), a LS approach is regarded as an essential tool desirable for enhancement of teacher collaboration and participant's MKT. However, both studies reported on challenges related to contextual issues. Those contextual issues revealed themselves as similar to the challenges that threatened to weaken the collaborative structure initiated by the participants in this current study. To overcome these challenges, participants felt a need for some sort of adaptation for a LS approach to work in their context. In the application of the revised adapted version of a LS approach, participants experienced a Teacher Collective (TC) in action using real and useful experiences (Ono & Ferreira, 2010).

The aim of this study was to examine the effects of a Teacher Collective for improving participating teachers' pedagogical and disciplinary content knowledge in Foundation Phase (FP) Mathematics. As this study targeted a small group of teachers, it adopted a case-study methodology. The participants were five Grade 3 teachers purposefully self-selected from two Port Elizabeth township schools. Semi-structured interviews were used to determine participating teachers' perceptions of a Teacher Collective as a Teacher Professional Development strategy necessary to promote Mathematical Knowledge for Teaching.

Descriptive methodologies which concern inter alia practices that prevail, relationships that exists, point of views that were held, processes that are going on and effects that are felt by participants were used (Creswell, 2013). The following major findings emerged from the data analysis: For the TC to be a successful alternative TPD, it requires that: (1) Teachers must regard themselves as being responsible for the own professional growth and own the TPD programme. (2) Participants of the TC must adopt flexible strategies to allow for active participation of the participants in building meaning for themselves. (4) A TPD strategy should be sensitive to contextual issues and be addressed accordingly. (5) A TPD programme should seek to improve classroom instruction but this must be based on the needs of the participants.

It is primarily the following structural features that affected teacher learning within the TC: (a) the form of the activity (joint lesson planning, observed lesson presentation, post lesson feedback, etc.), (b) collective participation of teachers within and across the schools and (c) the duration of the activity.

In this study the LS approach worked well as it sought to address the needs of the participants.

LIST OF TABLES

List of Tables	Title	Page
Table 3.1	Multiplication – Learner solution strategies	53
Table 3.2	Identification of appropriate multiplication strategy	53
Table 4.1	Format of chapter four	62
Table 4.2	Responses about effective functioning of a Teacher Collective	67
Table 4.3	Tools and frequency of engagement	73
Table 4.4	Identification of most suitable explanation	85
Table 4.5	Identification of appropriate multiplication solution strategy	86

LIST OF FIGURES

List of Figures	Title	Page
Figure 2.1	Professional Learning Communities model	22
Figure 2.2	Domains of Mathematical Knowledge for Teaching	34 & 84
Figure 3.1	Data collection activities	49
Figure 4.1	Structure of place value notation	93

LIST OF ABBREVIATIONS AND ACRONYMS

ANA	Annual National Assessment
C2005	Curriculum 2005
CAPS	Curriculum and Assessment Policy Statement
CoP	Community of Practice
CCK	Common Content Knowledge
CK	Content Knowledge
DBE	Department of Basic Education
DoE	Department of Education
FP	Foundation Phase
JICA	Japanese International Cooperation Agency
KCS	Knowledge of Content and Students
KCT	Knowledge of Content and teaching
LS	Lesson Study
MKT	Mathematical Knowledge for teaching
MSSI	Mpumalanga Secondary School Initiative
NCS	National Curriculum Statement
OB E	Outcome-Based Education
PCK	Pedagogical Content Knowledge
PLC	Professional Learning Community
RNCS	Revised National Curriculum Statement
SA	South Africa
SCK	Specialised Content Knowledge
SMK	Subject Matter knowledge
SMT	School Management Team
T1	Teacher 1
T2	Teacher 2
T3	Teacher 3
T4	Teacher 4
T5	Teacher 5
TC	Teacher Collective
TPD	Teacher professional Development

CHAPTER 1

BACKGROUND AND RATIONALE

1.1 INTRODUCTION

After the fall of apartheid, the South African (SA) government implemented wide ranging curriculum reforms such as Curriculum 2005 (C2005) in 1997, which was followed by the Revised National Curriculum Statement (RNCS) in 2002 and the Curriculum and Assessment Policy Statements (CAPS) in 2010. The aim was to develop mathematically competent, literate, creative and critical citizens (Ono & Ferreira, 2010) and to address imbalances of the past Tshiredo (2013). The teachers' role was viewed as essential for the effective implementation of these reforms. To do this, teachers were expected to demonstrate in-depth conceptual understanding of the pedagogical and teaching content, and employ a wide range of pedagogical skills to promote effective teaching and learning of Mathematics in their classroom (Adler, Pournara, Taylor, Thorne, & Moletsane, 2009; Taylor, Muller, & Vinjevold, 2003).

The Department of Basic Education (DBE) regarded teachers as the insightful presenters, who could implement the national curriculum effectively and efficiently in their classrooms. Meanwhile, different studies conducted in South Africa revealed a wide range of challenges related to curriculum implementation including skewed curriculum structure and design, lack of alignment between curriculum and assessment policy. Inadequate Teacher Professional Developmental strategies applied during orientation workshops and unavailability and insufficient use in the classroom was regarded as concerns (Chisholm, 2003; Jita & Ndlalane, 2009; Ono & Ferreira, 2010; Taylor et al., 2003).

During introduction of the curriculum-change (training) workshops, "the focus was on orientation of the new terminology, there was little attention paid to the substance" (Chisholm, 2003, p. 278) of the curriculum. Research conducted by Lombard, Meyer, Lombard, Warnich, and Wolhuter (2010) reaffirmed the findings of Chisholm (2003), as it revealed similar challenges such as:

- Inadequate teacher professional development (TPD) strategies used by the DBE to introduce curriculum reforms to teachers (mainly the Cascade model).

- Disparities in the availability of resources between schools in rural areas and those in urban areas need serious attention.
- A need to improve Mathematics performance of underprivileged learners who come from the low socio-economic group with limited or no resources and over-crowded classrooms.

Lack of readiness of teachers was indicated as one among many factors that hampered implementation of the of the new curriculum (Human, Van der Walt, & Posthuma, 2015). Due to challenges highlighted above, understanding the content and the requirements of C2005, NCS and CAPS varied within and between schools, as well as amongst and between teachers (Chisholm, 2003). Mouton, Louw, and Strydom (2013, p. 34) further illustrate the implementation of CAPS as "a sad repetition of OBE" that "has taken place without sufficient training of teachers".

The CAPS for Mathematics requires a grade three learner to know and be able to work with numbers up to nine hundred and ninety-nine (Mouton et al., 2013). But, participants in this present study found it difficult to cover all aspects of the curriculum in a year as prescribed in the CAPS for Mathematics. Their main challenge was learners' inability to apply the four basic operations (of addition, subtraction, division and multiplication) using three digit numbers and visualise, and describe relationships in numbers.

1.2 STATEMENT OF THE PROBLEM

A group of Foundation Phase (FP) teachers (the participants in this study) from primary schools, situated in township areas of Port Elizabeth, indicated their dissatisfaction with the levels of performance of the learners in the subject Mathematics. Their dissatisfaction was aggravated by the poor performance of their grade three learners in Annual National Assessment (ANA) conducted by Department of Basic Education (DBE). Initially, these participants formed a small teacher-collective amongst themselves in an attempt to address their concerns. The collective quickly proved to be problematic in that they neither had sufficient in-house skills to make the collaboration effective, nor clear goals that provide a guide and a rational for its formulation. As a result of the lack of clear focus, their TC found it difficult to address challenges facing them in teaching of grade three Mathematics. They

resolved to move out of their comfort zone and requested me (the researcher in this study) to assist them with workshops and classroom-based support.

The participants perceived the support from DBE, which focused on a Cascade model of teacher support, as being insufficient for their needs, as it did not appear to provide them with sufficient support. The teacher professional development (cascade) model neither challenged them to rethink nor review the pedagogical content knowledge (PCK) necessary to shape their teaching practice. As a result, they found it difficult to implement or meet the requirements of the curriculum while working in their isolated classrooms. The National Curriculum and Assessment Policy Statement for Mathematics (CAPS) specifies knowledge, skills and content to be taught, and assessed, on a grade-by-grade basis, as well as illustrating timeframes for teaching and completion of work for each academic year. In spite of the identified curriculum requirements, these teachers did not find the pre-determined schedules user friendly. Implementation schedules failed to take into consideration contextual factors (Ono & Ferreira, 2010), such overcrowded classrooms, lack of readiness of teachers, etc.

Due to challenges highlighted above, participants found it difficult to cover various aspects of the grade-three curriculum as required in the FP Mathematics CAPS (2010) document. Instead, they felt that strategies used in teaching and learning of Mathematics and the packaging of work to be covered within a specific period as laid out in the FP Mathematics CAPS did not always address the needs of the learners.

In an attempt to address their concern, participants decided to take responsibility for their own professional development. They identified that teaching in isolated classrooms was a barrier, as they were unable to address their problems without getting support or some form of intervention from either their colleagues or DBE subject advisors. At that point, the participants resolved to form a teacher collective amongst themselves. The main objective of their envisaged teacher collective was to support each other, with the intention of enhancing their Mathematics Knowledge for Teaching (MKT) necessary for a Foundation Phase classroom.

In spite of the fact that their collaborative initiative threatened to collapse, they were resilient enough to explore other avenues that might enhance effective functioning of their teacher collective. Participants approached me as a university Mathematics lecturer to assist them. As researcher, who was entrusted with a responsibility of assisting with strategies necessary for

their collaboration to be effective, my interest was to explore the influence of a Teacher Collective (TC) as Teacher Professional Development (TPD) strategy necessary to promote MKT for FP level. I suggested the idea of a Lesson Study as a strategy within the teacher collective to assist with the sustainability of their teacher collaboration.

1.3 RESEARCH AIM

The aim of this study was to explore the influence of a teacher collective as a professional development approach to promote high quality teaching of Mathematics in the Foundation Phase.

1.3.1 The objectives of the study were:

a. To investigate initial perceptions of a group of grade three teachers regarding the functioning of their Teacher Collective as a professional development approach.
b. To explore the Mathematical Knowledge for Teaching with respect to number sense that the teachers possessed before engaging in a Lesson study approach (seen as a Teacher Collective exercise in this study).
c. To investigate the perceptions of individuals within a group of grade three teachers regarding the functioning of their Teacher Collective after exposure to a Lesson Study approach.
d. To explore the Mathematical Knowledge for Teaching that the individuals within a group of grade three teachers possessed after engaging in a Lesson Study approach.

1.4 RESEARCH QUESTIONS

This study examined and provided explanations to the following questions:

1.4.1 Main question

How does a teacher professional development strategy, referred to as a teacher collective, contribute to development of Mathematical Knowledge for Teaching of Foundation Phase Mathematics teachers?

1.4.2 Sub-questions

a. What are the initial perceptions of a group of grade three teachers regarding the functioning of their Teacher Collective as a professional development approach?
b. What Mathematical Knowledge for Teaching with respect to number sense and corresponding error analysis did a group of grade three teachers possess before engaging in a Lesson Study approach (seen as a Teacher Collective exercise in this study)?
c. What are the perceptions of individuals within a group of grade three teachers regarding the functioning of their Teacher Collective after exposure to a Lesson Study approach?
d. What Mathematical Knowledge for Teaching did the individuals within a group of grade three teachers possess with reference to number sense and error identification after engaging in a Lesson Study approach?

1.5 LITERATURE REVIEW

In examination of a Teacher Collective as a professional development approach to promote FP Mathematics teaching, some of the successes and recurring challenges related to the teacher support models, duration and quality of training reported in various studies were taken into consideration. The review of previous studies gave me insights of the theoretical basis; definitions and terminology, and the nature of my research. To achieve that I checked for the research reports that were closely connected to my topic. For instance, some research reports cautioned against adoption and application of insufficient teacher support programmes. A study conducted by Bagwandeen and Louw ascertained that:

> *Initial training cannot provide 'the fuel and supplies' that a teacher needs for a lifelong journey. There is no question about the fact that, in times of rapid change initial training is not enough. Learning to teach and maintaining the competence is an ongoing continuous process* (Bagwandeen & Louw, 1993, p. 3)

To complement the view of Bagwandeen and Louw (1993), Taylor et al. (2003) were also against the application of a Cascade model of TPD to introduce the new curriculum. In their observation, once-off teacher training using a Cascade model did not help teachers to gain skills and knowledge needed in teaching Mathematics. Instead, in their report, they mentioned teachers showed significant weakness in pedagogical skills as well as in conceptual understanding of their teaching content (2003). They advocated for the establishment of ongoing collaborative teacher professional development programmes. For these researchers,

TPD programmes should be based on needs and readiness of participating teachers. According to Taylor et al. (2003),

> *The majority of teachers require a great deal more attention than they are presently receiving, if learning is to improve in our schools. Teachers request for more direct training, as opposed to the very weak Cascade design (Taylor et al., 2003, p. 24)* .

Van der Westhuizen et al. in Southwood (2002) addressed the desire for ongoing teacher professional development programmes from a different perspective. They described the experience of teachers in South African schools as a "solitary pursuit". As a study carried out by Southwood revealed, teachers often operate in isolation "within their own domains, aware only of their experiences, and basing their programmes thereon" (2002, p. 3). That implied working in isolated settings "limits feedback and professional growth, while concealing common problems and constraints" (Southwood, 2002, p. 3).

The nature of professional development activities is important. For instance, Fullan and Hargreaves (1996) noticed that teachers were more likely to change their behaviour and continue to use new ideas when they were realized and engaged as active participants during the process of their own learning. Active involvement might motivate teachers to see the need for improvement and analysis of their classroom practices. In the view of Jita and Mokhele, in many parts of the world, an ongoing TPD "is viewed as the most effective approach to improve the teachers' instructional practices" (2014, p. 1).

In South Africa, lack of sustained guidance in implementation of the new curriculum in schools is viewed as a critical factor contributing "substantially to teachers' negative reactions and resistance" (Mouton et al., 2013, p. 34). For instance, in situations where there was no follow-up support provided during on-site implementation of workshop ideas, some teachers got stuck and reverted to the old ways of teaching and learning (Mouton et al., 2013). Nonetheless, in SA, we still have teachers (e.g. participants) who took responsibility for their own professional growth. Such teachers tend to widen their comfort zones by moving out of isolated classrooms to ask for help. Those teachers initiated their own collaborative, discussed their learner performances, analysed their own performances and were likely to observe in each other's classrooms, as well. Such resilience may challenge and encourage them to learn in their own way and to continue to set new goals for their own professional growth.

Ono and Ferreira emphasised the importance of development of collaboration among teachers (2010). In their view, teacher collaboration might motivate teachers to plan their lessons, verify or check suitability and relevance of and reflect on their classroom practices as well. If such collaborations are encouraged, teachers might distance themselves from operating in their isolated domains (Southwood, 2002) and find ways that will help them gain meaningful understanding for both fundamentals of knowledge and social settings. Southwood (2002) highlighted two challenges that need to be considered or addressed in the reform of the South African education system:

a) Teachers' lack of readiness to implement the new curriculum effectively in their classroom.
b) Teachers' resistance to apply alternatives ways of teaching and learning advocated in the curriculum.

Issues raised in this study challenge different service-providers to expose teachers to various aspects and requirements of the national curriculum, in a non-threatening environment that would encourage and support teacher-collaboration.

1.5.1 Teacher collaboration to promote teacher professional development

From initial stages of this study, teacher collaboration was regarded as a key aspect of teacher professional development and served as a vehicle to promote development of quality Mathematical Knowledge for Teaching. As a consequence, it was imperative for me to gather information that would broaden my understanding of different forms of teacher collaboration. My intention is to provide a brief description and analysis of terms related to key concepts of a Teacher Collective and create theoretical foundation for my study.

1.5.2 A Community of Practice (CoP)

A community of practice is formed by a group of people who share a concern or a passion for something they do, and learn how to do it better as they interact regularly (Wenger, McDermott, & Snyder, 2002). This definition reflects how humans gain knowledge from those around them: that is a social environment. Wenger et al. (2002) does not ascribe the term CoP to one specific group of people. According to Wenger et al. (2002), CoP applies to broad spectrum of groups of people and might refer to a gang-group, whose members learn how to live in an unfavourable environment. On the other hand, it might refer to a group of teachers who learn how to design

and manage curriculum for their respective classroom, or a group of municipality staff who seek to improve service to citizens. Wenger (2011) pointed out that in all types of groups, the key common factors are:

- **The domain:** members are brought together by a learning need they share
- **The community:** their collective learning becomes a bond among them over time
- **The practice:** their interactions produce resources that affect their practice

1.5.3 Teacher Collective (TC)

In this study, a Teacher Collective (TC) is used as a form of a CoP that refers to a specific group of professionals. A teacher collective is the process, which refers to the frequent enrichment of collective capabilities and the improving of group effectiveness (Cheng, 2011). A collaborative process is a key feature of a TC. According to Cheng (2011) favourable outcomes of a TC are achieved when members of a community operate and learn through social interaction (Cheng, 2011). More than simple group attendance at TPD workshop, collective learning is a process by which the members share their values and beliefs (Cheng, 2011). When operating as a collective, members of the group are able to engage in a free and open dialogue about their focal point, challenges and processes of their work (Wenger et al., 2002). Cheng (2011) asserts that teachers learn more effectively when they interact with others and learn together as a team. It is for this reason that Cheng (2011) suggested that collective learning is more successful than individual learning.

1.5.4 Professional Learning Community (PLC)

Just like a TC, a Professional Learning Community (PLC) is a special type of a CoP adopted by the DBE in SA as a model of TPD. The only difference is that it is not confined to a specific group of professionals as it is the case with a TC. It can be assigned or referred to any group of professionals who meets regularly, shares expertise, and works collaboratively to improve their skills and performance and that of participants put under their care o guidance (Wenger et al., 2002). Shulman (1986) suggested possible the most elementary description of this type of CoP: professionals coming together in a group (referred to as a community) to learn.

1.5.5 Clusters

The concept of a cluster, as compared to teacher communities of practice is described as a group of nearby schools that are brought together to ease administrative of the service provider. According Jita and Mokhele (2014) a cluster approach facilitates collaboration of teachers within and across the schools, but this model of TPD as can be seen by teachers in my study does not always work, or achieve its intended outcomes. For these participants, their participation and engagement in the cluster project set up by the DBE was not voluntary, but obligatory. In their case (participants in this study), decision making processes were not democratic. Mostly, decisions were taken by the DBE subject advisor.

1.6 LESSON STUDY

The term Lesson Study is derived from the Japanese word ***jyugyo kenkyu*** (Jita & Mokhele, 2014). It can also be referred to as 'research lesson' which indicates the level of scrutiny applied to individual lessons (Jita & Mokhele, 2014). Lesson Study is a professional development process that Japanese teachers engage in to systematically examine their practice, with the goal of becoming more effective. This scrutiny involves teachers working collaboratively on a small number of study lessons.

1.7 PEDAGOGICAL CONTENT KNOWLEDGE (PCK) AND MATHEMATICAL KNOWLEDGE FOR TEACHING (MKT)

In the view of Shulman (1986), the term Pedagogical Content Knowledge (PCK) refers to the overlap of information about subject knowledge, that is knowledge of the subject being taught, and pedagogic knowledge, that is knowledge of how to teach (i.e. planning, assessment, teaching and learning, etc.). PCK is deep knowledge about the processes and practices or methods of teaching and learning and how it encompasses (among other things) overall educational purposes, values and aims. Shulman's initial understanding and description of PCK was reviewed and unpacked further by different researchers (Ball, Thames, & Phelps, 2008; Hill, Ball, & Schilling, 2008) who conducted studies to validate Shulman's findings and to elaborate his version of PCK. They suggest the concept of Mathematical Knowledge for Teaching (MKT), which is discussed further in chapter two.

1.8 NUMBER SENSE DEVELOPMENT

Gersten and Chard (1999) described number sense as an emerging construct that refers to a child's fluidity and flexibility with numbers. They further refer to number sense development as the awareness of what numbers mean and an ability to perform mental Mathematics. It is important for learners to be aware of the use and application of numbers in real life and make comparisons, when necessary. Sharing and discussing ideas of how numbers are used in everyday life is an ideal way of finding out and extending the knowledge and sense learners have of numbers. For example, numbers are used to quantify things (in measurement), identify dates, indicate the value, etc.

Any child could develop number sense when given access to a well-designed, focused programme of action that provides opportunities to explore and discuss concepts, and make connections between different concepts. Such interventions should be sensitive to the diverse nature of learners and engage strategies that would allow them to develop understanding at their own pace, while following an appropriate conceptual and developmental sequence (Griffin, 2004).

1.9 METHODOLOGY

This study is located in the social constructivism paradigm of the qualitative research approach (Hartas, 2010). The intention of this qualitative case study is to gather information using descriptive measures in a natural and social setting (Cohen, Manion, & Morrison, 2007), while empowering "participant's perspectives and ideas, and obtain rich descriptions of the contexts that surround their lives"(Hartas, 2010, p. 44).

1.9.1 Data collection

For data collection, this study used semi-structured (group) interviews to allow for the flexibility to probe the unexpected views or responses further. Semi-structured interviews provided me an opportunity to include open-ended questions in the interview guide (Check & Schutt, 2012). Semi-structured interviews could be described as a way of accessing a clear picture of participants' perceptions or account on a particular issue (Check & Schutt, 2012).

Interview schedules used in this study contained a range of question formats that required different modes of responses such as: checklist that required selection of a response that best

described activities that would promote effectiveness of a TC initiated by the study participants. Another question format required respondents to respond in a categorical response mode, which offered participants with possibilities and required them to select and indicate their preference.

1.9.2 Data coding and data analysis

Data analysis was an ongoing integral part of the investigation process. Information gathered from the first group interviews informed the development of the Lesson Study intervention programme. In a process to convert information from raw data to meaningful themes, the view of "the three Cs of analysis: from Coding to Categorising to Concepts" suggested by Lichtman (2010, p. 197) was used.

1.9.3 Ethics in qualitative research

Drew, Hardman, and Hosp (2008, p. 56) described ethics as a "cornerstone for conducting effective and meaningful research", as it is meant to deal with what is morally right and wrong. Hence, my obligation was to ensure safety of participants during the course of investigation by being sensitive and respecting their privacy and dignity, "and also the integrity of the institutions within which the research occurs" (Drew et al., 2008, p. 57). Meaning that issues of informed and voluntary consent, confidentiality and participants' ability to evaluate information received thus to make informed decisions based on their evaluation were highly considered.

For ethics approval, permission to continue with my research was obtained from the research committee of my institution (see appendix B). Appendix A contains permission received from the director of Port Elizabeth DBE district office. An approval was requested and granted by the principals of the participating schools, and participating FP teachers (see appendices C and D).

1.10 OUTLINE OF THE STUDY

This dissertation consists of five chapters. Chapter one introduced the study by providing the background and orientation to the study including synopsis of statement of the problem, aim of the study, research question, brief literature-review and research methodology. Theoretical foundations are discussed in chapter two. Research methodology that included paradigm

(location of the study), research design, approach and method, data collection and data analysis are presented and discussed in chapter three. Findings of the study are presented and discussed in chapter four. Chapter five draws conclusions from the findings. Suggestions on how a TC collective approach could be modified to make work more effectively is discussed in chapter five as well.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The main purpose of this chapter is to explore the literature that is relevant to understanding the development of, and interpreting the results of this study. The following review of literature is focusing on studies that: (a) examine a range of various models of Teacher Professional Development (TPD), including a Teacher Collective (TC) as one of the models for teacher-focussed development, (b) explore a Lesson Study as a tool that intensifies the interaction of a school-based collaborative and (c) view the Mathematical Knowledge for Teaching (MKT) as the central experience to the development of Subject Content Knowledge (SCK). The last part of this chapter (d) strives to set a context for the understanding of the effects of a Teacher Collective realised as a TPD to promote MKT based on teachers' perceptions of the concept of number sense development.

2.2 A GENERIC VIEW OF A TEACHER PROFESSIONAL DEVELOPMENT

Teacher Professional Development (TPD), also known as teacher education, can be described and organised in different ways and for different reasons. For example, Kennedy (2005) views TPD as the instruction provided to teachers to promote their development in a certain knowledge or skills area. Kennedy portrayed TPD as the tool by which in-service provider's projections for change are communicated or conveyed to teachers. Hill et al. (2008) became more specific in their description of TDP. They describe TPD as a strategy used to enhance teacher's effectiveness and competence in Pedagogical Content Knowledge (PCK), and development of the Subject Matter Knowledge (SMK).

TPD is perceived as a growth that occurs throughout the professional life of a teacher. In the view of Cheng (2011), active participation of teachers in continuous TPD activities is one way of engaging and keeping them well-informed about changes, and developments in their field of work. He (Cheng) regards such participation as a way of enabling teachers to meet the demands of the world around them. The findings of Bagwandeen and Louw (1993) regarding the effectiveness of a TPD illustrate a need for programmes that are relevant to both teachers and learners. In the view of Bagwandeen and Louw (1993), it is ongoing TPD programmes

based on classroom experience that can provide successful services to the beneficiaries of such programmes.

A degree of consensus has emerged on identification of some of the major features of effective professional development. However, Kennedy (2005) argues that, while most TPD experiences might be considered as a means of introducing or enhancing knowledge, skills and attitudes, it cannot be assumed that this is uncontested. For example, some researchers such as, Fullan and Hargreaves (1996) warn against use of TPD programmes that **do not:**

- Directly immerse teachers in the subjects they teach.
- Take into consideration the importance of inclusion of basic knowledge.
- Encourage development of abstract thinking and problem solving skills.

Once-off TPD programmes are considered as less effective than ongoing, collaborative TPD programmes based on teachers' daily experiences. The latter intending to challenge teachers to think and devise means to solve problems facing them, while the former may just be once-off events that might not translate automatically into improved classroom action.

2.3 TEACHER PROFESSIONAL DEVELOPMENT MODELS

This section examines different models of TPD to identify and compare their relative potential for effective practice and professional appropriateness. For Kennedy, (2005), TPD embodies a wide-range of models. Some of these TPD models are: Cascade model, Professional Learning Communities (PLC), Communities of Practice (CoP) and Clusters. These TPD models can be either pre-service or in-service teacher-training programmes (Kennedy, 2005). They might be offered as once-off (one-day to five-day) workshops, or as ongoing support programmes that seek to develop and sustain PCK and SMK of teachers (Ono & Ferreira, 2010). A TPD programme may be delivered in person or online during the school day or outside of normal hours of school (Jita & Mokhele, 2014). These TPD sessions may be facilitated by teachers within a school or provided by external facilitators, such as DBE subject advisors and non-governmental service providers (Jita & Mokhele, 2014; Ono & Ferreira, 2010).

TPD models can be regarded as designs for learning that embody a set of ideas about where knowledge about teaching practice comes from and how teachers attain or broaden their

knowledge. The presumption of this being that effectiveness and suitability of a TPD experience requires teachers to be able to articulate and apply their own conceptions or understanding of teaching and can select, and justify appropriate modes of practice. Circumstances in which each different model of TPD operates illustrate the form(s) of knowledge and competences that can be developed when applied (Kennedy, 2005). Power relations that characterise any individual model of TPD illustrates the extent to which that particular model is perceived and promoted either as an individual endeavour related to accountability, or as a collaborative endeavour which supports transformative practice (Kennedy, 2005). For example, in a TPD programme initiated by teachers as a group, there might be, if exists at all, only small power differentials. In such initiatives, the spirit of equity may prevail, because participants' goals will in all likely-hood be mutual. In a situation where TPD programme is initiated by the government or authority group there might be an observable division of power between the service providers and the participants. Participants will mostly be at the receiving end, while service providers determine programme and nature of delivery and support to participants.

Teachers may resist any form of 'compromised' support if it is based on perpetuating inequitable power-relation. In prevailing tendencies where there are inequitable power-relations, participants are always on the receiving end. Shaw (1992) identified that, in situations where participants are regarded as end-users, clients or just recipients, such programmes may neither address, nor be perceived as addressing their needs. As such, service providers are encouraged to involve their potential participants at all stages of development of their programmes, starting from a needs analysis, planning, implementation and evaluation of the TPD programme. Teachers tend not to take learning experience seriously when they are not perceived as active participants in a social practice (Jaworski, 2008). For progress in education to be of any value, all TPD strategies used should be embedded in motives and goals set up through engagements with potential participants in social contexts (Jaworski, 2008). Several researchers (Bagwandeen & Louw, 1993; Guskey & Yoon, 2009; Shaw, 1992) warn that professional development activities undertaken in isolation from teachers' on-going classroom responsibilities, seldom have much impact on teaching practices or student learning.

For a TPD programme to be successful, in-service providers are advised to listen to the voice of the teachers and allow them to have an input in the form and content needed (Fullan &

Hargreaves, 1996). A range of different models of TPD used in South Africa are discussed below:

2.3.1 Cascade model:

A Cascade model of TPD is referred to as a multiplier approach that allows transmission of information from the expert to the teachers (Ono & Ferreira, 2010). Sometimes, it is referred to as the train-the-trainer model that involves training through layers of trainers until it reaches the final target group. Application of a Cascade model assumes that information is transferred by an expert to the first layer of trainers and continues to flow from one to the next cohort of trainers until it reaches the target group or novice teacher operating at the ground level.

To introduce the new curriculum in SA, the Department of Basic Education (DBE) used a Cascade model through which teachers were trained and in turn had to pass the knowledge on to their colleagues (Ono & Ferreira, 2010). The DBE's actual training commenced with the training of provincial trainers by the national trainers. In turn, the provincial trainers provided training to the district subject-advisors (including teachers). For Prew (DBE, 2009), due to shortage of subject advisors at district offices, teachers were called to represent their respective districts at the provincial training. Thereafter, a first cohort of teachers were trained and introduced to the curriculum reform by the district trainers comprising teachers and subject advisors (Ono & Ferreira, 2010). The first cohort of teachers became the trainers of the second cohort.

A Cascade model of in-service training is widely considered to be a cost-effective means of TPD (Ono & Ferreira, 2010). This model is commonly used where a large number of teachers need training, in particular when funding for training is limited (Ono & Ferreira, 2010). One of the fundamental principles of this model is to provide a direct training in knowledge and skills thought necessary to enable anticipated changes in learner understanding and behaviours.

In application of a Cascade model to introduce the curriculum reform, DBE national trainers together with top ranked representatives from various sectors such as teacher associations, business sector worked together in critical analysis of the previous curriculum. They also decided about changes needed in the curriculum (i.e. curriculum reform), without conducting a survey of the challenges facing teachers in implementation of the curriculum or getting their views in terms of what is needed to be done. The Cascade model was used to introduce the

final product and teachers were expected to consume the final product produced by the curriculum specialists. A South African study conducted by Prew (DBE, 2009) revealed teachers' discontentment with these drastic changes in that they created the impression that these teachers' previous experiences were not deserving further consideration and just eradicated completely. Application of a Cascade model to introduce curriculum change in South Africa is reported as resulting in a 'water down' and/or misinterpretation of crucial information by Fiske and Ladd cited in Ono and Ferreira (2010).

Ono and Ferreira (2010) echoed the findings of the Prew (DBE, 2009) that the Cascade model proved to be inadequate as teachers frequently complained that even the district trainers themselves did not always understand the curriculum. The assertion of Ono and Ferreira (2010) and Prew (DBE, 2009) of inadequacy of Cascade model as a TPD strategy is affirmed by the three grade teachers in this study.

To affirm findings tabled in the report filed by Prew (DBE, 2009), a number of South African studies conducted revealed dissatisfaction with TPD Cascade model implemented to familiarise and introduce teachers to the curriculum reforms (Jita & Mokhele, 2014; Ono & Ferreira, 2010). All these researchers shared similar experiences and have common views regarding the problems experienced by teachers during both orientation workshops and implementation of the curriculum in the classroom. These problems with Cascade model were:

- The model failed to prepare either subject advisors or teacher for complexity involved in implementing the national curriculum.
- A great potential for misinterpreting the information, when the information is transmitted to the following level of training.
- The district trainers comprising both subject advisors and teachers did not always understand the curriculum
- The glaring disparities in the availability of resources between schools in rural areas and those in urban areas need serious attention.

The Cascade workshops did not succeed in helping teachers to gain deeper insights into Outcome Based Education (OBE) and the underlying philosophy of the curriculum (Chisholm, 2003). Neither DBE subject advisors nor the FP Mathematics policy document provided teachers with a clear guide in terms of the PCK necessary to promote meaningful conceptual

understanding of Mathematics. As a result, teachers, who are implementers of the curriculum in the classroom found it difficult to meet the requirements of the curriculum while working in their isolated classroom (Bocala, 2015; Doig & Groves, 2011; Ono & Ferreira, 2010). Due to challenges highlighted above, teachers continuously failed to cover various aspects of the curriculum as required in the Mathematics policy document (Ono & Ferreira, 2010). Instead, they felt that strategies used in teaching of Mathematics and packaging of work to be covered within a specific period as laid out in the FP Mathematics policy document does not always address the needs of the learners.

As indicated in the paragraph above, the use of a Cascade model in preparing teachers for the new curriculum-reform implementation was cited as ineffective in various South African studies (Chisholm, 2003; Jansen & Christie, 1999; Ono & Ferreira, 2010; DBE, 2009). For example, a study conducted by Jansen and Christie (1999) to validate effectiveness of a Cascade model of TPD used by South African Department of Education (DoE) to prepare teachers for the implementation of the new curriculum revealed a huge gap between the philosophical basis of the curriculum and what teachers were trained to do in the classrooms. The Cascade model neither offered enough time to gain insights of the curriculum reforms nor included a follow-up support structures for teachers who were to be involved in the long-term classroom implementation of the revised version of the national curriculum (Bantwini, 2009). For instance, the national Curriculum and Assessment Policy Statement for Mathematics (CAPS) adopted by the DBE (2011) specifies knowledge, skills and content to be taught, and assessed on a grade by grade basis. The CAPS illustrates timeframes for teaching and completion of work for each academic year. Teachers did not find these pre-determined schedules user friendly as they failed to take into consideration contextual factors and isolated from classroom situations (Ono & Ferreira, 2010) and needs of individual learners.

Inefficiency of this form of TPD and lack of follow-up support might contribute to the serious challenge facing South African education concerning lack of successful curriculum reform translation from theory into classroom practice. For Bantwini (2009), persistence of challenges highlighted will undermine the efforts and initiatives of any government-project aimed at improving the science teaching and learning.

To address and avoid further complications experienced by teachers in the application of the South African curriculum reform, active involvement of teachers in an ongoing TPD

programme is advised (Ono & Ferreira, 2010; DBE, 2009). To explore this view, various models of TPD based on socio-constructivism, that requires active involvement of participants in a social context are discussed below (Vygotsky, 1978). For example, different types of Communities of Practice (CoP) such as, Cluster model, Professional Learning Communities (PLC) and Teacher Collective (TC) are presented below. The following discussion includes a description, strengths and weaknesses, and provides example for each type of a Community of Practice.

2.3.2 Communities of Practice (CoP)

The concept of a Community of Practice (CoP) was proposed by Lave and Wenger (1991). A CoP is formed by a group of people who might or might not be in the same profession. This form of a cooperative group can evolve naturally as a result of the participants who share a common need or same idea. A CoP can also be formed intentionally with the aim of obtaining knowledge related to a specific need (Wenger et al., 2002). As indicated in chapter one, Wenger et al. (2002, p. 2) perceive a CoP as "a group of people who share a concern, a set of problems, or passion about the topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis". People operating in a CoP get opportunities for sharing of ideas, because belonging to a community of practice promotes engagement, encouragement and creativity (Wenger et al., 2002). As indicated above, operation in a CoP necessitates or perpetuates automatic adoption or implementation within the framework of socio-constructivist way of viewing learning. Adoption of socio-constructivist belief stance, require participants to share information and experiences with the members of the group, thus to gain knowledge from those around them in their social environment.

Wenger et al. (2002) do not ascribe the term CoP to one specific group of people. For them, CoP applies to a broad spectrum of groups of people. This term might refer to a gang-group whose members learn how to live in an unfavourable environment. It might also refer to a group of teachers who come together and work collaboratively as a group to address their point of interest.

Shah (2012, p. 1243) supports the way Wenger et al. (2002) describe a CoP and suggested that it is "a key aspect of teacher professional development and a vehicle to increase teacher knowledge". Wenger et al. (2002) and Shah's (2012) assertions concerning description of a

CoP reflect the view of Bandura (1997) that participants operating in a collaborative structure are those sharing similar vision, mission and goals to be achieved. In a CoP, participants share an identity and are associated "by the value they find in learning together" (Wenger et al., 2002, p. 5). Sharing experiences, helping each other and commitment to achievement of the set goals are some of the key components that yield success of a collaborative structure such as a CoP.

A CoP comes into existence as an initiative of a group of compatible, committed individuals, who bring and share their experiences, resources and expertise (Wenger, 2011). He (Wenger) argues that an effective CoP needs to be based on a well-defined structure and they suggested the key elements that are necessary to consider when establishing a CoP:

- Domain: Members of the group create and define their own identity within a point of interest. This shared identity is underpinned with goals and values making the group appear as a unique formation.
- Community: To pursue interests of their domain, members plan and do activities collaboratively as a team (e.g. participants meet and discuss strategies needed to perform their tasks). Such interactions motivate the members of the group to strengthen relationships, learn from each other and share information.
- Practice: All members become active participants in their own domain.

The influence of CoP in promoting both Subject Content Knowledge (SCK) and PCK necessary for teaching encouraged the formation of different forms of collaborative structures in the field of education. In countries such as China, America, South Africa, England, etc., where the concept of CoP proposed by Wenger et al. (2002) have been adopted (and adapted), various forms of school-based and inter-school CoP have been reported (Cheng, 2011; Ono & Ferreira, 2010; Ronfeldt, Farmer, McQueen, & Grissom, 2015). For example, a study conducted by Ono and Ferreira (2010) in South Africa, using the Japanese-Lesson study TPD strategy in the Mpumalanga province, required clustering of schools in a form of CoP. In United States of America (USA), teachers in schools were encouraged to move away from treating teaching as isolated effort and to form CoPs. Policy makers in USA "called for the creation of school-based Professional Learning Communities (PLCs)" to promote opportunities for ongoing collaboration among teachers (Ronfeldt, et.al., 2015, p. 475). The main focus of these teacher-collaborative formations was to promote self-sustained TPD

programmes and encourage development of self-reflective teaching in the field of teacher education (Jaworski, 2008; Ono & Ferreira, 2010; Ronfeldt, et.al. 2015).

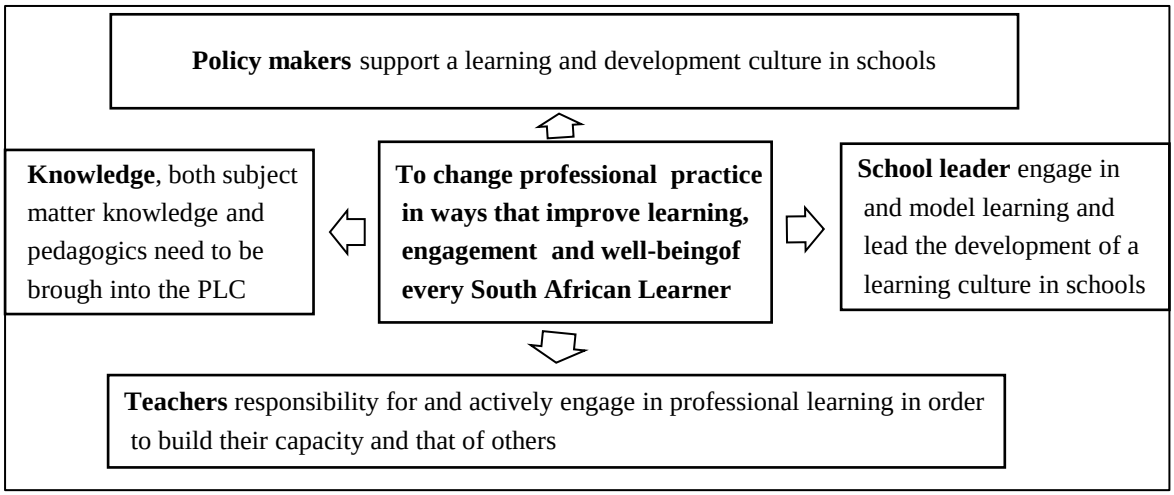
Advocates of CoPs are advised to be aware of several challenges that can be experienced while using a CoP as a TPD strategy. For example, some members of the group may not be open to new ideas and criticisms (Rodger, 2011). The team may depend on the facilitator or coordinator to give directives on what, when and how to act and as such the CoP might not be as independent and sustainable as initially hoped. Collaborative teams are further advised to be proactive and devise strategies to counteract challenges that may emerge (Rodger, 2011).

2.3.3 Professional Learning Communities

As indicated in chapter one, the Professional Learning Community **(**PLC) is a special type of a CoP referring to a group of professionals working cooperatively as a team. This form of a cooperative is not confined to a specific group of identical professionals (from the same profession) as it is the case with a Teacher Collective (TC). The term, PLC can be assigned or referred to any group of professionals who meet regularly, share expertise, and work collaboratively to improve their skills and performance and that of participants put under their care or guidance (Wenger et al., 2002). A PLC is described as an increased opportunity for social interaction that promotes collaboration among colleagues within a similar field of work. Thus, it is often used in schools as a way to organize teachers into a working group (Ronfeldt et al., 2015).

In many cases, education PLCs are established by the DBE and in-service providers, and formalised to become a policy. For example, in South Africa, policymakers and the DBE have called for initialization of school-based PLC. These PLCs are realised as organisational structures. The aim is to promote regular opportunities for teachers to work in collaboration with colleagues (DBE, 2015). Figure 2.1 illustrates how the DBE envisaged connectedness among the key components of PLCs: policy makers, school leaders and teachers. Knowledge of subject matter and PCK is viewed as one of the crucial elements of a PLC. The DBE (2015) recognises the importance of a shared vision for a PLC to be successful and can influence professional practice to change in ways that improve the learning, engagement and well-being of every South African learner.

Figure 2.1: PLC model used by the South Africa DBE



(DBE, 2015, p. 7)

School Management Team (SMT) comprising the school principal, Head of Departments and teacher representatives are tasked as driving force of their own PLC. The SMT is expected to guide the process, encourage active involvement of teachers and create conditions from which their respective PLC can succeed (DBE, 2015). In that process, the District DBE officials and SMTs (who are people in position of power) are expected to identify people who are willing to take up leadership roles and to support PLCs by resource allocation, logistics and timetabling (DBE, 2015).

The top-down approach used by DBE to initiate and decide about the type and delivery mode of the support needed by PLCs is different from the shared leadership advocated by Wenger et al. (2002). According to Wenger et al. (2002), it is a structured CoP based on collective decision making processes and active participation of its members that may reach its intended outcome. PLCs advocated by South African DBE policy gives those in authority more power than the ordinary participating-teachers (DBE, 2015). Such practices tend to create impression that a PLC is another admin driven meeting. Weber (2011) describes dependency on decisions and instructions received from those in positions of power as the main challenge that might result in a dysfunctional state of a PLC.

Both teachers and administrators might make a shift from teaching in isolation to operating as a collaborative team, if a TPD programmes sought to address their needs. For any form of CoP (including PLCs) to be successful, those in position of power need to listen to the voice of the teachers and allow them to have an input in the form and content needed (Fullan & Hargreaves,

1996). Giving outsiders a power to decide for the group might generate a variety of challenges that prevent the PLC from reaching its goals. Participants might resist and show lack of commitment to the activities of the group (Weber, 2011).

In a top-down approach, PLCs are given instructions or tasks to use in their PLC (Weber, 2011). For example, in one district, teachers were required to develop and administer common assessment tasks. The intention was to use the results of the assessment to inform and improve instructional delivery. What leadership fail to understand most, is that teachers lack the experience and expertise to develop reliable and valid assessment task (Weber, 2011). As a result, the collected data were faulty and misleading. The main disadvantage of that situation was poor decisions made based on false results.

(Weber, 2011) describes goals as the foundation of a PLC. Successful teams establish goals and when the team begins to succeed or fail, members return to their goals. Shared goals of the group help the team understand how to communicate their views, how shared decisions will be handled. In situations in which PLC operates without goals, the group lacks a sense of direction. Individual members of the team might tend to put their own needs first. Some teams fail to establish goals because they believe that teaching hard and developing rigorous lessons will support learner achievement and thus be good enough (Weber, 2011). Other teachers had a lack of trust, and they do not wish to share instructional strategies or discuss learner misunderstanding. Establishing a school or district PLC will not mean that a team automatically meets its goals any more.

A successful and effective CoP base their operations on mutual agreements and decision making processes, and have a well-defined structure (Wenger et al., 2002). In an effective PLC, both administrators and participants (who are SMT and teachers in the case school-based PLC) always begin their TPD processes by doing needs analysis (Ronfeldt et al., 2015). In the view of Weber (2011), such an exercise helps to determine in advance internal strengths and weaknesses, as well as its external opportunities and threats open to their envisaged PLC. According to Weber (2011), an atmosphere based on trust might prevail if school and staff readiness, and possible barriers are identified in advance.

Purposeful facilitation methods that are agreed upon and appreciated by the collective should be applied to counteract domination and promote balanced power relations between members

of the PLC and people in position of power (Weber, 2011). For example, facilitation process discussed in a study done by Ronfeldt et al. (2015) is regarded as the key component of the a PLC activities that brought about change. Facilitation practices reported by Ronfeldt et al. (2015) were based on interactive problem solving and support that occurs in the context of a recognised need for improvement and a supportive interpersonal relationship. However, in situations where internal facilitators are used, members of the group may perceive them as biased for or against certain participants or decisions (Weber, 2011). At the same time, members of the group might be reluctant to challenge people in position of power. External facilitators are viewed as likely to use or integrate varied implementation intervention, while performing the needed problem solving and supportive roles (Weber, 2011). The latter might create an atmosphere of neutral and unbiased facilitation. They might bring fresh perspectives to the discussion that would that might promote change.

Wenger et al. (2002) acknowledge emergence of various forms of CoPs. However, they maintained that it is the voluntary, informal form of CoP that has a common domain, goals and takes decisions together that are sustainable. Wenger et al. (2002) categorise a form of CoP formulated external of its participants as teams. For them, the latter survive for a short time compared to a CoP set up by the participants themselves to address their own needs.

2.3.4 Clusters

Unlike a Communities of Practice that are considered as informal endeavours, in which membership is self-selected and participants initiate and organize their own activities (Wenger et al., 2002), in South Africa, Clusters are initiated by external service providers. Clusters in the SA definition and experience are set up by an outsider, who might be either Department of Education (DoE) officials or any other in-service provider for a specific purpose, to perform specific tasks. Wenger et al. (2002) characterise such formations as administration teams, since they are created by external agents to complete a specific task or project within a specific period. Advocates of a cluster type model, illustrates the fundamental reasons for setting up clusters as the need to improve the quality of teaching and learning. In a Cluster model, as used in SA member schools are encouraged to share resources, experience and expertise and facilitate the school administration load of the service provider, which is the DBE in this case (Jita & Mokhele, 2014).

In SA a large-scale TPD Cluster project was initiated by the DBE in conjunction with the Japanese government in the Mpumalanga province (Ono & Ferreira, 2010). The aim was to replace the Cascade model used to introduce the curriculum reform and apply an approach that would have a direct impact on teachers' classroom practices for both Mathematics and Science (Jita & Mokhele, 2014). Application of a cluster approach manifested involvement of different stakeholders such as the DBE subject-advisors and Non-Governmental Service providers, who were responsible for the establishment and functioning of the cluster, cluster leaders and teachers. Subject advisors were viewed as specialists whose responsibility is to facilitate subject-specific support for teachers in schools. The cluster-leaders were nominated by the service provider personnel (who were subject advisors in that case) from participants and they were the ones who were tasked to facilitate cluster meetings. The responsibility of participating teachers was sharing of TPD and classroom experience among members of their respective groups (Jita & Mokhele, 2014).

According to De Lima (cited in Jita & Mokhele, 2014), the effectiveness of the cluster approach is still unclear. Even the Mpumalanga cluster-project initiated and led by the DBE and Japanese government did not appear to the yield achievement of the intended outcomes.

There is a clear distribution of roles and categories in a Cluster model. For example, in the Mpumalanga there were three distinct stakeholders: teachers, leader-teachers and DBE officials. Roles of these stakeholders were distributed according to category. The DBE subject advisors were expected to support establishment and functioning of a cluster, while leader teachers' responsibility was workshop facilitation. Teachers were limited to teach and share classroom experiences. Teacher training sought to develop MKT and did not consider a need for inclusion of workshop-organisation and facilitation skills in their teacher-support strategy. The role of the teachers was to implement workshop ideas in their classroom and share their experiences during cluster-workshops (Jita & Mokhele, 2014).

The South African TPD policy does not allow teacher training during teaching time (Jita & Mokhele, 2014). On the other hand, the application of a Lesson Study requires teachers to meet and observe lessons presented by their colleagues during teaching time. The project started to show signs of instability when the key drivers (subject advisors) of the Mpumalanga project changed their focus to attend to other demands and pressing issues needed their attention. The change of focus of the DBE to accommodate training of the Revised National Curriculum led

to the deterioration of the project (Jita & Mokhele, 2014). Some of the clusters tried to keep the momentum but in the due course, their endeavours failed and became redundant as the DBE prioritised other TPD programmes.

We need to find and promote ongoing sustainable TPD strategies that are based on the needs of the teachers. Such strategies should be based on experiences of the teachers and allow for involvement of the participants (teachers) from the conception of their own TPD. Seemingly, the inability of a Cluster approach to equip teachers with skills necessary to initiate and run their own TPD programmes is paving way for development of the TPD programme that realise the importance of the sense of ownership.

2.3.5 A Teacher Collective as a model for teacher-centred professional development

Unlike a CoP and PLC that apply to a broad spectrum of groups of people (Wenger et al., 2002), a Teacher Collective (TC) is a special form of CoP constituted by a specific group of teaching professionals. A TC is an informal self-directed form of CoP initiated by a group of teachers who share common vision. For Wenger et al. (2002), this formation is self-directed in this sense, members of group direct and administer activities and make their own decision about the well-being of their TC. Membership is voluntary, no one is obliged to join a TC (Wenger et al., 2002). Members of the group craft and commit to the goals of the group and are responsible for their own professional growth and that of their colleagues.

Cheng (2011, p. 33) regards a TC as a crucial factor in TPD. For him, it aids in sustaining professional competency of teachers and in acquiring "professional content knowledge required for implementing the new curriculum". He further describes the main objective of TC, as a TPD strategy that enhances professional growth and cultivates a culture or a spirit of cooperative teaching and learning among teachers. Cheng (2011) understands TC as a management strategy necessary to promote teacher collective learning. This assertion portrays a TC as a tool necessary to facilitate a work-based opportunity for collective learning and knowledge sharing among teachers. Social interaction applied in this form of collaboration supports achievement of the intended outcomes, hence it is viewed as a strategy "by which the members share their values and beliefs during the collective learning process" (Cheng, 2011, p. 33).

Jita and Mokhele (2014) regard the teacher collaboration as one aspect of professional development that requires active participation of role players in building meaningful understanding of Mathematical Knowledge for Teaching (MKT) for themselves. Membership of a collaborative structure such at TC is self-selected and managed by teachers themselves (Jita & Mokhele, 2014). Such a formation is orchestrated and initiated by a group of teachers who might be dissatisfied with their current teaching methods or learners' performance (Shaw, 1992). Teachers tend to look for and form support groups, when they realise that for things to improve there should be a change. Additionally, these teachers might also envision what the change will involve. At this stage, participants in a TC collaboratively visualize actions needed to be taken to change the situation. In a TC, participants engage and collaborate in planning, teaching and reflection (Shúilleabháin, 2013).

Various studies claim that the purpose and functions of a collaborative structure is to enhance knowledge and skills and stimulate inquisitive minds, while taking in consideration contextual factors of its beneficiaries (Doig & Groves, 2011; Jaworski, 2008; Ono & Ferreira, 2010; Ronfeldt et al., 2015). These collaborations (e.g. TC) require the collective to engage in social-interaction practices and in decision making processes, while sharing successes and addressing challenges facing their constituency. Participants identify and prioritise their needs, and schedule their action plans accordingly (Cheng, 2011).

When teachers commit to a change, they tend to take a firm decision to move beyond awareness and take an action that will attempt to eradicate the problem (Shaw, 1992). Teacher participation provides an opportunity to take part in the practices or activities involved, grow into those practices and learn through doing and acting. In this way, teachers could develop the necessary background for broadening their range of choices and for making more informed choices (Bagwandeen & Louw, 1993).

Neither bureaucratic ideologies nor external forces and measures dominate processes and procedures in structures such as TC. Formation and vision of such collaboration is "not created solely by administrators or imposed from the top down" (Cheng, 2011, p. 36). Involvement of departmental officials or external facilitators depends on the discretion of teachers operating in a TC. A vision is generated by members of the group through social interaction, and through challenging and ongoing dialogue. The fundamental of a shared vision among teachers is to sustain an ongoing process that aims to inculcate a sense of commitment, and desire to achieve

recognised goals and a sense of ownership (Cheng, 2011). Participants are viewed as important contributors to the process of exploration and inquiry into effective ways whereby the TC promotes quality teaching. In such collaborations, learning is viewed as a social process, whereby opportunities will be provided for teachers to learn through interaction with their colleagues (Vygotsky, 1978). For example, in a situation where involvement of an external facilitator is required, his or her mandate is limited to guide and monitor progress in addressing problematic areas indicated by the collective (Weber, 2011). Thus, the involvement and contribution of the external facilitator should be guided by the needs of the group.

Ronfeldt, et al. (20015, p. 478) advised that at inception of a TC, participants should not only highlight the "extent to which teachers collaborate about certain topics, but also the degree to which different kinds of collaboration are useful in supporting their practice".

2.4 LESSON STUDY

Lesson study (LS) is viewed as a process that intensifies the interaction of a (school-based) collaborative by developing the habits of self-reflection and critical thinking through interaction with colleagues (Ono & Ferreira, 2010). A LS approach supports teachers' ability to work in collaboration with their colleagues. Instead of offering school-based teacher learning experiences to individual teachers only, the LS approach activates development of collaborative structures that help all teachers in the collaboration to improve their instructions. Ono and Ferreira (2010) view a LS approach as a team-based, teacher-led collaborative way of learning, since teachers employ a wide variety of learning strategies in building meaning for themselves.

In the application of a LS approach, teachers jointly draw up a detailed plan for the lesson, while working cooperatively as a group. Thereafter, one of the teachers will present the planned lesson plan to her or his learners in a real classroom situation. A LS approach involves planning, teaching while being observed by colleagues, and critiquing the lessons. Selection of a central goal related to the challenge teachers want to address provides a focus for the planned lesson (Ono & Ferreira, 2010).

In an attempt to address challenges raised in different South African studies such as Ono and Ferreira (2010); in Prew cited in DBE (2009) regarding a Cascade model used as a TPD strategy

to introduce the curriculum reform, a LS approach was introduced in SA as a joint venture of both Mpumalanga Province Department of Education and Japan International Cooperation Agency (JICA) (Ono & Ferreira, 2010). The Mpumalanga DoE and JICA clustered schools to set up Mpumalanga, Secondary Schools Initiative (MSSI). The aim was to improve teaching of Mathematics, Science and Technology teachers (Jita & Mokhele, 2014; Ono & Ferreira, 2010). Although JICA experienced challenges during the process of implementation of the LS, Jita and Mokhele (2014) reported a success in terms of teachers taking responsibility for their own professional growth.

The use of a LS as an approach necessary to enhance professionalism, instruction is regarded as the key element in the whole process. A LS approach allows instruction to be manipulated and improved through consultation with colleagues. The consultation process requires participants to plan the lesson jointly, trial the planned lesson in the classroom, critique and modify the lesson (Doig & Groves, 2011; Ono & Ferreira, 2010). Both Ono and Ferreira (2010) and Doig and Groves (2011) understand the importance of the process of TPD advocated by a LS approach, but they differ when it comes to its description. For instance, Ono and Ferreira (2010, p. 64) describes the process of TPD used in a LS as a three phase: "plan-do-see". In their description of the LS process, Ono and Ferreira (2010) combine the lesson critiquing and modifying phases as the 'see' phase (that involves both observation and immediate feedback), while Doig and Groves (2011) split the 'see' phase into two separate entities. Both studies conducted by these researchers emphasise the importance of consolidation in the process of TPD, where teachers or participants are inspired to engage in discussion that seek to ratify different aspects of their planning and implementation process, until they reach agreement (Doig & Groves, 2011; Ono & Ferreira, 2010). Then, the final-result of their discussion is documented.

For example, Lewis cited in Doig and Groves (2011) describes the Lesson Study cycle as having four phases and they (Doig and Groves) base the LS process on this view:

- Goal-setting and planning, which includes the development of the Lesson Plan.
- Teaching the planned lesson. This phase enables and allows for lesson observation
- The post-lesson discussion helps to give immediate feedback.
- The resulting solidification of learning.

There is no clear difference between Doig and Grove's (2011) third and fourth phases. Both these phases require participants to engage in post lesson discussion and provide an opportunity for teachers to comment on the impact of the lessons on their understandings about subject matter teaching. The discussion of LS approach presented below is based on the phases identified by Ono and Ferreira (2010, p. 64) namely: "plan-do-see" phases.

Phase 1: Formulating goals, study curriculum, study teaching material and draw up lesson plan.

Consideration of contextual factors, including needs of their learners and anticipated challenges becomes the key aspect of the first phase of LS (Ono & Ferreira, 2010). In this phase, teachers are required to start by setting goals and developing an action plan that includes a schedule of teaching and learning activities that needed to be enacted by the collective (Bocala, 2015; Ono & Ferreira, 2010). Development of an action plan is followed by identification or selection of a topic from the action plan and the study of teaching materials. In this process, study material becomes useful in clarifying unclear points and to confirm and strengthen the Content Knowledge (CK) necessary to teach the topic. Thereafter, a lesson can be planned and distributed to observers, who happen to be fellow participants before teaching. Members of the collaborative are advised and expected to anticipate learners' responses and indicate how they intend to deal with incorrect solutions. This can be achieved only when teachers are aware of their SCK and PCK.

Phase 2: Presenting a lesson, while being observed by other participants.

The second phase of a Lesson Study requires participants to present lessons in their respective classrooms while being observed by members of the collective (Ono & Ferreira, 2010; Doig & Groves, 2011). Before teachers engage with classroom observations, there is a need to sit together as a group and craft principles that will guide individual observation practices to avoid destructive criticism of the instructional skills of the presenters. Observers are cautioned to focus on how learners interact with one another and with the instructional task. Below are some of the principles agreed to by the Mpumalanga project in South Africa:

- First, identify positive aspects of the lesson.
- Comment on the lesson, not the presenter: the lesson instead of the teacher.
- Identify areas to improve with suggestion(s) (Ono & Ferreira, 2010, p. 67).

Among the observers there might be participants (such as, subject advisors, teachers from the school) who are not part of the TC. Hence a pre-observation explanation of the instructional decisions that was made during lesson design is advised. Thereafter, teaching of the observed lesson may commence.

Phase 3: Reflecting on lesson presentation and planning process.

The third phase of requires participants to engage in a post-lesson discussion and reflect on the entire process of implementation. During the post-observation reflection session, observers are expected to give constructive feedback based on their observations (Ono & Ferreira, 2010; Doig & Groves, 2011). Such gatherings are intended to refine and improve future operations and pave a way forward. The group of teachers in the collective then come together to discuss their observations of the lesson. Often, the group revises the lesson, and another teacher implements it in a second classroom, while group members again look on. The group will come together later to discuss and debrief the observed instruction. Finally, the teachers produce a report of what their study lessons have taught them.

Various research studies discuss and critically analyse LS engagements and experiences of teachers operating as a CoP (Bocala, 2015; Doig & Groves, 2011; Jita & Mokhele, 2014; Ono & Ferreira, 2010). Although these studies report success stories of teacher CoP who apply a LS as a TPD approach to promotes quality teaching, they warn that teachers do not quickly change their way of thinking and teaching strategies at the beginning of a lesson study experience, or exposure. Instead, they start as novices and gradually, gain momentum and understanding when natured in a meaningful and convincing manner.

The success of a LS approach is realised when members of a CoP play an active role and take charge of their own professional development. TPD programmes adhering to the LS theoretical position automatically assume a constructivist perspective that acknowledges social actions taken by participants in the development of their knowledge, within their own CoP (Doig & Grove, 2011). Thus, a LS is regarded as a vehicle necessary to strengthen teacher-communities (Doig & Groves, 2011; Ono & Ferreira, 2010). Advocates of a LS approach, view teaching as a public activity, that opens for teachers' classroom performances to a collective analysis and comments (Doig & Groves, 2011).

For a LS to be meaningful and meet its intended outcome, participants need to identify specific subject content within the selected subject that should serve as a focal point of their TPD activity. Identification of a learning area automatically leads the collective to a detailed study and understanding of the curriculum, PCK and SCK for the purpose of improving instructional practices in their classrooms (Doig & Groves, 2011). Time spent by a collective studying the subject matter enable greater insights to the topics. Teachers' reflections help teachers to think and document their own learning.

2.5 MATHEMATICAL KNOWLEDGE FOR TEACHING (MKT)

A revised version of Shulman's (1986) view of PCK, as per Ball et al. (2008) and Hill et al. (2008) serves as fundamental theory that should underpin teaching and learning of Mathematics. For instance, Shulman's (1986) interest in teacher education was triggered by the focus of studies used to inform the content of TPD programmes. These studies focused their investigations on general pedagogical knowledge which tries to explain "how teachers manage their classrooms, organise activities, plan lessons and judge general student understanding". Subsequently, in an elaboration of existing conceptions of teacher competency, Shulman puts emphasis on the importance of content knowledge in teacher education. He differentiates "among three categories of knowledge: (a) subject matter content knowledge, (b) pedagogical content knowledge, and (c) curriculum knowledge" (1986, p. 9). In his view, pedagogical content knowledge is a combination of content and pedagogical knowledge. Hence, he conceptualised knowledge needed by subject-content specialist to promote effective teaching as the PCK (Shulman, 1986).

The notion of PCK introduced by Shulman's (1986) attracted numerous discussions and reconceptualization and served as the basis for many studies in education. Shulman's initial understanding and description of PCK was reviewed and unpacked further by different researchers (Ball et al., 2008; Hill et al., 2008; Lannin et al., 2013) who further elaborated on Shulman's version of PCK. As an example of these adaptations, Marks, (cited in Lannin, et al., 2013) identified four categories in conceptualisation of PCK: knowledge of student understanding, knowledge of subject matter for instructional purposes, knowledge of media for instruction, and knowledge of instructional processes. On the other hand, An, Kulm, and Wu (2004) and Hill et al. (2008) identified three categories, namely: knowledge of content, knowledge of curriculum and knowledge of teaching. Meanwhile, a study conducted by Lannin

et al. (2013) reveals the dissatisfaction demonstrated by Marks (1990) with Shulman's (1986) view of PCK. Marks (1990) felt that Shulman's view or explanation may not trigger strong connection to the actual teaching and learning. He then identified categories of PCK as the: knowledge of students understanding; knowledge of subject matter for instruction; knowledge media for instruction and knowledge of instructional process.

In critical analysis of Shulman's view of PCK, Hill et al. (2008) noticed that Shulman's explanation of PCK does not provide a clear distinction between PCK and other forms of teaching knowledge. In their refinement of Shulman's conception of PCK, they came up with the notion of "Mathematical Knowledge for Teaching (MKT)" to define the Mathematics that teachers need to know (Ball et al., 2008). Figure 2.2 helps to explore the relationship between teachers' knowledge, their instruction, and student learning (Ball et al., 2008). In this sense teachers need to be in a position to identify educational problems, select and devise plans and strategies for "their resolutions, adopt new attitudes, knowledge and skills required to carry out those strategies and choose and design appropriate means of acquiring them" (Bagwandeen & Louw 1993, p. 31). Exposure to different world views (beliefs) about teaching may involve a change of how teachers believe children learn (Bagwandeen & Louw 1993).

Development of the Subject Content Knowledge (SCK) is viewed as an important aspect of learning, but how to teach it is of great value as well. Hence the Mathematical Knowledge for Teaching (MKT) is central to development of SCK. (Ball et al., 2008). To promote development of meaningful understanding and application of MKT, Ball et al. (2008, p. 394) conducted a study that sought to investigate the "use of knowledge in and for teaching rather than on teachers themselves". For (Ball et al., 2008) to find answers for their study, they had to first rework the study conducted by Shulman (1986).

Ball et al. (2008) broadly describe teaching as everything a teacher needs to do to support learning in their classrooms. In their view, teaching demands understanding of the school curriculum. It also involves guiding and showing learners how to solve problems, being able to answer questions by learners and check their work. They further describe teaching as the interactive work of teaching lessons in the classrooms and all the tasks that arise in the course of that work. "But we also mean planning for those classwork to parents, making and managing homework, attending to concerns for enquiry" (Ball et al., 2008, p. 395).

Ball et al. (2008) and Hill et al. (2008) found the notion of MKT useful to create more opportunities for teachers to learn how "to carry out the work of teaching Mathematics" by further dividing the concept of MKT into two categories for it to be more manageable and understandable (See figure 2.2). To identify and analyse other aspects of the work of teaching and to analyse the demands of the content of teaching, Ball et al. (2008) and Hill et al. (2008) decided to categorise and explain their concept of MKT further. The two categories were: PCK, comprising knowledge of content and students (KCS), knowledge of content and teaching (KCT) and knowledge of curriculum, while the second was subject matter knowledge (SMK), comprising common content knowledge (CCK), knowledge at the mathematical horizon and specialised content knowledge (SCK).

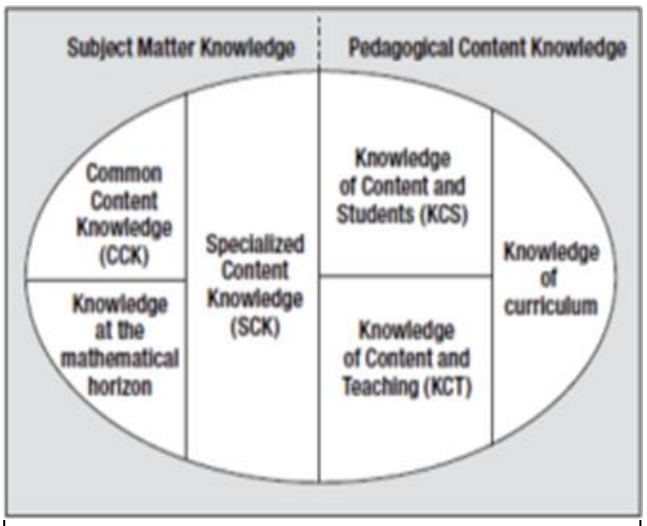


Figure 2.2 Domains of mathematical knowledge for teaching (Hill et al., 2008, p. 377)

In an analysis of the different types of knowledge that a Mathematics teacher needs, it becomes evident that teaching requires a specialised kind "of pure subject matter knowledge" (Ball et al. 2008, p. 396). For example, both Ball et al. (2008) and Hill et al. (2008) assert that specialised subject matter knowledge (for Mathematics) cannot be mingled into various categories of PCK, as it purely deals with the knowledge of Mathematics. Their studies illustrate that specialised knowledge in Mathematics "is not needed or used in a setting other than in Mathematics teaching" (Ball et al. 2008, p. 396).

In finer analysis of MKT, Ball et al. (2008), reformulated and divided content knowledge in to two categories: CCK and SCK, and PCK into KCS, KCT. For example, they defined:

- **Common Content Knowledge (CCK)** as the (mathematical) knowledge and skill used in settings other than teaching. It is not unique to teaching. CCK is not specialised understandings.
- **Specialised Content Knowledge (SCK)** is regarded as the knowledge and skill unique and need to be acquired to perform the continual tasks of teaching a particular subject.

- **Knowledge at the Mathematical Horizon** is an awareness of how mathematical topics are related over the span of Mathematics included in the curriculum. Being aware of mathematical horizon helps teachers to prepare and lay a firm foundation for later years of schooling. For example, it is important for teachers in the early grade to know how Mathematics they teach is related to the Mathematics learnt in the higher grades.
- **Knowledge of Content and Students (KCS)** is knowledge that combines knowing about students and knowing about Mathematics. When assigning a task to learners, teachers need to anticipate what learners may do in solving the problem and be in a position.
- **Knowledge of Content and Teaching (KCT**) includes knowing about teaching and knowing about Mathematics. The task of teaching Mathematics requires a mathematical knowledge of the design of instruction. Teachers are expected to sequence content for instruction in a manner that will help learners gradually gain meaningful understanding of Mathematics.
- **Knowledge of Curriculum** provides a scope or way of knowing what learners have experienced in schools and sets a common basis on which to build additional learning.

(Ball et al. 2008)

MKT is viewed as an important aspect of Mathematics teaching (Ball et al. 2008). Their analysis of teacher's practice revealed substantial mathematical demands of teaching. Ball et al. (2008, p. 396) assert that a need for the "knowledge for teaching must be detailed in ways unnecessary for everyday functioning". Ball and her colleagues implies that a Mathematics teacher needs to know more and different mathematics than an ordinary person. Mathematics teachers need an understanding and analysis of learner strategies that lead to both correct and incorrect answers in mathematical problems. Ball et al. (2008) assert that to spot incorrect answer does not require a special knowledge, but to identify the origin of and the reasons that led to the incorrect answer does require specialist knowledge. According to Ball et al. (2008, p. 397), "skilful teaching requires being able to seize up the source of a mathematical problem". As indicated by Doig and Groves (2010), participation in a LS collaborative planning of a lesson provide opportunities for teachers to study subject matter, analyse errors and understand thinking of their individual learners. Error analysis, explaining the procedure and establishing a proof should be the common practice of a Mathematics teacher (Ball et al. 2008).

Competency is viewed as the key aspect of MKT and PCK necessary for Mathematics teaching (Ball et al. 2008). Thus, subject matter knowledge is crucial, for a teacher to be in a position to analyse errors, establish proofs for solutions and explain procedures efficiently and effectively. Hence, a LS approach discussed in paragraph 2.3 of this chapter is deemed appropriate (TPD strategy) to expose participants to a detailed study and understanding of the subject matter. It was therefore important for this study to investigate one aspect of Mathematics content (number sense) which was identified as of the areas of the National Mathematics curriculum that set a challenge in teaching grade three learners.

2.6 NUMBER SENSE DEVELOPMENT

This section strives to set a context for the examination of the effect of a TC as a TPD approach to promote MKT based on teachers' perceptions of the concept of number sense development. Various studies reported on the effect of expectations and perceptions of teachers regarding to SCK and PCK. For example, when, and if teachers are treating numbers as disembodied entities and where Mathematics is perceived as a fixed body of knowledge involving numbers, learners tend to be exposed to rules and application of those rules (Griffin, 2004).

On the other hand, teachers who define Mathematics as a set of conceptual relationships between quantities and numerical symbols (Griffin, 2004), focus their teaching and learning on meaningful conceptual understanding. Then, learning is not about application of rules and finding the correct answer. Instead, emphasis is on construction and discovery of relationships between quantities and numbers and the examine ways to describe and record these relationships (Griffin, 2004). It appears to be of great value for this study to interrogate and understand the nature of practice, these grade three teachers need to know about Mathematics to be successful with their learners in the classroom (Ball et al, 2008).

The view of Naudé, Meier, and Bosman (2014, p. 3) confirm the findings of a study conducted by Wynn cited in Griffin (2004), that humans are born with the ability to be numerate. For these researchers, human beings are born with the ability to represent number in various ways and perform simple calculations. As children grow older their natural quantitative competences expand and they acquire language. Their ability to count using language develops. They experience a revolution in thought to compare quantities and start counting without needing

physical objects to make a variety of quantity judgement (Griffin, 2004). Teachers should gain more insights on MKT needed to promote meaningful mathematical understanding.

Number sense develops gradually and over time resulting from an exploration of numbers, visualizing numbers in a variety of contexts, and relating to numbers in different ways. In the view of Griffin (2004) the concept number sense refers to a well organised conceptual framework of number information that enables a person to understand numbers and number relationships and to solve mathematical problems that are not bound by traditional algorithms. There are five components that characterise number sense: number meaning, number relationships, number magnitude, operations involving numbers and referents for numbers and quantities. These skills are considered important because they contribute to general intuitions about numbers and lay the foundation for more advanced skills. Naudé et al. (2014) uphold that number sense development is linked with skills observed in learner's proficient in the following mathematical activities:

- mental calculation
- computational estimation
- judging the relative magnitude of numbers
- recognising part-whole relationships and place value concepts
- problem solving

Number sense development requires the construction of a rich set of relationships among the actual quantities that exist in space and time; the counting numbers in the spoken language; and formal symbols, such as written numerals and operation signs introduced by Griffin (2004). For example, to promote understanding of the concept of a number, learners should be exposed to a range of numerical strategies and concepts in conjunctions with the ability to use these skills in different ways in different contexts. Learners learn best when they work cooperatively and develop understanding through using prior experience, discourse, and reasoning, in a learner-centred, negotiated, and active mathematical environment (Naudé et al., 2014). This teaching process is necessary for constructing knowledge and solving problems.

As indicated at the start of this chapter, South African reformed-curriculum introduced the Curriculum and Assessment Policy Statements (CAPS) in 2010 to show SCK and sets of time frames for completion of work. Although CAPS does not explicitly equate the act of counting to understanding of numbers, counting is presented as the starting point of developing number

sense (Naudé et al., 2014). Counting is presented as an important mathematical skill necessary to enhance problem solving throughout the FP (CAPS, 2010). Counting skills develop, during early years of schooling lay a firm foundation for calculations (Naudé et al., 2014). Teachers are advised to focus on developing conceptual understanding, strategic competencies (application), reasoning, and calculating skills for the learners to understand and apply the four basic operation. Unlike the CAPS document that specifies timeframes and predetermine skills and concepts, Naudé et al. (2014) suggest that this responsibility of determining the how and where the skills and concepts should be dealt with rest with teachers.

An effective teacher should have the solid background knowledge of FP Mathematics and the good teaching skills necessary to promote and assist learner performance. The FP teacher are encouraged to realise her/himself as the facilitator of learning, not transmitter, of knowledge (Powell & Kalina, 2009). One of the responsibilities of a FP teacher is to motivate learners to actively examine and extend their thinking, shape a conversational environment in which learners share and construct their own knowledge. They are also expected to design lessons that enable learners to learn by doing (Naudé et al., 2014). The classrooms should maximise students' learning.

2.7 ERROR ANALYSIS

In mathematics, error analysis is the study of kind and quantity of error, or uncertainty, that may be present in the solution to a problem. Sarwadi and Shahrill (2014) describe an error as a concept of deviation from what is appropriate answer or correct. For instance, if a learner does not have meaningful understanding of the mathematical concepts, it is natural they will be committing errors in performing the operations. Thus, the errors made by learners are realised as a result of misunderstanding of the concepts (Sarwadi & Shahrill, 2014). Analysis of learner errors is viewed as a process which involves critical evaluation of learner's solution for remediation. Hence, Sarwadi and Shahrill (2014) saw a necessity for application an analytical approach, which seeks to identify the specific elements in learning ability that need remedial action. "Diagnostic tests help to locate the areas of difficulties of the learner and are administered to locate the specific weakness in the skill or knowledge that are causing trouble and difficulties in learning" (Sarwadi & Shahrill, 2014, p. 2). Unless the type of weakness is found and the source of error in known, it is difficult to correct it and prevent return of the error. (Ball et al., 2008).

2.8 CONCLUSION

This chapter examined a selection of published literature on issues related to various models of TPD. The importance of the nature of TPD strategy employed in empowerment of teachers is emphasised. In-service providers are advised to listen to the voice of teachers and structure their TPD programmes in a way that is in compliance with the needs of the teachers.

There is an emerging tendency to conceptualise TPD in ways that present a significant move from the traditional once-off workshops for teachers using a Cascade model. Researchers are now increasingly interpreting and promote ongoing collaborative models of teacher support as potentially balanced TPD strategies (Jita & Mokhele, 2014). Willingness to change, learn and work in collaboration with colleagues, and commitment are noted in the same chapter as the crucial elements of a TC to be successful. Teachers are portrayed as lifelong learners, who have a potential to take charge of their professional growth. However, for this to become a reality, teachers first need to be aware of and believe in the benefits of working cooperatively as a group.

The next chapter will elaborate on methodology used in this study to determine the viability of a TC as a TPD strategy to improve quality teaching of Mathematics at FP.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

As stated in chapter one, this study seeks to examine and reveal the influence of a professional development strategy referred to as a Teacher Collective (TC) on the development of mathematical knowledge for teaching (MKT) in the Foundation Phase (FP). The study seeks to elicit the teachers' perceptions and experiences of a TC in which they are operating. In setting up the research design, careful consideration was therefore given to each aspect of the research methodology that could lead to the achievement of the intended aim of the study. Thus

this chapter describes the research design and specific methodology employed, and their application.

Various methodological considerations realised as being relevant for this study are presented and discussed in different sections of this chapter. The purpose of section 3.2 below is to discuss the research methodology and rational for its use, followed by the presentation of different paradigms and reasons for choosing the interpretive paradigm as the most suitable one for this study, in section 3.3. Relevance of qualitative approach to this study is presented in section 3.4, followed with the discussion of a case-study method and selection of the case, or sample of the study, in section 3.5. In addition, factors related to the data collection process and discussion that shows how data were analysed are presented in sections 3.6 and 3.7. Ethical considerations of the research and its potential limitations are provided in the last section of this chapter.

3.2 THE RESEARCH METHODOLOGY AND RATIONAL FOR ITS USE

According to Lichtman (2010) a type of question that a researcher seeks to address determines the research methodology and paradigm needed for a particular study. Lichtman's assertion had a great influence in shaping the methodological framework of my study. For instance, most of the research questions items used in this study are open-ended rather than closed-response items that sought to retrieve information from the participants (Lichtman, 2010). Hence, I found it appropriate to locate my study in the social interpretive paradigm of qualitative research approach (Hartas, 2010).

A research methodology implies more than simply the methods used to collect data (Cohen et al., 2007; Creswell, 2013). According to these scholars, it refers to how and why a researcher selects a strategic approach to gather information and carry out research. For this study, identification of a research methodology guided the selection and identification of methods, principles and rules needed in a study (Creswell, 2013). The selection of suitable research methods led to the identification of techniques and procedures needed to unveil perceptions that led to informed decision making (Creswell, 2013).

As I sought to examine and gain participants' perceptions regarding their self-supporting structure, realised as a Teacher Collective (TC), the interpretive paradigm seemed to be the suitable choice to achieve the aims of the study.

3.3 DIFFERENT PARADIGMS

In research, a paradigm is perceived as a system of interrelated views adhered to and patterns of thinking that underpin actions of a (specific) group of scholars (Lichtman, 2010). Scholars, such as De Vos, Delport, Fouché, and Strydom (2011, p. 513) describe a research paradigm as a "model or patterns containing a set of legitimated assumptions and a design for collecting and interpreting data" (De Vos et al., 2011, p. 513). To create a better understanding and illustrate the rational for adopting an interpretive paradigm as suitable for this study, this section starts with the overview of three main research paradigms namely, interpretive, positivist and critical paradigms.

3.3.1 Interpretive Paradigm

In striving to maintain alignment between my research question and research methodology adopted in this study, I decided to locate this study in a research paradigm that is characterised by a concern for individuals. Application of interpretive paradigm paved way for an exploration of the Teacher Collective (TC) strategy (discussed in detail in chapter two) from the perspective of the participants.

Unlike the positivists-oriented researchers, who base their studies and findings on experimental and objective responses, and critical theorists who believe in reality constructed and inclusive of equity issues, the interpretive paradigm seeks to understand subjective perceptions of individuals (Creswell, 2013). Interpretive researchers interact dialogically with the participants when attempting to uncover their beliefs and to understand the meanings of their actions and intentions (Creswell, 2013). Interpretivist accepts the inseparable bond between values and facts and attempt to understand reality, especially the behaviour of people, within a social context (De Vos et al., 2011).

According to De Vos et al. (2011) proponents of interpretive paradigm share the same goal as those of the constructivist approach, in understanding the complex world of lived experience from the point of view of those who live it (De Vos et al., 2011). In this sense, both proponents of interpretive and constructivism advocate for understanding meaning constructed by social actors through complex processes of social interaction involving language and action (Cohen et al., 2007). For these scholars, to understand the world of meaning of others, one must interpret it. Such a view provided more value for situating this study within the interpretive

paradigm, as I was interested in understanding the experience through interacting with participants and interpreting their actions and perceptions by concentrating on the qualities of their behaviour (Creswell, 2013). To achieve that, the beliefs and values upheld by teachers participating in a TC were investigated by means of descriptive measures. Such engagement facilitated data capturing in the words of the participants**.**

Situating the study within the interpretive paradigm, gave me an opportunity to interact with participants in their own context (Cantrell, 1993). The influence of the TC as an approach to promote MKT at FP was investigated in a real context. Such interactions helped me to gain insights and report unfolding interactions, human relationships and other factors in a unique instance (Creswell, 2013). Application of interviews focused my investigation on processes by which meanings were created, negotiated, sustained and modified within a real context of human action (Creswell, 2013). Contrary to positivism that insists on studying a large number of cases, my study explored perceptions of a small group of grade three teachers regarding their teacher collective.

3.3.2 Positivist Paradigm

Positivists believe that the reality is independent of personal experience (Cohen et al., 2007; Creswell, 2013). For them reality is out there and they hold that reality is constituted by observable, measurable and quantifiable facts that can only be observed objectively. For these scholars (Cohen et al., 2007; Creswell, 2013), the major concern of positivism paradigm is to establish relationships and to test theories. Scholars ascribing to the positivist point of view exercise control of variables as much as possible, and applies precise sampling techniques. Researchers operating within positivist framework adopts a neutral stance in the process of revealing the truth (De Vos et al., 2011). Findings are generalised to comparable situations.

3.3.3 Critical Research Paradigm

Contrary to positivist research which adopts a quantitative approach, both interpretive and critical research paradigms tend to be more qualitative in nature. In critical and interpretive research, the relationship between the researcher and the participants is essential (De Vos et al., 2011). For critical theory, the interaction between the researcher and the participants encourages empowerment of the participants and the researcher is viewed as the social activist. In the critical research paradigm there is a higher degree of subjectivity, while positivists

"believe that an objective reality exists outside of personal experience" (De Vos et al., 2011, p. 6).

According to De Vos et al. (2011) proponents of critical research seek to affect social change and not to create knowledge for the sake of knowledge. Some of the responsibilities of a researcher operating within this view therefore, are to bring social change and raise the participants' awareness of injustices and inequalities of the society. Unlike in interpretivist view, a researcher operating in critical research paradigm "seeks not just to study and understand society, but rather to critique and change society" (Lichtman, 2010, p. 9). Advocates of critical research seeks to promote democracy by making changes in different social problems or issues involving beliefs and systems. A critical research paradigm mainly deals with problems related to oppression and inequalities in a society that attempts to liberate both an individuals and affected group to gain power and have freedom from the different barriers such as: social, political, economic discrimination existing in the society.

The discussion in paragraph 3.3.1, 3.3.2 and 3.3.3 clarifies the research theoretical stance taken by this study. The qualitative nature and the aim of the current study are clarified and contrasted with both positivist and critical research paradigms. Those discussions asserted the aim of the study as the key determent of the suitable research paradigm for location. This study seeks to understand perceptions of a small group of research participants, while operating in their own context as a Teacher Collective (TC). As a result, this study is located in the interpretive research paradigm.

3.4 QUALITATIVE APPROACH

Paragraph 3.3 above discusses and contrasts the three main research paradigm. The discussion of these three paradigms was imperative as it provide a rational for situating the study in the interpretive paradigm. For instance, this study did not intend to construct findings that were arrived at by means of statistical procedures or other means of quantification (Drew et al., 2008). Instead, research methods adopted in this study are based on the view of Hartas (2010, p. 44) that "reality is understood through human activity". Hartas (2010, p. 44) further describes qualitative research as "a way of knowing in which a researcher gathers, organizes, and interprets information obtained from humans using his or her own eyes and ears as filters" as it always involves interviews of individuals in a natural and social environment.

In the view of Creswell, (2013), a qualitative approach does not limit a researcher to the understanding of issues raised through research question only. Situating this study in a qualitative paradigm, enabled me to have a direct contact helped to observe and take note of body language which revealed issues such as social and emotional state of the participants (Creswell, 2013). Situating this study in qualitative approach, did not limit me to use predetermined information from the literature or rely on results from other research findings (Creswell, 2013). I interacted with the participants in their own classrooms, in the township situated in a large South African Metropolitan, during their Lesson Study (LS) sessions.

Qualitative methods allow for flexibility and adaptation of the interaction between the participants and the researcher by using mostly open-ended questions rather than closed questions (Creswell, 2013). Thus, the relationship between the researcher and the participants is viewed as less formal in qualitative than in quantitative research (Creswell, 2013). Application of qualitative methods provides participants opportunities to elaborate and respond in greater detail than it is the case with quantitative methods (Creswell, 2013). It also allows for immediate response (on the part of the researcher) to what participants say by rephrasing or asking subsequent questions as a follow up (seeking clarity) to information participants have provided.

For Creswell (2013) it is through talking with the participants that a researcher is able to gain an understanding of the successes and challenges facing them, (the participants) in their own setting. To achieve this, a Lesson Study approach was applied where participants planned lessons together, observed each other's presentations, reflected on their lesson presentations with the intention to identify successes, challenges and strategies for improvement. Creswell (2013, p. 49) believes that "to undertake a qualitative research requires a strong commitment to study a problem and its demands of time and resources". Taking into consideration the view of Creswell (2013), as a qualitative researcher, I decided to dedicate most of the time doing field work: collecting data. I also conducted two three-hour mentorship workshops, as per participants' request. I spent one hour during the first mentorship workshop explaining the concept of a Lesson Study. The next two, hours required active involvement of the participants, in crafting the goals of their TC and decided about their action plan. They also selected a Mathematics topic that they wanted to plan (for teaching) together as TC. Towards the end of the first mentorship workshop participants were requested to study the curriculum statements,

find and bring relevant references (including textbooks) to the next session. We (I and the participants) agreed and selected one of the participants to facilitate the second workshop together with me. The following workshops wore conducted by the participants themselves and I attended those workshops as an observer.

My interest was to be ready for the time-consuming process of data analysis. Such a process required me to sort large chunks of data, while trying to identify and reduce them into manageable themes.

3.5 A CASE STUDY

A case study is one technique employed by a researcher to examine the characteristics of an individual unit. Typical of interpretive methodology, the case study is a small, information rich sample study (Cantrell, 1993). He (Cantrell) claims that the case study's appropriateness when a researcher is interested in detailed information specific to the particular object of study and the particular context. He further makes known its inappropriateness when a researcher finds information that is easily generalizable to a larger population or other context.

This qualitative study aimed to generate an in-depth description and understanding of a single group. A study of this nature necessitates a case-study design that is typically used to understand a situation by engaging in scholarly research questions (Creswell, 2013). Thus, my research design could be described as a single case study focusing on a group of teachers operating in a TC. Application of a case study design in this qualitative study provided for in-depth study of a complex educational issue in context. Application of a case study method provided me an opportunity to discern on-going behaviour as it occurred so as to make appropriate notes about silent features (Cohen at. al, 2007) of a collaborative structure used by a community of mathematics teachers for their own professional development purposes. Thus, use of this technique helped me to investigate and analyse intensively various aspects that constitutes the life cycle of one of the TC. As a result, this study is classified as a case study, since the TC is viewed as a bounded system (Creswell, 2013).

Cohen et al. (2007) illustrates the characteristics of a case as its possession of identifiable boundaries and therefore understands a case as having a structure in terms of the participants, locality and the activities. A case study design is applied when the researcher wants to focus

on one instance of a particular entity or event at a specific time in order to understand its complexity as well as to generate informative insights (Creswell, 2013; Yin, 2014). Creswell (2013) further clarifies the status of the case studies as units of investigation that can comprise a group, or individual, or event, etc. operating in a social setting.

The case study method provided me an opportunity to detect and capture perceptions of the participants operating in a collaborative structure for their own professional development purposes.

3.6 SAMPLING

In the view of De Vos et al. (2011) the aim of qualitative sampling approaches is to draw a representative sample from the population of the study, so that the results of studying the sample can be generalised back to its population. In contrary, Creswell (2013) and Lichtman (2010) make known that the selection of appropriate sampling method depends upon the aim of the study. As a result, the nature and purpose of my study presented in chapter one allowed for the application of one of the sample selection strategies suggested by Lichtman (2010) discussed below.

3.6.1 Selection of the case

Selection of a case in this study is based on the three types of cases identified by Lichtman, namely: "the typical, the exemplary or model and the unusual or unique" (2010, p. 82). Lichtman further portrays 'typical' type as the most popular method used to select a case, as it is a representative of a bigger group. Such a case is "typical of others in the same set". The exemplary method tends "to study the best or most outstanding" element of the case "in a specific area or system" (Lichtman, 2010, p. 82). In the view of Lichtman, an unusual or unique method of selection of a case is not recommended for a qualitative research. The latter is a "representative of all cases of a particular type" (Lichtman, 2010, p. 83) as it results in massive amounts of data that would be impossible or very difficult to analyse using qualitative data analysis methods. Researchers using an unusual method of selection are usually "thinking about making generalisation to other cases" (Lichtman, 2010, p. 83), whereas that is not the case in qualitative research.

I found an exemplary selection method as most suitable for this study, as I viewed the participants in this study as exceptional amongst their colleagues. When they were dissatisfied with the influence of their own classroom practices on learner performances, they decided to work collaboratively as a team. Later, when their collaborative efforts could not manifest the expected outcomes, they themselves vowed to leave their comfort zone and ask for external support. As such, to bridge the gap identified by the grade three teachers between the requirements of their national curriculum and the pedagogical content knowledge needed in teaching of Mathematics, participants were introduced to a LS strategy described as three phases that were collectively referred to as 'plan-do-see' in terms of Ono and Ferreira (2010).

3.6.2 Type of Sampling and purpose

In qualitative research, sampling occurs subsequent to establishing the circumstances of the study clearly. The stance of Patton in De Vos et al. (2011) gave more value to my opinion regarding participants in my study. Patton maintains that there are rules for the population size in qualitative inquiry. When unpacking those rules, he indicated that population "size depends on what we want to know, the purpose of the inquiry, what is at stake, what will be useful, what will be credibility, and what can be done with the available time and resources" (De Vos et al., 2011, p. 391).

As I indicated in chapter one, the participants of the current study comprise a group of five grade three teachers coming from two Port Elizabeth township schools. These participants initiated a collaborative structure. When their collaborative structure threatened to collapse, participants were resilient enough and approached me (the researcher in this study) to support their TC. It was for that reason that I saw it appropriate for me to examine the influence of their TC in characteristics that were of interest in my study. For instance, they demonstrated willingness to work cooperatively as a group and to improve the quality of teaching Mathematics at FP level. Then, I used purposeful sampling strategy to select participants to this study thinking that they could purposefully inform me about the research problem under examination (Creswell, 2013). Issues related to convenience such as geographical access; distance from my place of work; commitment and financial resources were also determining factors that influenced the selection of the participants. The schools where the above group of teachers comes from are situated at about 40km from my workplace.

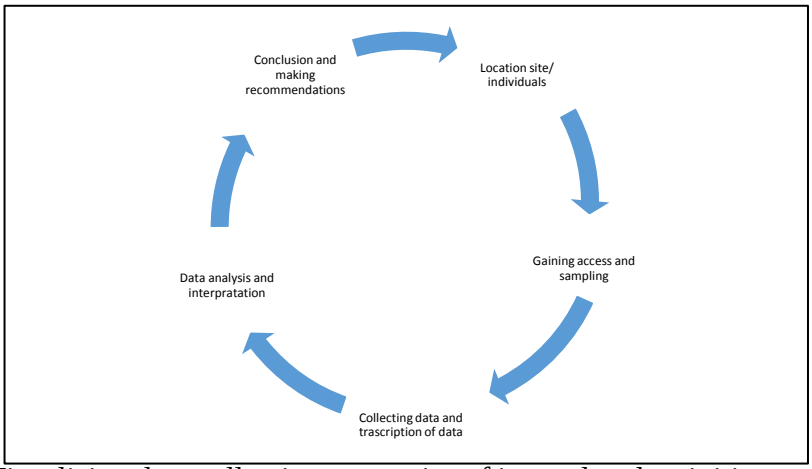
Participants in this study are black, female, isiXhosa speaking teachers. Five of the participants were in the 31 - 40 year-age category. The fifth participant was 55 years old. One of the five participants had taught FP for 30 years. The teaching experience of the remaining four participants was between 7 and 16 years. All the participants in this study had solely experienced teaching in 'black' township schools.

3.7 DATA COLLECTION

For Creswell (2013), the purpose of data collection process is to gather and capture data in a format that is appropriate for the research task and analysis that will follow. The latter description affirms a qualitative research as an engaging exercise that requires active participation of the researcher. It is for this reason, other than solely undertaking the role of an investigator, that a researcher turns to be a research instrument as well (De Vos et al., 2011).

Data collection is defined as a series of interrelated activities intended to collect information to answer the research question (Creswell, 2013). The descriptive input is signalled the key to answering the research question (Creswell, 2013; De Vos et al., 2011). Thus, accurate data capturing is essential for accurate findings and conclusions to be made. To manage the process of data gathering and analysis well, I decided to adapt and use Creswell's (2013) data collection cycle in figure 3.1 to illustrate activities and processes that I used. Adoption of the data collection cycle helped me to handle the process of data collection, data analysis and report writing simultaneously in this study.

Figure 3.1: Data Collection Activities.



(Creswell, 2013)

Visualising data collection as a series of interrelated activities was aimed at collecting data that would help to answer the research question (Creswell, 2013). For instance, after determining a strategy for the purposeful sampling of participants, gaining access to various sites (as

discussed below), I made decision about the most appropriate data collection and analysis strategies needed for this study. The aim was to collect data and reduce the data into themes through the process of coding, so as to be able to find answer to the research question (Creswell, 2013).

Considering Creswell's (2013) opinion regarding data collection in qualitative research, I adopted the inductive process that enabled me to gathering data without preconceived notions, from which themes and categories emerge. Application of Creswell's idea of inductive process enabled me to work back and forth between the themes and the transcripts until I establish a comprehensive set of themes.

3.7.1 Getting Ready for Data Collection: Negotiating Access into Research Sites

Having received a request from the participants to guide their MKT development while operating as a collaborative, I decided to formalise my intervention by following proper processes of getting access to and permission to conduct my study. For example, my next task was to seek access to the research sites and clarify the nature of involvement and commitment required in determination of the influence of the TC in promoting development of MKT. Research sites can be described or classified either as public or private areas, with considerable differences and implications on how they can be accessed (Drew et al., 2008). Public domains are easily accessible, because there is no formal permission required to carry out research in public domains. Whereas, it is more difficult to access private domains, due to the presence of gatekeepers whose responsibility is to control access to such domains. For example, irrespective of whether schools are private or public entities, they fall under private domains when it comes to research. Gatekeepers are those people who by virtue of their positions of authority in an organisation make decisions regarding access into their respective institutions (Drew et al., 2008). For a researcher to gain access to a private institution or organisation for research purposes, he or she is expected to seek and be granted permission at various levels (Drew et al., 2008).

In my case, permission needed to be sought from different gatekeepers, or stakeholders, since this study required active participation of teachers in order to address its main research question. I requested, and I was granted a permission by the University Research Committee (see appendix B), the director of Department of Education district office (see appendices A),

principals (see appendix D) to access the potential participants in schools. Permission granted by the principals, did not give access to the potential participants. I was ethically obliged to seek and get informed consent (see appendix C) from the potential teachers to participate in the research from individual participants (Check & Schutt, 2012). Finally, a meeting with prospective participants that clarified data collection processes and instruments discussed below was arranged.

3.7.2 Data Collection Methods: Interviews

The research interview can be defined as (a two or more person) interpersonal conversation initiated either by the interviewer or interviewee, (depending on context) for the specific purpose of obtaining research relevant information (Cohen et al., 2007). These scholars acknowledge that a research interview is not always a two-person conversation, as there are times where the researcher may need to interview a group depending on the purpose of his/her research. Furthermore, they stated that the researcher does not always initiate the interview (Cohen et al., 2007). Some of the interview techniques such as a non-directive interview allow the participant to initiate the interview. In that situation the participant ends having greater control (Cohen et al., 2007).

Cantrell described the interview as a data collection instrument that makes possible for the researcher to gather descriptive data in the participant's own words and enables "the researcher to gain insights into how the participants interpret and make meaning of the world" (Cantrell, 1993). Similarly to Cantrell (1993), Cohen et al. (2007) perceive interviews as the potential means of pure information transfer that enable multisensory channels to be used in various forms, like verbal and non-verbal. However, Cohen et al. (2007) provide a number of factors on which gathering of data that has direct bearing on the research objectives depends:

- The researcher needs to have access to the perceptions of the participants.
- Competence of the researcher
- The type of interview.

The type of interview identified as the suitable tool to examine perceptions of the participants regarding the influence of their collaborative on Mathematics teaching was semi-structured group interviews. This type of interview allowed, and encouraged, sharing and discussion of issues of common interest that emerge among the participants (Check & Schutt, 2012). For,

instance, I used semi-structured interviews to investigate the first and the second sub-questions of this research. Later, I conducted the same semi-structured interview (to find answers from the third and the fourth sub-questions) to elucidate views of the individual participants regarding their collective support structure, as well as the influence of their TC in promoting quality MKT. The individual interviews searched for clarity of issues noted from the previous stage (semi-structured group interviews) of data collection.

Application of semi-structured (group) interview led to identification of specific areas of interest and questions (as indicated below in 3.7.2.1 and 3.7.2.2) to be pursued. As Check and Schutt (2012) suggest this type of interviews allowed for flexible adjustment of items and formats to suit the developing logic of the interview. It also made it possible for me (researcher) to gain insights of specific issues relevant to the study through posing more prompts to probe unexpected responses (Cohen et al., 2007). Although Cohen et al. (2007) describe this type of interview as one of the research instruments that yield useful information, they advise researchers to acquaint themselves with its limitations (Cohen et al., 2007). For example, some members of the group might dominate discussion, a researcher should encourage all members of the group to take part in the discussion and avoid dominance whereby one member of the group dominated the discussion.

The semi-structured interview schedule used open-ended interview items, to create opportunity for participants to express and fully elaborate on their points of view. To expand on this view, Creswell (2013) asserts that open-ended interview items allow the participants to express their views, ideas and come up with suggestions that might address question posed to them. Closed interview items were not popular in my study, as they tend to limit the researcher to focus or ask the scheduled questions only. However, closed questions were used to a limited extent, particularly for collecting demographic information in the early stages of interview.

In trying to explore the main research question, I translated the research objectives into sub-questions that informed the interview schedule (Cohen et al., 2007). The interview schedule used a wide range of question formats. For example, categorical response mode that offered several possible answers was used. Participants were required to select a suitable response from each category and give reasons for their selection.

3.7.2.1 Semi-structured (group) interviews to explore 1st and 2nd research sub-questions

Semi-structured group interviews made it possible for me to gather information from participants with similar interests and who were willing to work cooperatively with each other. The semi-structured interview schedule was prepared and divided into two parts. The first part contained items that sought to elicit responses on demographics and perceptions and opinions of the participants related to different aspects of a TC before enacting a LS exercise. The interview items that sought to examine the perception of the group were derived from the first and second research sub-questions of this study provided below:

- What are the initial perceptions of a group of grade three teachers regarding the functioning of their Teacher Collective as a professional development approach?
- What Mathematical Knowledge for Teaching with respect to number sense did a group of grade three teachers possess before engaging in a Lesson Study approach (seen as a Teacher Collective exercise in this study)?

Some of the items used at the first part of the semi-structured interview schedule were extracted and adapted from Ronfeldt et al. (2015). This category required participants to share their views pertaining to the goals, functions or management of their teacher collective and indicate the extent to which they agree or disagree with the items below, such as:

a. Share with us the goals of the teacher collective that you initiated as a group of grade three teachers.
b. Indicate to what extent do you agree or disagree with the following items and give reasons (For more details, see appendix E)

The interview items presented in the second part of the semi-structured interview schedule sought to understand capabilities and to identify barriers preventing affecting effectiveness of Mathematics teaching. To draw more information from participants, items that permitted for prompts and granted a freedom to modify the sequence, change wording, explain and add to gain greater depth of the situation when necessary, were included (Cohen et al., 2007). Some of the items used in part two of the semi-structured interview schedule were items adapted from Ball and Hill's (2008). A sample of those items is given below:

a. Imagine that you are working with your class on multiplying two-digit by two-digit number. Among your learners' papers, you notice that some their work in the following ways:

Table 3.1: Multiplication – learner solution strategies (Ball & Hill, 2008)

Student A	Student B	Student C
26	26	26
x 13	x 13	x 13
78	78	18
+ 26	+ 260	60
= 338	= 338	60
		+ 200
		= 338

b. Which of the above students would you judge to be using a method that could be used to multiply any two whole numbers? Why do you think so?

Table 3.2: Identification of appropriate multiplication solution strategy

(Ball & Hill, 2008)	Method would work for all whole numbers.	Method would work for all whole numbers.	I'm not sure.
Method A.	1	2	3
Method B	1	2	3
Method C.	1	2	3

Administration of semi-structured interview provided an opportunity to gain insights of the participant's initial perceptions of their TC.

3.7.2.2 Semi-structured (individual) interviews to explore 3rd and 4th research sub-questions

Cohen et al. (2007, p. 269) affirm that to gather data that has "direct bearing on the research objectives," the researcher needs to have access to the perceptions of the participants. The same interview schedule used during the group interviews was applied again during individual interviews. The second-round interviews sought to examine perceptions of individual participants of their TC activities in strengthening collaboration and in enhancement of MKT after participation in a Lesson Study exercise. The aim was to find answers to the following research sub-questions:

- What are the perceptions of individuals within a group of grade three teachers regarding the functioning of their Teacher Collective after exposure to a Lesson Study approach?
- What Mathematical Knowledge for Teaching did the individuals within a group of grade three teachers possess after engaging in a Lesson Study approach (a teacher collective exercise)?

3.7.2.3 Personal Journals

Each participant was required and agreed to keep a record of their journey or experiences while operating in a collective to document their TC experiences. They (participants) were required to describe their TC experience. Their written entries required summaries of what was learnt and the actions that participants would take to be more effective in the future. Future actions were to be based on the experience reported in concrete experience and linked to the theories and concepts discussed in planning session. They were expected to explain how they foresee their action plans being carried out (Farrell, 2013).

Participants were required to bring their personal journal to each of the four tree-hour contacts session and share their personal experiences with members of the group. Regrettably, it was evident from the very first session that cultural effects are playing role, whereby word of mouth or oral was the main way of sending message through to others (or reflection). The writing exercise that required documentation of their respective experiences seemed to be a great challenge to this group. Participants were more comfortable in sharing their experiences orally and even demonstrate what happened in the classroom, during contact sessions. To address that challenge, participants resolved to spend the first ten minutes of each contact session sharing and discussing classroom-based experiences orally (as a group). Time was provided to write up their experience.

3.8 DATA ANALYSIS

In qualitative research, data analysis consists of examining, categorizing and testing gathered evidence to address the purpose of a study (Lichtman, 2010). Creswell (2013) further expresses research analysis as a strategy that involves breaking of data into manageable themes. In general, data analysis means a search for patterns and identification of emerging themes in data. The process of data analysis necessitates all recordings carried out during data collection stage be transcribed. In the view of Cohen et al. (2007) ability to answer or address a research question adequately, depends on accurately data processing. If a researcher fails to do that, the efforts and time spent in generating large amounts of data and interview transcripts would count for nothing. The ultimate goal of data analysis in qualitative research is to uncover patterns, determine meanings and construct conclusions (Lichtman, 2010).

In the process of converting information from raw data to meaningful themes, I applied the view of Lichtman (2010) of the three Cs of analysis. Her data analysis strategy requires the researcher to move from "Coding to Categorising to Concepts" Lichtman, (2010, p. 197). It was also important for me to note that Lichtman (2010) uses the terms 'concepts and themes' interchangeable. Hence, the third C of the three Cs resulted in identification of themes. I also considered the suggestion of De Vos, et al. (2011) that researchers need to:

- Read transcripts carefully to get a clear picture
- Pick a transcript randomly to read and note some points, as a starting point
- Read the transcript more than once, while marking relevant meaningful units
- Relate the units of meaning to the sub-categories and major-categories (themes).

Coding is a process of organising and sorting data. In linking data collection and interpretation, coding becomes the basis for developing the analysis. Lichtman (2010) describes codes as a mechanism used by a researcher to label, compile and organise data. It is the process of coding that grants a researcher an opportunity to summarise and synthesize what is happening in his or her data. According to Creswell, (2013), coding can be done in any number of ways, but it usually involves assigning a word or phrase to each coding category.

Analysis of data formed an ongoing integral part of the investigation process in this research. The process started with a thorough description and coding of the data that led to emergence of categories which are recommended as important steps in the process of analysing the data (Creswell, 2013). Coding of data led to emergence of categories which led to identification of themes. This enabled me to organise and examine data into themes.

Semi-structured interviews were analysed by means of open coding, an approach that allowed for analysis of data in terms of trends, which emerged as the data were repeatedly reviewed. The use of an open-coding approach allowed for categorisation of trends in a coherent manner (Lichtman, 2010). Application of the open-coded system in analysis of data serves as a guide that highlights important aspects of data needed to be considered. That led to elimination of less important information, selection of important information and continuous verification of results or interpretation in the process of data analysis. For example, analysis of data gathered from the first round of the interviews helped to understand challenges facing the participants in implementation of their TC and informed the development of the Lesson Study activities.

3.9 ETHICS IN QUALITATIVE RESEARCH

Ethics in research is an important consideration and should be taken seriously. Ethics are described as a cornerstone for conducting effective and meaningful research (Drew et al., 2008, p. 56). Thus, researchers are encouraged to always take ethics to consideration into their studies and be cautious in their interaction with the participants by safeguarding maltreatment and destruction. For example, some of the ethical considerations might be related to the health threatening situations that participants were exposed to during data collection process, or might be the result of misrepresentation of published data (Creswell, 2013).

During the initial stage of the project, I joined one of the meetings of the TC to introduce and negotiate their involvement in the research project. An observable uneasiness was noticed amongst participants at the initial stage of our discussion. Such observation or reaction encouraged me to take the view of Creswell (2013) into account that application of ethical considerations need to be taken into account and applied at initial stages of the study. Creswell (2013) warns against potential clashes regarding the right to privacy of the participants and the desire of the researcher to obtain their contact details for the purpose of study. Hence, my obligation was to ensure that I adhered to the following ethical principles and guidelines:

- Informed and voluntary consent:

  Safety of the participants was always taken into account during the course of the investigation by being sensitive and respect their privacy and dignity. The integrity of the institutions (schools) within which the research occurred was maintained (Drew et.al. 2008). This implies that issues of informed and voluntary consent, confidentiality and participants' ability to evaluate information received attention, thus to make informed decisions based on their evaluation were highly considered.

- Privacy and confidentiality
  - The pseudo names/codes to identify the participants, such as T1, T2, T3, T4 and T5
  - Because I used interviews to collect the data their identity was known only to me (except in the group interview).
  - During reporting no names were mentioned
- Risks and benefits
  - Ethical clearance form illustrated the benefits of the study and assured participants that there were no health threatening situations, and no defamation of character.

To gain trust and raise awareness of the participants, I made them aware of the ethical principles that were applied. I read the English version of the consent form and interpreted each section of the form in the participants' home language (which is isiXhosa). After getting permission to proceed on with my research, the involvement of the participating group in the research was a function of informed consent. As suggested in Cohen et al. (2007) and Creswell (2013), participants were made aware of the fact that:

- Participants might withdraw at any stage of the research, if so desired.
- Participants would have an access of data such as interview transcripts.
- Confidentiality of the participants, schools and their TC would be maintained.
- Participant might not complete or respond to particular items if they feel uncomfortable.

Thereafter, participants started to respond to my questions and participated freely in the discussions. Clarification of ethical issues helped to preserve the confidence and the dignity of the participants, as the consent of the participants to their involvement in a study was also critical. It is advisable for a researcher to obtain ethical clearance in accordance with policies of institutions concerned before embarking on study (Creswell, 2013). Based on that, I fully informed the participants about the purpose of the study before their participation. Respect was illustrated as the key for guaranteed willingness and motivation for sharing and staying on agreed upon responsibilities up to the end of the study. A sense of worth and dignity of the participants was maintained right through the study. Thus, idea of avoiding manipulation of participants so as to achieve their aims and that of acting objectively remained the underlying principle of this study (Creswell, 2013).

3.10 MEASURES TO ENSURE TRUSTWORHINESS OF THE FINDINGS

A need to present a balanced report of the views of the participants while operating in their natural setting necessitated application of strategies that sought to promote trustworthy of the findings. To establish trustworthiness of the findings, I had to obtain the inside perspective on how the participants feel and on the unfolding of events in their setting as suggested in Creswell (2013). In this study, the endeavour was to present a fair account of the impact of information as stated by the participants and to inspire fairness in terms of conveying the perceptions of the participants. To achieve that various strategies needed to promote trustworthy and validity of the findings were applied.

Consideration of the aspect of trustworthiness helped to raise my concern about the accuracy of the overall conclusion drawn from the study in terms of the data collection instruments, data collected, findings and explanations. The aim was to limit the bias or prejudice on my part as a researcher. Thus, it was always important for me to ensure that information collected reflected accurate picture of the claims and descriptions of the participants. Furthermore, trustworthiness encompassed the relationship of accuracy concerning the responses of the participants and the reality the participants' perspectives.

To obtain inside information on how the participants feel and on the unfolding events in their natural setting, fairness in terms of conveying the perceptions of the participants was always the key focus of my study as suggested in Creswell (2013). Accordingly, the concept of authenticity was always considered, while striving to present a balanced report of the views of the participants. My aim was to verify and present a fair interpretation of information gathered to reflect the views of the participants.

To reduce the effects of bias when coding data and to support trustworthiness for my study, participants were required to review transcripts and preliminary findings of the study. Furthermore, I sought to be transparent in revealing unforeseen barriers that presented in the research process, supporting the credibility of the research findings. I gave the raw data and the transcripts to my colleague to review the consistency and integrity of the data. That review supported the identified themes and confirmed accuracy of findings. For example, the study was conducted in isi*Xhosa* (the first language of participating teachers) and English (the first additional language of the participants). That encouraged responses to be given in a combination of English and isi*Xhosa*. As a result, after transcription of responses, respondents were requested to go through them and check, if the transcription was a reflection of their original responses. In instances where participants responded to the interviews in their home language (which is isiXhosa in this case), I translated or converted their responses into English. To ensure trustworthy of my translation, isiXhosa language specialist (my colleague) was requested to check if English version (translation) was the true reflection of participants' original responses. Then, my colleague confirmed that the raw data were accurately represented under the core ideas and categories.

According to De Vos et al. (2011) there are certain aspects of trustworthiness that a qualitative researcher should take into consideration, such as, truth value, neutrality, credibility, applicability etc. (Creswell, 2013). Some of the aspects of trustworthiness (that are suitable for quantitative research) such as applicability were not considered as they were not applicable for this qualitative research. In my study credibility was sought in different ways, namely: participants check, supervisor of my study debriefing and discussion sessions, and review of raw data and transcripts by one of my colleagues. Additionally, trustworthiness was increased by a thorough description of source data.

Neutrality is viewed as the degree to which the results are a function solely of the informants and conditions of the research and not of other motivations, and views. Information gathered should reflect the main issue being investigated. Thus, findings should signify, as far as possible the specific situation being investigated as opposed to the beliefs, or biases of the researcher (Creswell, 2013). It is according to the perspective that the integrity of results is based on the data and that the investigator must properly tie together the data, and findings in a manner that the reader is in a position to confirm the adequacy of the findings.

3.11 CONCLUSION

This chapter took the reader through the issues related to methodological procedures that were utilised in an attempt to find answer to the research question. The chapter started with highlighting the need to develop an effective plan for the investigation of the identified problem. In the chapter different research paradigms are contrasted with the aim of justifying application of interpretive paradigm and qualitative approach as the suitable methodological aspects for this research.

As part of the methodological plan, a case-study method, semi-structured group and individual interviews, and personal journals were adopted as the primary modes of data collection. For data analysis and coding, the concepts of the three Cs suggested by Lichtman (2010) was explored. Finally, the chapter concluded with a discussion of ethical matters and adherence of this research to such was discussed. Findings of information collected from participants are presented and discussed in chapter four.

CHAPTER 4

PRESENTATION AND DISCUSSION OF FINDINGS

4.1 INTRODUCTION

In the previous chapter the methodology guiding the development of this research was presented. The methodological choices made and the justification for those choices was stated. To close the chapter, the ethical considerations, adhere to in this study were explained.

In this chapter the aim is to present the analysis and interpretation of the data gathered during fieldwork. As stated in chapters one and three, the data presented in this chapter were collected through semi-structured (group and individual) interviews and personal journals from a group of five grade three teachers. The interview schedule comprised questions and statements that sought to initiate and guide discussion of a Teacher Collective (TC) experience (Appendix E). Each question or statement was followed up with prompts to pursue additional information to seek clarification of responses. I start the discussion by presenting a table which guides the reader on how the themes and sub-themes link to the questions posed in chapter one and chapter three. In addition, the table is meant to illustrate how the findings are presented in this chapter.

4.2 DISCUSSION AND PRESENTATION OF FINDINGS

As stated in 4.1 above, the intention of including this table is to clarify the process of reporting the findings.

Table 4.1: Format of chapter 4

Sub-Research Question	Themes and sub-themes
Part one sought to understand participants' perceptions about Teacher Collective and Lesson Study	
Part 1: Group interviews What are the initial perceptions of a group of grade three teachers regarding the functioning of their Teacher Collective as a professional development approach?	• Challenges experienced by teachers while using a Cluster approach • Collaboration within a Teacher Collective • Tools and frequency of engagement
Part 1: Individual interviews What are the perceptions of individuals within a group of grade three teachers regarding the functioning of their Teacher Collective after exposure to a Lesson Study approach?	• The goals of a Teacher Collective as expressed by the individual participants to professional development. • Benefits of the teacher collective from a Lesson Study experience a. Lesson Planning b. Lesson Presentation c. Lesson Observation and reflection within the Teacher Collective • Tools and frequency of engagement between teacher
Part two sought to understand participants' Mathematical Knowledge for Teaching with regard to number sense and error analysis	
Part 2: Group interviews What Mathematical Knowledge for Teaching with respect to number sense did a group of grade three teachers possess before engaging in a Lesson Study approach (seen as a Teacher Collective exercise in this study)?	• Selected aspects of participants' Mathematical Knowledge and Teaching (Specialised Content Knowledge and Knowledge of Content and Teaching) demonstrated during analysis of learner solutions before LS experience
Part 2: Individual interviews What Mathematical Knowledge for Teaching did the individuals within a group of grade three teachers possess after engaging in a Lesson Study approach (a teacher collective exercise)?	• Participants' MKT (SCK and KCT) demonstrated during analysis of learner solutions after LS experience.
Personal Journals	• Personal experiences of a TC

As highlighted in the table 4.1, the discussion below is done in two parts:

- Part one sought to understand participants' perceptions about Teacher Collective and Lesson Study.
- Part two sought to understand participants' Mathematical Knowledge for Teaching.

Semi-structured **group** interviews were administered before application of a Lesson Study (LS) approach to strengthen the TC, and to ascertain participants Mathematical Knowledge for Teaching (MKT). Later while participants were engaged in LS, semi-structured **individual** interviews were administered. Both group and individual interviews were administered in the afternoon of the teaching day to avoid disruption of the daily-school (tuition) timetable. Each semi-structured interview was divided into two sections which were administered on two-successive afternoons. On the first afternoon, I administered the first part of the interview schedule comprised items that sought to elicit perceptions of the group regarding the functioning of the TC. Section B of the interview schedule that contained the items based on MKT was administered on the second afternoon (Appendix E).

4.2.1 PRESENTATION OF THE FINDINGS FROM SEMI-STRUCTIURED GROUP INTERVIEWS OF PART ONE

Part one of the semi-structured group interviews sought to address the first research sub-questions outlined in chapter one namely:

- What are the initial perceptions of the group of grade three teachers of a Teacher Collective-Lesson Study exercise?

Prompt items were generated from the research sub-research questions to either get clarity of responses or elicit more information from the group. Analysis of data collected while examining initial perceptions of the participants of a TC before engagement in a LS approach realised as TC exercise led to identification of themes and sub-themes discussed below.

4.2.1.1 Challenges experienced by teachers while using the traditional Cluster approach

The interview items of part one of the semi-structured interviews sought to generate data that would reveal functioning of a TC as a professional development strategy that sought to promote quality Mathematics teaching at FP level. Participants did not respond directly to the items that sought to understand the goals of their current collaborative structure (known as a TC). Instead, they shared experiences of their previous collaboration, known as a Cluster approach referred to as a form of Community of Practice (CoP) in chapter two.

According to the participants, before setting up their TC, they were operating as a cluster that was formed by the Department of Basic Education (DBE) subject advisor, similarly as

indicated in chapter two. Their cluster comprised Foundation Phase teachers from nearby schools. To illustrated the decision making processes of their cluster, T3 said,

> *Participation and engagement in the clusters project set up by the DBE was not voluntary but obligatory. Inflexible way of setting up DBE cluster gave the subject advisor power to decide about the demarcation of schools for our cluster, programme of action needed, the content and duration of the TPD programme put together for our cluster of schools.*

Decision making processes were not democratic. The DBE subject advisor appointed a cluster coordinator and decided about her role. The role of a coordinator was to notify members about the dates of the cluster workshops and be the chairperson of the cluster meetings. DBE subject advisors were the sole facilitators of learning in the process.

In the same way as in the Mpumalanga-TPD programme discussed in chapter two, the cluster-TPD programme described by the participants was initiated by the external agent, which is DBE subject advisor (Jita & Mokhele, 2014; Ono & Ferreira, 2010). The DBE subject advisor was responsible for the establishment, and identified one of the participants as a cluster leader (Jita & Mokhele, 2014). Functioning of the Cluster was the responsibility of the Cluster coordinator, who was a novice just as her colleagues. In a cluster approach, the role of the participants is always determined by the outsider. For instance, the role of the participants (in the current study) was to discuss their classroom experiences: challenges and successes. Wenger et al. (2002) characterise formations that are created by external agents for a specific task and that are not based on the needs of the participants, as teams.

Signs of instability reported in a study conducted by Jita and Mokhele (2014) were detected in the Cluster programme described by the participants. Some of those signs were reported as the failure to base the Cluster programmes on the needs of the participants and the absence of a key driver, which was the DBE subject advisor in that case resulted in a lack of commitment and dissatisfaction of the participants. Bagwandeen and Louw (1993) advocates for TPD programmes that are based on the needs of the participants and allow for the involvement of the participants from its conception. They warn against application of TPD programmes that are not based on the needs of the participants. It was noted that situations that do not provide for transfer of skills that might motivate a novice teacher to be responsible for their own professional growth, mostly result in unevenness of power relations and dissatisfaction

(Weber, 2011). The teacher would always be on the receiving end while those in authority remain sources of knowledge.

Having said this one participant described her experience of the cluster with satisfaction that "c*luster workshops were conducted mainly by the subject advisors"* (T3). But others experienced the cluster as a pseudo experience of collaboration. It was more of a top-down administrative approach. "*Transfer of skills that sought to motivate and empower a novice teacher to be responsible for their own professional growth was not an option"* (T1).

Participants noted poor attendance at the cluster meetings as one of the contributing factors that led to a failure of their Cluster. For example, T1 said *"the attendance was always a problem. As a result, the cluster did not last long. Meanwhile, challenges in Mathematics teaching and poor learner attainment persisted"*. Participants continued to cite more challenges with the cluster such as, their inability to cover all aspects of the curriculum within a specified period, planning of lessons that would promote effective teaching and learning, and selection and use of teaching and learning support material to promote quality teaching and learning. The participants appeared to have ideas of how to address the challenges they faced. For example, T4 said, *"we tried to address these challenges by forming a group of grade three teachers in our school to support each other"*. They also indicated that they were later joined by two grade-three teachers from a nearby-school. This suggests a natural indication towards a more informal collaboration rather that the top down approach.

4.2.1.2 Collaboration within a Teacher Collective

Apart from the group expectations and goals of the TC, it was important for me to understand participants' perceptions regarding their collaboration. My interest was to gather information that would help me to understand how they took charge to ensure the effective functioning of their collective. In the view of the participants, each and every member should honour and take the decisions of the collective serious. For example, T1 said "*we are here at our own will. That means, each and every member of the group should make sure that this support group achieve its goal"*. Instead of spelling out the goals of their teacher collective they started to describe processes and strategies based on the reasons for conceptualisation of their TC as voiced by T4 in the extract below:

> *We know what we wanted to achieve: is to improve our learner performance in Mathematics, they cannot continue to fail or always be on the borderline of ANA [*Annual National Assessment*]. We want better results, but are unable to meet the demands of the curriculum, due to poor performance of our learners.*

In a study conducted by Weber (2011), the research findings highlighted goals as the foundation of any collaborative structure. Clearly articulated the goals work as an indication of whether the organisation is successful or not. In the view of Weber (2011), goals help participants to look back as to whether they are achieving or not achieving their intended goals. Contrary to these findings by Weber (2011), I detected from the responses provided by the participants that they never thought of setting up the goals of their TC, instead they continuously emphasised the importance of hard work and commitment.

Conversation with the group of teachers revealed their firm belief that working collaboratively was still their chosen option to address the challenges they faced in teaching grade three Mathematics. However, the findings showed that their existing TC had shortcomings, for example, it lacked structure as there was no action plan in place and as a result the group was to an extent functioning ineffectively. The group felt that the cluster approach used by the DBE was not an option because of its top-down approach to teacher development. To address the shortcomings of the group's existing TC, we (I together with the participants) went through the survey questions about collaboration in instructional teams used in Ronfeldt et al. (2015). After a discussion the group identified from the survey questions used by Ronfeldt et al. (2015), items or activities that could be adapted and used in their TC and their frequency.

Participants were required to indicate the extent to which they agreed or disagreed with ideas gathered from Ronfeldt et al. (2015) indicated in table 4.2. They were expected to give reasons for their answers as well. For that task, individual members of the group were requested to first read and provide answers. Thereafter they were required to discuss their responses as a group and give reasons for their answers. The main idea behind this was to stimulate discussion that might help the group reach common decisions about the nature of support and activities deemed necessary for their TC to achieve its goals.

Table 4.2: Responses about effective functioning of a Teacher Collective

	Suggested activities and goals	Extent of Agreement/ Disagreement	Reasons provided by the group/participants
a)	Formulation of goals	Agree	Goals would guide progress and productivity of the TC.
b)	Develop lesson plans and teaching strategies and study curriculum and teaching material	Strongly Agree	They agreed to: • Plan lessons jointly as a TC. • Study curriculum and a wide range of teaching material to broaden their understanding and widen their scope and be able to select activities that might help to gain more insights about the topic.
c)	Visit each other's classroom to observe lesson presentation	Not Sure	• The group had conflicting views. Learners cannot be left un-attended. They opted for school-based classroom visits. They indicate a need for involvement of their own school principal and request for teacher-aids or parent-volunteers to take care of learners during lesson observations.
d)	Reflect on lesson presentation and planning process	Strongly Agree	They agreed to: • Form school-based teams - prepare tasks based on joint lesson for their learners and teach. • Bring a sample of learners' work to TC session. • Reflect on the whole process starting from planning, and suitability of resources and teaching methods.
e)	Reviewing learners' classroom work		
f)	Address classroom management issues	Agree	• Big classes were illustrated as a challenge. They needed strategies that would promote active involvement learning.
g)	Nominating coordinators	Agree	• School-based coordinator to ease communication between school-based teams.

(Ronfeldt et al., 2015)

The exercise presented in table 4.2 served as needs analysis that guided the development of a framework for TC activities. As indicated in Ronfeldt et al. (2015), participants were inspired to think and decide about the goals, type of support and activities needed to promote effectiveness of their TC. When participants were invited to share their views regarding the proposed engagements indicated in table 4.2, one participant figured out the essence of the exercise and expressed her feelings as follows:

> *You know what ladies, now I am becoming excited. I am gaining a sense of direction. Most of the activities presented here promise to be very helpful for our Teacher Collective. Now, I have an idea, if we agree on these activities, we can easily develop an action plan for our Teacher Collective.* (T3)

Some members of the group did not understand T3's point of view and started to cite challenges that might prevail. For example, T5 asked,

> *Why do you think we can do all activities indicated in this paper? Remember, we are not supposed to leave learners unattended, meaning that classroom observation is out. Even, nomination of a coordinator is not an option for me. Did you forget about the cluster coordinator that failed us*?

Comments and questions posed by T3 and T5 challenged the group to think and determine internal strengths, weaknesses, external opportunities and threats open to their envisaged teacher support group, in advance (Weber, 2011). The group discussions motivated the development of professional competency that led to the setting of goals, planning of lessons and selection of suitable instructional strategies and teaching material together (Wenger et al., 2002). Such discussions promised to earn the TC a relaxed working condition built on mutual-agreement and trust. This observation links with Weber's view on the value of discussions in promoting mutual understanding amongst members of a group. At the end, possible solutions to counteract identified challenges were brainstormed.

According to Wenger, a decision-making process based on inclusive participation is crucial in the life of a collaborative TPD programme (Wenger et al., 2002). The value of a collective decision-making process became evident while the participants engaged in a discussion that required them to agree on necessary engagements (i.e. actions, activities and arrangements). After a lengthy discussion of each item presented in table 4.2, participants agreed on a general framework by identifying key aspects needed to strengthen their collaboration, namely;

a) collective formulation of goals,
b) study curriculum and teaching material, lesson plans and instructional strategies,
c) visit each other's classroom to observe lesson presentation,
d) reflection on the whole process and review of learner's work,
e) classroom management issues
f) nominating coordinators

The discussion that illustrates the views of the group, during the decision making-making process are presented below.

a) Collective formulation of goals

Participants supported the view of devising collective goals that would serve as a measuring tool to measure the effectiveness of their TC. T2 was captured saying, "…. *deciding about the goals of our TC as a group will promote the spirit of togetherness. We can check our achievements against the goals of a TC"*. T1 supported T2 by adding the following statement "*of course, goals will guide the activities of our TC, because we will work towards achievement of our goals*". These opinions exemplified the view indicated by Bandura (1997) in paragraph 2.2.1 in chapter 2 who described participants operating in a collaborative structure as those who have a similar vision, mission and goals to be achieved. Similarly to Bandura (1997), Weber believes that shared goals might serve as an indicator on how shared decision could be handled (2011). In the latter author's view formulation of goals is the fundamental aspect of any successful cooperation (Weber, 2011): It brings members together for a common cause.

b) Study curriculum and teaching material, lesson plans and instructional strategies

Engagement in an exercise that required identification of activities helped participants to find value in planning together. For them, collective planning of lessons gave 'life' to the functioning of their TC. A need for the members of the TC to familiarise themselves with the requirements of the curriculum was viewed as the fundamental aspect of their collaboration. They considered this as potentially leading to quality Mathematics teaching. For example, one of the participants said:

> *If we know what Mathematics content needs to be covered in grade three, it will be easy for us to select relevant resources that will provide finer details of the content. That will also help us to decide about suitable teaching and learning strategies that we will need to enhance our learner performances*. (T1)

The participants shared similar concerns about strategies and processes needed to promote quality Mathematics teaching in their classrooms. For example, T2 described a need to study the curriculum together, select suitable teaching and learning support material, and instructional strategies as "*steps towards development of effective lesson plans*" (T2). To assert a need for collaborative activities, T3 said "*interactions with each other on ongoing basis will enhance our own MKT*". In the view of Bandura (1997) participation similar to the one described above could be associated with the value participants found in working together.

Participants' operation in a TC might provide opportunities for sharing of ideas, because belonging to a community of practice promotes engagement and creativity (Wenger et al., 2002).

c) Visit each other's classroom to observe lesson presentation

Participants were in favour of classroom observation by peers. However, T2 raised an undisputable concern pertaining to the views of her school principal, *"in our school, we are not allowed to leave learners un-attended, during teaching time"*. The same concern that school principals require teachers to be in the classroom all the time was raised by all participants. Seeing that teachers were not allowed to attend TPD sessions during normal school hours, T4 made a suggestion in a form of a question, "*how about doing school-based lesson observations and request our respective school principal to find teacher-aids or parent-volunteers to take charge of our classrooms for the duration of the lesson presentation*"? Participants unanimously agreed to inform their respective principals about the challenge that would prevent learning from their colleagues in a real classroom situation. The idea of using teacher-aids or parent-volunteers as teacher-replacements for the duration of lesson observation was raised and agreed upon by the participants. The Department of Basic Education policy does not create space for caregivers, parents, etc. This was thinking 'outside the box' for those teachers in their TC.

The resilience and the innovative spirit demonstrated by these participants verified the belief of Cheng (2011). He (Cheng) advocates for TC thinking that is based on authenticity and innovative way of the participants' decision. He supports the idea of teachers taking charge of their own professional growth and that of their colleagues by being creative at overcoming hurdles to this practice. In this view, for a TC to be successful, neither bureaucratic ideologies nor external forces should influence their decisions or derail creative solution to challenges (Cheng, 2011). In this case, it was the participants themselves who decided about their future social-interactions regarding classroom visits. As indicated in the literature, classroom or lesson observation is viewed as one of the important components of a LS approach as it allows participants to engage in a post-lesson presentation, and reflect in the whole process (Doig & Groves, 2011; Ono & Ferreira, 2010).

d) Reflection on the Lesson Study process and review of learner's work

Participants viewed the reflection process and review of learners' work as one strategy that would enable both presenters and observers of lessons to reflect on the teaching and learning processes. Just as Ono and Ferreira (2010) suggested, T3 said "*classroom observation will help to see the impact of our teaching on learners and plan for future*". They agreed to reflect on the whole process starting from planning, effectiveness and suitability of resources and teaching methods. School-based teams and review of learners' classroom work was described as the best way to replace cross-school visits (for lesson observation), as participants would not be able to visit and observe presentations of planned lessons across schools. Finally, school-based teams were tasked to observe and reflect on the lesson presented by one of their colleagues. Those reflections were to be presented by each school-based team, at the next TC session. In the view of the participants, such engagement would allow sharing of their classroom experiences.

e) Classroom management issues

The issue of large number of learners, ranging between 40 and 60 (with an average of 46) learners in one class was raised as the challenge that did not have an immediate solution. One of the participants explained the challenge as, "*I have 61 learners in my grade three classroom. Desks are arranged in rows. I find it difficult to apply cooperative learning, and move between the rows to support the learners*" (T1). The second participant added, "*I have 42 learners in my class, and the desks are put together to accommodate six learners in a group. Yet, I am unable to get all groups focused on their work, due to the noise level*" (T4). Participants wanted to be advised and equipped with strategies that would engage and promote active involvement of learners in their own learning. They put their faith on LS processes that enable them to think and apply suggested strategies together, rather than being told (through oral presentations) by office-based instructors, who do not have first-hand classroom experiences about how to manage large classes of learners. The spirit of sharing with each other demonstrated by the group supported the view of Cheng (2011) that a TC is a strategy by which its members share their values and beliefs.

f) Nominating coordinators

There was notable reluctance among members of the group, when it came to nomination of coordinators. Participants did not want to be bullied or have one person who thinks she is

superior to others. For example, T5 said, "*it would be much better if we can make our decisions together as equal partners. We do not need supervisors in this TC*". However, other members of the group saw a need and agreed to nominate school-based coordinators to ease communication between the two school-based teams, as well as their respective school principals. Thus, this role is merely an administrative one rather than a leadership or instructor one.

Selecting and deciding about activities and type of support that might be suitable for the TC engaged the participants in deep thinking during the process of decision making. That exercise invited much discussion among members of the group, as they seemed not to agree with some of the responses given by members of the group. Nevertheless, the discussion continued until the group reached a mutual-agreement about the activities and the nature of support needed by the group. The intensity of the group discussion and commitment of the participants resulted in the identification of a well-defined structure of their TC. The decisions of the group illustrated in table 4.2 above could be interpreted as an indication of how this TC intended to base their operations on mutual agreements and decision making processes (Wenger et al., 2002).

4.2.1.3 Tools and frequency of engagement

Another way of getting meaningful understanding of the processes anticipated by the TC was the examination of tools and frequency of engagement of the group presented in table 4.3 below. In the next interview item, I asked the group which of the following activities they thought might strengthen and promote effectiveness of their TC. I gave the group a table consisting of different examples depicting possible activities needed to promote effectiveness of a TC, such as:

1. Which of the following activities do you think may strengthen and promote effectiveness of your mathematics teacher collective? Look, respond as a group and give reasons for your selection.

Table 4.3: Tools and frequency of engagement

Tools	Tick only those you will use	Tick to indicate your proposed frequency			
		Weekly	Quarterly	Monthly	Semester
Workshop/planning sessions	✓		✓ 1st month	✓ 2nd month onwards	
Reflection and planning meetings	✓				
Classroom-based support	✓				
Other: (Specify)					

Participants were required to identify and select only those activities deemed suitable to strengthen and promote effectiveness of the teacher collaboration and illustrate frequency of such events. None of the participants was against the setting up of a committee to steer the activities of their TC. However, I noticed that workshops, planning meetings and reflection sessions were highly valued by the participants. For example, T2 said:

> *Workshops and meetings will provide opportunities to share ideas and plan Mathematics lessons together. You know what, the Department wants us to plan and keep record of our lesson plans. That has always been a problem. Now, ideas presented in this table give us a leeway to work collaboratively as a group to overcome any challenges that we may face*.

The group agreed to have workshops and meetings fortnightly, for the first two months. Thereafter, fortnightly workshops would be reduced to monthly workshops. Participants were clear about the mode and frequency of the reflection sessions needed to promote effectiveness of their TC. They needed a 'two-phase reflection', which was foreign to me. I required the group to explain what they meant by 'two-phase reflection'. T3 explained:

> *The reflection will happen in two phases. By 'two-phase reflection, we refer to school-based and TC-based reflection. We always refer to school-based reflection as phase-one reflection and TC-reflection as phase-two reflection.*

T2 added, "*we would carry out phase-one reflection at our individual schools immediately after observed lesson presentation*". At the beginning of each workshop session scheduled for all members of the TC to attend, each school-based team will share their phase-one experiences.

4.2.2 PRESENTATION OF THE FINDINGS FROM SEMI-STRUCTIURED INDIVIDUAL INTERVIEWS OF PART ONE

Part one of semi-structured individual interviews examined perceptions of participants with regard to a TC adopted by the group as a TPD approach to promote MKT at FP. This data collection instrument sought to elicit perceptions of the individual members of the group with regard to effects of a LS approach in the context of teacher collective exercise. During the second round of interviews, individual participants seemed to be more confident, focussed and at ease when reflecting on their teaching needs and experiences

4.2.2.1 The goals of a Teacher Collective as expressed by the individual participants

Unlike, in the group interviews conducted prior to the LS intervention, participants were more explicit and confident about intended goals of their TC. In response to the interview item that sought to understand the intended goals of their teacher collaboration, participants provided a wide range of responses to illustrate what their teacher collaboration planned to achieve. It was easy to identify harmony and participants' mutual understanding of the intended outcomes of their TC. The participants individually identified the following as the goals of their teacher collaborative structure to:

- Improve their Mathematics Knowledge for Teaching through collaboration.
- Engage in a LS approach to enhance collaboration and content knowledge.
- Creating opportunities for sharing of ideas during LS sessions.
- Learn from each other and build teamwork
- Have school-based lesson observations
- Creating opportunities for practical/ hand-on experience during workshops
- Learn about alternative ways of teaching Mathematics
- Organise meetings to discuss their classroom experiences.

The exercise of goal setting by members of a TC, confirmed the view of Cheng (2011) that formation and goals of a collaborative structure are not supposed to be created solely by administrators or imposed from the top down. Formulation of goals should be treated as a joint effort of the collective. Engagement in a shared mental exercise is a fundamental tool necessary to promote development of trust that Cheng (2011) described as one of the building blocks of any Community of Practice (CoP) or any cooperative organisation. In essence, having collective goals might strengthen collaboration and eventually assist in the creation of a shared

vision. Furthermore, common goals could promote the adoption of ongoing TPD programmes that sought to inculcate a sense of commitment, a sense of ownership and a desire to achieve the agreed upon goals.

Through setting of goals, members of the TC created and defined their own identity within a particular point of interest, which, in this case, was the promotion of MKT. Goal setting enabled the TC to clarify what constituted the value of their collaborative engagements. This finding is in line with the view of Bandura that shared goals promote equality and help participants understand how to communicate their views and how shared decisions could be handled (1997). One of the participants described goals as the back-up tool whenever things go wrong. This is what she said, *"our goals will be used as a point of reference when things go wrong"* (T1). In essence shared goals were viewed by the participants as the fundamental aspect of the collaborative. Such collaborative exercise was necessary for the creation of a shared identity underpinned by goals and values thus making the group appear as a unique formation. In terms of Weber (2011), in situations where organisations operate without goals, they tend to be deficient in their practice and lack a sense of direction.

4.2.2.2 Benefits of the teacher collective from a Lesson Study experience

My observation was that some of the issues that were expressed by the participants during the group-interview session were not forth coming during the individual interviews. In this case, I used the same strategy as in group interviews to probe the discussion by presenting table 4.2 above. The participants were as a result reminded about the resolutions of their TC planning meetings and they were as such able to describe the functions and activities of their TC.

There was a common view among participants regarding the organisation, the delivery mode and the Subject Content Knowledge. For example, they were satisfied with the level of consultation and joint organisation of the activities of their TC. Most of the participants described their LS experience as a well-organized collaborative exercise that inspired social interactions and sharing of ideas. To illustrate this, T2 described the first step of a LS approach as the development of an action plan, followed by identification of a topic from the action plan and the study of the teaching materials. Study material was used to clarify, confirm and strengthen the Subject Content Knowledge (SCK) necessary to teach the topic. According to

T3, "*preparation and steering a LS session alongside our facilitator motivated me to research and plan my topic thoroughly and present my ideas to my colleagues with confidence*".

One of the content related issues, highlighted in almost all individual interviews, was the benefit of collaborative planning in promoting learning from each other, e.g. different ways of approaching the implementation of the curriculum in the classroom. This observation was captured well by T4 who expressed it as follows, *"sitting together as a group and plan lessons during Lesson Study sessions helped me to learn from my colleagues how to approach the concept of four basic operations in my class*" This finding supports the views of Doig and Groves (2011) and Ono and Ferreira (2010) who describe LS as an approach that allows instruction to be manipulated and improved through consultation with colleagues.

T1 referred back to their cluster workshop experiences discussed in paragraph 4.2.1.1, to illustrate benefits of the group from a LS approach adopted by a TC. She said,

> *Unlike in cluster workshops* [discussed in clause 4.2.1.1 above] *that solely allowed for the subject advisors to be the on the foreground* [as facilitators of learning], *while we were always kept on the receiving end of knowledge, a LS approach requires our active participation during learning process. Such active involvement exposed me with different teaching and learning styles that I can adapt and adopt for my own classroom (T1).*

Experience of a cluster approach shared by T1 support the report of Jita and Mokhele (2014) that described subject advisors as specialist whose responsibility was to facilitate subject-specific support for teacher. According to the participants, the cluster approach never provided opportunities for holistic professional growth other than basing its workshop on development of their Subject Content Knowledge.

Participants were appreciative of the idea of workshops conducted by both the external facilitator (me) and members of their group. "*The facilitation and leadership skills applied by the facilitator help me to realise my potential*" (T2). To follow-up on T2's assertion, I asked her to explain and give example to show how the facilitator helped her to realise her potential. In her response T2 indicated that at the beginning, the facilitator explained the LS approach and allowed time for questions, comments and discussion. Participants were required to split into two groups and brainstorm areas of Mathematics that they found difficult to handle in their

classroom. "*That exercise helped me to understand the importance of thinking together, as we collectively identified number sense development as problematic area"* (T2). To express the value of presenting a workshop together with the facilitator, T5 regards herself as the co-facilitator, and a researcher of knowledge. Instead of waiting to be told what to do by the subject specialist and how to do that in development of classroom curriculum, *"I am the one who research knowledge for myself. Sometimes, I volunteer to co-facilitate a workshop together with the facilitator"* (T5). I noticed that facilitation of lessons by members of the TC encouraged them to take responsibility of their own professional development and that of their colleagues. My observation links with the assertion of Cheng (2011) which referred to the TC as a TPD that enhances professional development and cultivates culture of cooperative teaching. Just as Weber (2011) observed, involvement of the external facilitator in a TC helped to create an atmosphere of neutrality through unbiased facilitation. She also brought fresh perspectives to the TC that could affect positive change.

Participants described a LS approach as a strategy that motivated them to see value in learning together as a team. During individual interviews, participants indicated that, their engagement in a LS helped them to build their own Mathematical Knowledge for Teaching (MKT), instead of waiting to be told some bits of MKT. Hands-on experiences in analysis of the national Mathematics curriculum and exposure to a variety of Teaching and Learning Support Materials were viewed as the most useful part of the LS approach. This finding links with Ono and Ferreira (2010) who view a LS approach as a team-based, teacher-led collaborative way of learning, since teachers employ a wide variety of learning strategies in building meaning for themselves. The participants across the individual interviews highlighted lesson planning, lesson presentation and lesson observation as the most important elements of a LS.

a) Lesson Planning

Cheng put emphasis on the importance of planning lessons collaboratively and being well-prepared as these enable one to be more likely to handle whatever unexpectedly happens in the lesson (2011). Lesson planning was viewed as a vital component of the teaching process as it provides a useful basis for future planning. T4 stated that lesson planning helped her to be more organized, gave her a sense of direction in relation to the requirements of the curriculum and boosted her confidence in teaching Mathematics. According to T1, her engagement in collective planning broadened her understanding of the concept of number sense and equipped

her with more ideas on how to approach number sense development in her classroom. This is how T5 communicated her experiences of collaborative planning, "*we have learnt to base our planning on the needs of the learners and take into consideration the context in which teaching and learning take place"*. Benefits of engaging a LS as one of their TPD strategies were described in a slightly different manner by T2. She (T2) illustrated the process of lesson planning as the vital part of the LS. In her view, the process followed when planning of a lesson used in a LS cultivate the development of a research mind-set in participants.

> *There are moments when we found ourselves researching the topic. That enable me to see the value in starting by identifying the topic, and study of teaching material to clarify and confirm SCK needed to teach the topic, and decide about suitable teaching strategies needed* (T2).

According to T3 proper planning of a lesson kept all participants organized and allowed them to help learners reach objectives of the lesson. These benefits confirms the finding by Ono and Ferreira (2010) who had similar observations that involvement in a LS is beneficial. In addition, T5 noted that she also came to the realisation of the importance of understanding how learners learn best.

b) Lesson Presentation

The presentation of a lesson depends on how well you are prepared to teach and how well you deliver the material. T5 described lesson presentation in front of her colleagues for the first time in her teaching experience as quite a scary exercise. "*At the beginning, I did not want to appear as stupid in front of my colleagues"* (T5). However, she further indicated that observing lessons presented by her colleagues and listening to constructive observations of her own teaching boosted her self-esteem and self-confidence. T3's experience of the LS approach highlighted the importance of setting clear lesson outcomes. For her (T3), "*engagement in a LS taught me the importance of having a clear understanding of what the learners should typical do, understand, and care about as a result of teaching, before the lesson presentation".* Lesson presentation was described by one of the participants as

> *an act that includes information needed for learners to gain knowledge and skills, learning and teaching support material to show learners examples of what is expected as an end product of their learning and checking whether learners gained meaningful conceptual understanding before proceeding to the next level* (T3).

In my observation, these participants displayed an awareness of a need to create opportunities for learners to demonstrate their understanding by working through activities under the teacher's direct guidance and for the teacher to intervene when necessary. One of the participants said, "*I realised the need for moving around the class to determine the level of mastery and provide individual remediation as needed*". Participants indicated a number of strategies they applied during guided learning, such as, praise, questions for clarification, and probing questions, to elicit learner's thinking about the activities they were doing. They also learnt the importance of providing opportunities for learners to share their knowledge with peers in their small groups and with the whole class.

c) Lesson Observation

During individual interviews, all participants described lesson observation by colleagues as a strategy needed to promote quality Mathematics teaching. The TC derived its guiding principles from Ono and Ferreira (2010) that required observers to focus their observation on how learners interact with one another and with the instructional task. Emphasis was on the process and strategies used by learners in solving mathematical problems posed by the teacher. According to T4, "*reading and discussing the principles crafted by our TC to guide lesson observations, before engagement in classroom observations helped to focus on the process of learning"*. Similarly to Ono and Ferreira (2010), consideration of observation guiding principles before lesson observation led to prevention of destructive criticism of the instructional skills of the presenter (see details on page 29 of this study). T3 said, "*the good thing about principles, they equip the observer with skills necessary to build both presenter and observer's confidence"*. I picked up from their interviews that participants were cautious and learnt to start by identifying positive aspects of the lesson before commenting on the lesson, not the presenter. Finally, they identified areas that needed attention followed by suggestions on how to improve the identified areas.

According to T5, observing a lesson in a real classroom situation provided her first-hand information about what her colleagues actually do and say, rather than being told what they do. For example,

> *I noticed that the presenter had adapted the lesson planned jointly by the TC to suit needs of her class. She used a story of their school-principal who wanted*

to order learner books to introduce her lesson. Before the actual calculation, they started to talk about their school shortage of learner-books in their school. Thereafter learners were asked to work in groups and help the principal to find the total number of books she needs to order". *She moved around the class, visiting each group to guide learning (*T5).

Immediately, after lesson observation each school-based team met to discuss their own findings. The coordinator from each school gave feedback to the TC during their feedback session. Participants took turns to report their observations. I noticed that, the presenter of the lesson was always given a chance to be the first reporter. Each report was followed with questions that sought clarity when necessary. In some instances, participants (both presenters and observers) shared with their school-based group and TC group on how they would improve their classroom practices.

From the reflections of both observers and presenters of lessons, I noted similarity to the view of Bandura (1997) reciprocity. Reciprocal learning from peers was evident in this TC. Participants were simultaneously learning and contributing to professional growth of the fellow members of their group. Their performance during both school-based and TC reflection sessions were based on mutual understanding and experience. Such practices promoted the spirit of equality to prevail and sharing similar sentiments.

4.2.2.3 Tools and Frequency of engagement

Individual interviews reveal the same findings as the group interviews with regard to TC meetings. The findings of the group interviews revealed that formation of a committee was not an option for the participants and as such it was not considered. According to one of the participants, they were not comfortable about using a committee as one of the tools of engagement due to their previous experience of working with a DBE subject advisor who tended to dominate their TPD programmes as indicated in clause 4.2.1.1. For this group, their TC comprise a small group of participants, thus, they did not need a committee. They also highlighted a number of challenges that might be the result of having a committee. A committee might make undemocratic decisions, prevent their TC from reaching it goals, or cause groups to break apart. Whereas, working as a collective that involve everyone would promote active participation, engagement by all members and shared decision making rather than allowing

few members of the group decide for their TC. Individual participants expressed the value of the workshops, classroom-based support and reflection meetings.

Similarly, T1 expressed limitations of setting up a committee as a barrier that would prevent them from taking decisions as the group, whereas, the main purpose of their setting a TC is to involve everyone in the process of decision making. According to T2, T3 and T4, they would prefer to have a coordinator instead of having a committee. They further illustrated the role of school-based coordinators as liaison officers, who serve as links between members of the group in their schools and the SMT. The following extract by T3 illustrates the participants' view about the role of school-based coordinators; "*A coordinator does not make decisions for the group, but communicates decisions of the TC*" (T3). In one interview, one of the participants said,

> *We set up this collective as a team of grade three teachers who experience problems in teaching Mathematics in our isolated classrooms. Our aim is to make the decisions and solve our problems as a group. I am afraid of letting few people dominate our decision-making processes and think they are more important than the TC* (T2).

Just as participants indicated in the group interview conducted prior to the LS exercise, all participants were clear about the nature of teacher support they needed. They all referred to the action-plan of their TC, in which they agreed as a team about frequency and dates of workshops, and feedback meetings in 4.4.2, all believe that there are tools necessary to promote quality of teaching Mathematics in FP classrooms. From individual interviews, I noticed that workshops and reflection meetings promoted professional growth and cultivated a culture or a spirit of cooperative teaching and learning among participants. For T3, *"our workshop sessions are interactive in nature, we are regarded as contributors. Now we tend to be responsible for the development of our Mathematics teaching skills*". When asked to explain this comment, she (T3) said, "*During workshop sessions, we work together as a team to study material and the curriculum document. That practice helps us to gain deeper understanding of Mathematics concepts*". The view of T3 was noted in T5-individual interview responses, while saying, "*we become active participants and learn by doing in workshop session. The facilitator continuously refers to what we know. That helped me to build my confidence. I will definitely use these ideas in my classroom*" (T5).

Reflection meetings are regarded as the important aspect of a TC by the participants. T2 said, "*Now, I am motivated to always think about my teaching, and talk about my own performance in a meeting situation*". T4 said, "*It is only now that I understand that sharing experience is a valuable exercise. I changed my teaching styles. I involve my learners in their learning and ask them to share their findings*". Application of reflection meetings as one of the focus areas of the TC gradually encouraged the participants to be reflective practitioners who think about the effect of their own teaching, then merely realising themselves as the sources of knowledge. From the above finding, I had noticed that participants were applying skills they got from their reflection session in their classroom.

4.2.3 PRESENTATION OF THE FINDINGS FROM SEMI-STRUCTIURED GROUP INTERVIEWS OF SECTION TWO

As previously stated in Chapter 3, this study sought to examine and reveal the influence of a professional development strategy referred to as a Teacher Collective (TC) on the development of mathematical knowledge for teaching (MKT) in the Foundation Phase (FP). In paragraph 4.2.1 and 4.2.2 above I explained how I conducted the group and individual interviews contained in part 1 of the semi-structured interviews. During part one the aim was to elicit perceptions of the group regarding the functioning of the TC. In Part two of the interview schedule the aim was to understand how a TC contributed to the development of the MKT of the participants. In the following discussion therefore, the focus is on the findings around the contribution of the TC exercise to the development of the participants' mathematical knowledge for teaching number sense, with special focus on the four basic operations.

In order to guide the discussion, I refer to the sub-research question outlined below, which was meant to directly explore participants' MKT:

- What mathematical knowledge for teaching with special focus to number sense and error analysis, do teachers possess before engaging in TC (Lesson Study) exercise?

The items used in part two of semi-structured interviews examined MKT possessed by the participants in identifying mathematical problems, selecting and devising plans and strategies for their resolutions (Bagwandeen & Louw, 1993). In order to answer the sub-question above, participants were required to analyse learner errors and solutions as a group before engaging

in a Lesson Study approach. To gain insights into how teachers carry out the work of teaching Mathematics, I considered the two elements of the concept of MKT identified by Ball, et al. (2008) and Hill, et al. (2008) namely Specialised Content Knowledge (SCK) and Knowledge of Content for Teaching (KCT).

4.2.3.1 Participants' MKT (SCK and KCT) demonstrated during analysis of learner-solutions before LS experience

Teaching Mathematics involves more than identifying an incorrect answer. Error analysis is viewed as one of the important aspects of Mathematics teaching (Ball et al., 2008). As indicated above, participants were required to analyse learner solutions, as a collective. The first interview item, in section two of the semi-structured interview schedule required participants to analyse and determine mathematical steps that might produce the given errors.

a) Analysis of strategies used by participants to identify errors made by learners and solutions effected during <u>subtraction</u> computation

To gain insight on how participants carry out the work of Mathematics teaching in their classrooms, they were required to identify errors made by learners and solutions used during computation. Participants just looked at the learner-solutions presented to them and remained quiet for the first few minutes. After a while, they whispered and made ticks on learner 2 and on learner 3's solutions (see appendix E: Section B, Question 3, on page 114). I probed the participants to give reasons of marking learner 2 and learner 3 solutions correct. Participants simultaneously told me that those two solutions were straight forward and it was easy for them to see how learner 3 got the answer. When responding to a prompt that required them to explained the mathematical processes applied by learner 3 to get the difference of 139, they quickly explained the standard algorithm used by learner 3. For learner 2, they noticed that seven is one less than eight and there was a shortage of 60 in ten-digit. Surprisingly they found it difficult explain the positive 200 in that solution and attempted to move to the next question. I decided to use the following prompt to bring their attention to learner 1's solution: "*How will you address such challenges in your class: 307 – 168 = 169*"? T1 bravely responded in isiXhosa language. "***<u>Iyho!! inzima ke le, kuba aba bantwana uyababonisa balibale</u>". (***"*Wow!! This one is difficult, because you show these learners and they forget*").

Instead of attempting to analyse learner 1's error, participants continued to express other related challenges facing them when teaching Mathematics in their FP classrooms. I listened and gave them a chance to share challenges they experience in teaching of Mathematics without interference. For example, in her response T2 said "*these are typical problems I always experience in my grade 3 class*". When expressing her classroom experiences T3 said "*my learners are unable to explain how they got the answer/s*". According to T4, she always shows her learners how to add, subtract, multiply and divide, but when she gave them sums to work at their own, they always get incorrect answers. I continued with my prompts immediately after T5 gave an answer that partly identified the error saying, "*I think this have to do with learner one's lack of understanding of the concept of place value*". When asked to give reasons for her answer, she said "*this learner was supposed to borrow one form hundreds and subtracted 6 from 10*".

In the figure 2.2, one can detect that one can interpret Hill et al. (2008) illustration of MKT as everything a teacher needs to do to support learning in their Mathematics classrooms. However, as stated in 4.2.3, for the current study, I decided to focus on SCK and KCT. The aim was to focus on sections of MKT that could equip a teacher with skills to determine the extent and the source of the error and promote effective and skilful teaching of Mathematics. According to Ball et al. (2008), a teacher would need a special kind of mathematical reasoning that many people do not have to determine the source of learner one's error, that is, SCK and KCT. None of the participants associated learner 1's error with difficulty related to application and understanding of algorithm for subtracting multi-digit numbers. In this case I had to intervene (see example below of my intervention).

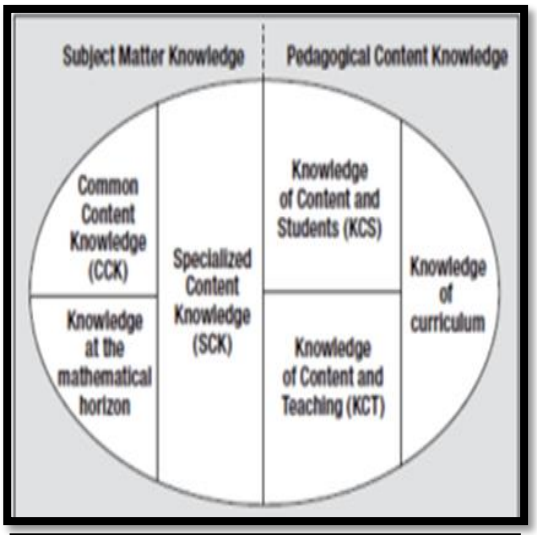


Figure 2.2 Domains of mathematical knowledge for teaching (Hill et al., 2008, p. 377)

For example, learner one's error is based on borrowing.

Learner one treated the number borrowed from hundreds as 10. She/he added that 10 and 7 together and got 17. She continued to subtract 8 from 17 and the difference was 9. She/he brought the 6 down and subtracted 1 from 2 and got the difference of 1, then she/he recorded her answer as 169. MKT also

involves guiding and showing learners how to solve problems, being able to answer questions asked by learners and check their work. Ball et al. (2008) advised teachers to avoid delays and respond immediately to questions and in addressing errors of the learners. They need to plan lessons and think different solutions and errors that might prevail (Cheng, 2011). Mathematics teaching is further described as the interactive work of teaching lessons in the classrooms and all the tasks that arise in the course of that work (Ball et al., 2008).

b) Analysis of strategies used by participants to identify the most suitable explanation provided by learners in the following addition computation

The next task required the group to select an explanation that shows sufficient understanding of why the sum of addends in the horizontal line will always be the same as the sum of addends in the vertical line for all similar plus signs on the hundred square (Ref: Section B, question 1, page 114).

Table 4.4: Identification of most suitable explanation

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	93	05	96	97	98	99	100

		Yes	No	Not sure
i.	The average of the three vertical numbers equals the average of the three horizontal numbers.	1	2	3
ii	Both pieces of the plus sign add up to 96	1	2	3
iii	iii. No matter where the plus sign is, both pieces of the plus sign add up to three times the middle number.	1	2	3
iv	iv. The vertical numbers are 10 less and 10 more than the middle number.	1	2	3

All participants agreed and selected the second statement as the most suitable one. T3 was captured saying "*yes, both pieces of the cross add up to 96, the second statement is the most suitable one*". Participants concentrated on the correct answer. They did not consider examining the relationships between numbers and use the number board to construct similar plus signs. Such a move would enable them to draw a conclusion based on tested and proved

experiences. I also notice a lack of knowledge at the mathematical horizon (Ref: figure 2.2.), i.e. is an awareness of how mathematical topics are related over the span of Mathematics included in the curriculum, which is important in preparing and laying a firm foundation for later years of schooling (Ball et al., 2008; Hill et al., 2008). For example, it is important for teachers in the early grade to know how Mathematics they teach is related to the Mathematics learnt in the higher grades. A FP teacher should understand that the mean is the average of the numbers and how to calculate an average: a learner should add up all the numbers, then divide by how many numbers there are. In other words, it is the sum divided by the count. For example, to get the average of the following set of numbers: 22, 32, 42, a learner should find the sum which is equal to 22+32+42= 96 and divide 96 (the total number of numbers) by 3. That means 96 ÷ 3 = 32. So, the average is 32.

c) Analysis of strategies used by participants to identify errors made by learners and solutions effected during multiplication computation

The following task required participants to imagine that they were working with learners in their individual classrooms on multiplying large numbers. Among their learners' papers, they noticed that some of the learners displayed their work in the following ways (Ref: Section B, question 1, page 114). Some of these methods cannot be used to multiply any two whole numbers. Participants were asked to find out if methods presented below could work for any similar exercises.

Table 4.5 Identification of appropriate multiplication solution strategies

	Learner A	Learner B	Learner C
	26 x 13 78 + 26 = 338	26 x 13 78 + 260 = 338	26 x 13 18 60 60 + 200 = 338
	Will work for all whole numbers.	Will not work for all whole numbers.	I'm not sure.
i. Method A.	1	2	3
ii. Method B	1	2	3
iii. Method C.	1	2	3
If a colleague wants you to give reasons for your answer, What will your tell her/him?			

These TC participants were more comfortable with the solution provided by learner B than those of learners A and C. They indicated that learner B shows understanding of the rule and applied the column method appropriately, although he failed to show his borrowed numbers. T2 felt that, "*learner C's method can also be used or introduced to grade three learners*" on second thoughts, she said (T2), "*but learner C's method is too long. It may confuse a grade*

three learner and end up getting the incorrect answer". In learner A's solution, the group was not happy with the number 26 instead of 260. One respondent continued and said, "*I do not think this this child has fully grasped the concept of place value yet*" (T3). T4 said: "*OK, I see, learner A is correct, but she/he must always remember to write zero in the unit digit column when multiplying by 10*". From the above discussion or findings, I came to realise the gaps in participants' MKT. For instance, these participants failed to judge learner A's solution through the eye of the learner. Instead they were just not happy about the number 26 instead of 260.

In my view, participants (being Foundation Phase teachers) should demonstrate more insights on MKT needed to promote meaningful mathematical understanding, in particular KCT. Maybe participants needed to be exposed to the view of Naudé et al. (2014). According to those authors, to avoid incorrect presentation of number values and promote understanding of the concept of a number, learners should be exposed to a range of numerical strategies and concepts in conjunctions with the ability to use these skills in different ways in different contexts.

4.2.4 PRESENTATION OF THE FINDINGS FROM SEMI-STRUCTIURED INDIVIDUAL INTERVIEWS PART TWO

As indicated in paragraph 4.2.3 above, the second round of semi-structured interviews examined mathematical knowledge for teaching with regard to number sense that teachers have after engaging in a LS approach regarded as a TC exercise.

4.2.4.1 Participants' MKT (SCK and KCT) demonstrated during analysis of learner solutions <u>after</u> LS experience

Participants in the current study identified number sense development as their area of focus. A Lesson Study approach was identified as a suitable tool in that it provided a logical sustainable framework for the Teacher Collective activities. Application of a Lesson Study approach also promoted Subject Content Knowledge and Knowledge of Content and Teaching with respect to this focus area (see chapter two). Participants were exposed to a LS approach that aimed to provide a structured activity for their TC and enhance their MKT. The discussion below is guided by the following question:

- What mathematical knowledge for teaching with regard to number sense and error analysis, do teachers have after engaging in a Lesson Study approach (a teacher collective exercise)?

Participants acknowledged error analysis "*as a powerful tool to determine learning difficulties and consequently give indication of corrective measures needed*" (T3). T4 asserted that discussion and exposure to learner-error analysis has provided valuable contribution to her teaching style. When she reflected on her own teaching, she came to the realisation of the inefficiency of her own strategies of remediating errors by simple explaining the same topic over again, or assigning additional practice exercises. T3 and T4 signalled their professional readiness as they showed awareness of the value of understanding the causes and the nature of errors made by learners.

a) Analysis of strategies used by participants to identify errors made by learners and solutions effected during <u>subtraction</u> computation

The first interview item required individual participants to explain the source of error, whereby a learner subtracted 168 from 307 and got 169 as the answer. T3 responded by calculating the sum using standard algorithm. Thereafter, she explained mistake done by the learner. In her explanation, she focussed on the tens and hundreds digits. She said "*the learner did not borrow 100 from the hundred-digits. Instead, she/he moved 60 from the subtrahend and place it between hundred and ten digits to represent tens in the difference*".

307
<u>- 168</u>
<u>= **169**</u>

T1, T2 and T4, they were quick to notice and explain the mistake done by the first learner, during their individual interviews. T1 and T4 noted 'borrowing' as the root cause of the problem. For example: according to T1 ***"la mntwana uthabathe ikhulu, kumakhulu amathathu, wabe engqondweni esiba uthabathe unye. Endimangalisayo lo nye sele wajika walishumi".*** (That learner subtracted 100 from 300. In his mind he thought he is subtracting 1. What surprises me, this 1 is converted to be 10). I followed up with a prompt: ***"Kutheni ucinga njalo nje"<u>?</u>*** ("Why do you think so"?). T1 explained ***"Kuyacaca umenza ishumi kuba naku ngoku efumana ishumi elinesixhenxe, ukuba ebemenze unye ngethe akudibanisa unye nesibhozo afumane isithoba".*** ("It is clear: the learner treated the 1 as 10 because the answer is 17. If he treated 1 as a unit-digit, the learner would have added 1 and 8 and get 9"). T2 identified lack of understanding of place value and borrowing method as the underlying factor that led to that error. For T2, "*the learner did not pay attention or consider the value of the digit-numbers*". T2 described application of borrowing method as the challenge to that learner.

b) Analysis of strategies used by participants to identify errors made by learners and solutions effected during addition computation

21	22	23
31	32	33
41	42	43

In a question that required teachers to identify a statement or an explanation that shows sufficient understanding and why is it true for all similar addition signs that the sum of numbers in a vertical line will always be the same as the sum of numbers in a horizontal line.

This was a bit tricky for the participants during individual interviews. All participants chose the third statement as the most suitable response. T4 justified her selection of the third statement as follows: "*if the middle number for both sequence of numbers is the same, and is also a third of both series of numbers, it will work for any similar addition sign*". I observed T1 being quiet and starring at the task. After a while, she said, "*Thami* (facilitator's pseudo name) *remind me please. What is an average and how do we calculate an average? Remember we do not deal with such concepts at FP*". I answered by simple saying, you get an average of a series of numbers just by adding all the given numbers and divide your answers or sum by the total number of addends. Then, T1 started to make her own crosses of numbers. She calculated to find the sum of the horizontal numbers and the sum of the vertical numbers in other boxes, and divided each sum by three. For, example:

21	22	23
31	32	33
41	42	43

22 + 32 + 42 = 96
31 + 32 + 33 = 96
The middle number is 32.
96 ÷ 3 = 32

3	6	9
12	15	18
21	24	27

6 + 15 + 24 = 45
12 + 15 + 18 = 45
The middle number is 15.
45 ÷ 3 = 15

5	10	15
20	25	30
35	40	45

10 + 25 + 40 = 75
20 + 25 + 30 = 75
The middle number is 25.
75 ÷ 3 = 25

After calculations, T1 said

> *There are two statements that are correct. That is the first and the third statements. It is true that the average of the three vertical numbers equals the average of the three horizontal numbers. It is also true that no matter where the similar plus sign is, both pieces of the plus sign add up to three times the middle number.*

Unlike T4 and T3, T1 identified the educational problem. Before attempting to solve the problem, T1 requested to be reminded when she asked, "*What is an average? How do we*

calculate an average"? After my explanation, T1 devised a plan to solve the problem (Bagwandeen & Louw, 1993). Then, it became evident that a specialised kind of subject matter knowledge is required in teaching (Ball et al., 2008). For example, both Ball et al. (2008) and (Hill et al., 2008) assert that specialised subject matter knowledge (for Mathematics) cannot be mingled into various categories of PCK, as it purely deals with the knowledge of Mathematics.

d) Analysis of strategies used by participants to identify errors made by learners and solutions effected during <u>multiplication</u> computation

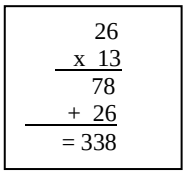
Below are the activities adapted from Ball and Hill's (2008). The instrument used to measure Mathematical Knowledge for Teaching (MKT) deemed to be suitable to achieve the goals of this study (Ball et al., 2008). The task required participants to imagine that they were working with their classes on multiplying two-digit by two-digit number. Participants were given learner A, learner B and learner C's solutions to check if the learner solutions provided below would work for all whole number.

Learner A	Learner B	Learner C
26 <u>x 13</u> 78 <u>+ 26</u> = 338	26 <u>x 13</u> 78 <u>+ 260</u> = 338	26 <u>x 13</u> 18 60 <u>60</u> <u>+ 200</u> = 338

In all interviews, participants were convinced that Learner B's method would work for all whole numbers and their explanation was similar. For example, T5 said

> "*Learner B started with multiplying 26 by 3 which is the unit digit and got 78. Thereafter, he/she used 10 to multiply 26 to get 260. Finally, Learner B added both answers together and got 338*".

T1 was not sure if Learner A's method could be applied in similar situations. T4 thought it will not work for big numbers, while T2 was convinced that Learner A's method would work for all numbers as long as the child knows and understand the concept of place value well. For example, except for T2, all other four participants thought that the method used by learner A might not work for all whole numbers. For them, learner A's method might confuse other learners. In his/her answer,



the learner placed the number 26 under tens and units, yet in her/his mind the first digit in 26 represents hundreds and the second digit represents tens. According to participants, that method could easily confuse learners. However, T2 was adamant that, "*the method used by learner A is correct and can work for all whole numbers, as long as you know the value of the number written as 26 in your mind*". I posed a prompt that required T2 to explain the concept of place value, because the placement of 26 in the learners' solution does not look as if it represents 260. T2 said,

> *I mean, this child knows the concept of place value well in his/her mind, even if it is not clearly stated or shown on the paper. It is the representation of the number 26 that need to be corrected in this method. For example, if I was Learner A's teacher, I would ask him to explain to the whole class how did he/she got the answer and encourage other learners to ask questions or talk about her/his method, just to check what would they say about placement of the number 26. I would also show him/her the standard way of representing the number 260.*

T4 said:

> *Learner A is correct by representing her/his answer in groups of 26. The first answer is represented as 3 groups of 26. Her or his mistake was to represent the second answer as one group of 26, instead of representing the number as 10 groups of 26 and write it as 260. I think this method will not work with big number. It will confuse learners.*

T5 added *"I think Learner A copied his answer from another learner sitting next to her or him. There is no way that addition of 78 + 26 can give a sum of 338".*

From the interviews, I gathered that Learner A's solution was based on mental calculations done by the learner. The learner used the grouping strategy to calculate the product of 26 and 13 without taking into consideration the value of each digit and importance of correct presentation of facts. As the participants noted during individual interviews, Learner A did not consider the importance of relationships among columns that might have helped him to place the digits according to the place value. He or she decided to regroup the numbers without

paying attention to the value of their places. Yet the answer is correct. However, it is reported as a common practice for learners to create and use their own non-standard methods that are unfamiliar to the teacher (Ball et al. 2008) and still get the correct answer. For instance, the solution structure used by Learner A underplayed the important role of zero that would help to reflect the value of the product of 26 and 10, which is 260.

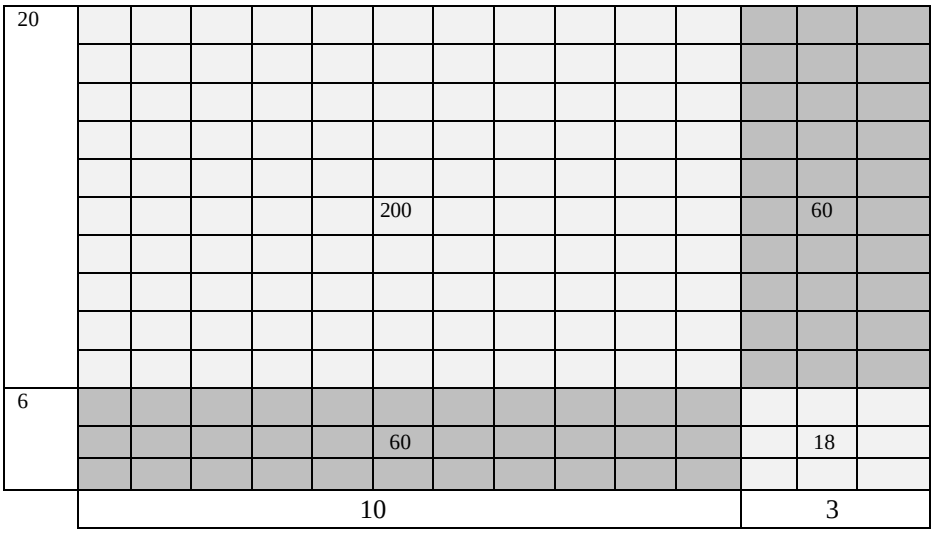
Learner A's solution confirms the view of Naudé et al. (2014) and Wynn cited in (Griffin, 2004), that we are all born with the ability to be numerate. Learner A showed his inborn ability to represent number in various ways when performing the calculation. Those internal abilities enabled him to perform complex calculations. Learner A proved and displayed the growth of his natural quantitative competences that enabled him to count without needing physical objects or standard methods to display his thought (Griffin, 2004). Teachers should gain more insights on MKT needed to promote meaningful mathematical understanding. All participants felt that Learner C's method would work for all whole numbers, because it showed all the steps and it is easy to understand Learner C's thinking. For example, T2 said:

> *"This method is clear and easy to understand; it will work for all whole numbers. The learner uses each digit in the multiplier to multiply each digit in the multiplicand. It like 6 x 3 =18; 20 x 3 = 60; 6 x 10 = 60 and 20 x 10 = 200. A learner can add all those total together like: 200 + 120 = 360 + 18 = 338"*

Mathematical problems or learner solutions presented to participants during individual interviews (after a LS experience) challenged and stimulated their thinking. As I observed participants during the second round of interviews, they analysed and explained themselves in more details than in the first interview. Form the responses provided during individual interviews, a need to rectify or help learner A was a central feature throughout the analysis of multiplication methods. Learner A's method might be confusing if not addressed soon. The idea of requesting learners to present their methods to the whole class and explain what going on in his method might challenge the learner to think about his own thinking. It might encourage discussion as well, whereby other learners might ask questions for clarity or identify weaknesses of learner A's method. Participants' analysis put emphasis on importance of both SCK and PCK (Ball et al., 2008).

Participants in this study showed awareness of mathematical issues involved in learner A's method and processes being modelled. T2 noted worthwhile Mathematics learning as she indicated constructive view of how knowledge is developed. According to T2, the correct answer provided by learner A showed that he or she knew in his or her mind that is the value of that number is 260 not 26 as displayed in in her/his solution (Griffin, 2004). T2 was also aware of the need to refine learner A's solutions. Participants showed skilful and efficient ways of dealing with Mathematics representations. For example, in one interview, participants explained that learner A represented 26 x 13 as 3 groups of 26 and 1 group of 26. Mathematically: 78 + 26 = 104 and not equal to 338. Forming groups was a worthwhile exercise, but there were important aspects of Mathematics that learners needed to know, like importance of place value and the value of zero that was omitted in this case. Teachers should think of using visual representation to make the standard algorithm more visible. For instance, when refining the concept of place value, one could make use of the structure of place value notation, as shown in figure 4.1. For example, learner Cs' strategy could be represented as:

Figure 4.1: Structure of place value notation



The representation made the method to be visible. It would help learners to see smaller parts produced by 20 x 10 = 200, 20 x 6 = 60, 6 x `10 = 60 and 6 x 3 = 18.

4.3 PRESENTATION OF THE FINDINGS FROM PERSONAL JOURNALS

During the initial stage of the research, participants were requested, and they agreed, to keep personal journals. The purpose of personal journals was to document and reflect of personal experiences of a TC.

4.3.1 Personal experiences of a TC

Initial stages of journal writing, participants' writing tended to focus on personal experiences. Mostly, journal entries explained how participants benefited from the collective, in terms of their own professional growth. According to T3, "***i-teacher collective yethu ingxininisa kukubaluleka koplano nokulungela ukufundisa, ukuba sifumana ukuphucula izinga lwabafundi bethu bakwa-grade three kwizibalo" (****"Our TC emphasise the importance of planning and readiness for teaching, if we want to improve our grade three performances in Mathematics*"). On the other hand, T4 acknowledged that she still had to learn to balance her life and improve her time management, because ever since she joined their TC, ***"ndichitha ixesha elininzi ndifundisa i-maths, kwaye ndiyahlala esikolweni ndisenza umsebenzi wam kudekube-late emva kwemini"****. ("I spend more time teaching Mathematics and stay at school doing my work, until late in the afternoon*").

Some of the journal entries indicated a need for classroom-based support that would allow them to observe lesson presentations and support each other in a real classroom environment. T4 highlighted the challenge that presented itself as barrier that prevent them from getting classroom-based support from peers saying, "*the only challenge, we are not allowed to leave our classes unattended during teaching time"* T4. In an attempt to address their challenge, they applied the decision of their TC. They arranged a meeting with both school principals and their Head of Department (HOD). In that meeting, they requested and were granted permission to observe presentation of lessons planned jointly by the TC. The school principal agreed to get parent-volunteers to take care of the learners during their absence. The concession of using school parent-volunteers strengthened school-based teams. Participants were motivated to spend their free time planning and talking about Mathematics teaching. For example, T2 wrote:

> *These days, I find myself spending my 'break time' talking with my colleagues about my classroom experiences. Sometimes, I bring learners work to show my colleagues. My engagement in a Teacher Collective helped me to open up, and talk freely about my classroom experiences. Before participation in a teacher collective, I did not want other teachers to know my inadequacies and pretended as if all goes well. My participation in a teacher collective and my engagement in a Lesson Study taught me to ask question, to study curriculum and feel free to talk about my own teaching.*

In her journal entry, T1 wrote, ***"yonke into iyacaca xa ndisebenza nee-coleagues zam kwi-Lesson Study, kodwa ndakufika kweyam i-classroom ndizame ukusebenzisa ezi ngcebiso ndivela ndiphixane ndixakwe".*** ("Everything become clear when I work with my colleagues during Lesson Study, but, when I apply the TC ideas and activities in my classroom, I easily get confused"). According to T1, when more than two members of their TC reported challenges facing them during implementation of suggested activities, in their individual classrooms, their TC collective encouraged formation of sub-groups within their schools, which were referred to as school-based teams. The classroom-based support teams were expected to spend an hour after school (once a week) discussing previous week teaching experiences and preparing following week's work. One participant wrote, "*We spend one hour after school sharing successes and discussing problems we encountered during teaching of Mathematics, and got advice from members of the school-based team*." (T2).

LS planning sessions enabled the group to gain insights of the Mathematics content knowledge needed for their grade three classes using a variety of resources and curriculum policy documents. In her journal, T5 wrote about one of the requirements of the LS approach. She (T2) said,

> *Application of the LS approach taught us the importance of starting by analysing the curriculum and learning to sequence Mathematics (classroom) activities according to the level of difficulty during planning of a lesson*". (T5)

From journal entries, I gathered that LS approach encouraged participants to use a variety of Mathematics textbooks and compared information gathered from those textbooks as well. LS sessions created within TC opportunities for the participants to equip each other with various teaching and learning strategies to promote active and effective learning in their classrooms. During LS sessions, Participants were encouraged to think about mathematical (content) errors of their learners During planning sessions, "*our facilitator put emphasis on importance of thinking about possible solution strategies that might be used by learners, as well as possible errors that could be made by learners*" (T1). Participants discovered alternative ways of supporting their learners, that of analysing their mistake. To express her gratitude, T4 wrote:

> *I owe my teacher support group a big thank you. Now, I know the importance of analysis of learner solutions, particularly their mistakes. Before engagement in Lesson Study Approach that require group planning, discussion, lesson observation*

and feedback, I use to mark my learners wrong and write the correct answers on the chalk board for them to copy in their classwork books. All the time, I thought I was helping them. Funny enough that approach did not help to improve their performance. Now, as I'm engaged in the support group, I have discovered many ways of identifying and solving problems experienced by my learners.

The major challenge indicated by all participants was teaching Mathematics in isiXhosa language, with limited or no supporting documents at all. It is only the Mathematics Curriculum and Assessment Policy Statement (CAPS) that is written in isiXhosa, all other supporting document received from DBE are written in English. Teachers are expected to translate those resources into isiXhosa. The issue of teaching Mathematics in isiXhosa was indicated as a challenge. According to T4,

Some of the Mathematics terms that we have in isiXhosa are not used in learner's daily language, like ***isangqa*** *for a circle. We do not have some of the Mathematics terms in isiXhosa, such as two- dimensional, etc. Lastly, some of the mathematical concepts carries a total different meaning, e.g. light means* ***ukukhanya*** *in isiXhosa, whereas in Mathematics, light means not heavy or weighing less which will be* ***ikhaphu- khaphu*** *in isiXhosa language. It is complicated to teach in isiXhosa. I wish, we can be allowed to use a bilingual approach".*

4.4 CONCLUSION

In this chapter I presented the findings of the data collected using semi-structured interviews and personal journals from a group of five, grade three teachers. I started by presenting a brief overview of the previous chapter to highlight an action plan that I used to investigate the problem that was introduced in chapter one. Thereafter, I designed a reporting format to clarify how the themes and sub-themes generated from the analysis address the sub-questions as outlined in chapter one. The findings were then discussed according to the themes and were supported by verbatim quotations from the transcripts of the semi-structured interviews and personal journals. Finally, the findings were compared to relevant literature as reviewed in chapter two. In the next and final chapter, conclusions of this study will be drawn.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

In chapter four, I presented the findings from the interpretation and analysis of the data gathered through semi-structured interviews and personal journals from a group of five grade three teachers. Chapter four began the discussion by presenting a table which guides the reader on how the themes and sub-themes link to the questions posed in chapter one and chapter three. I analysed the two sets of transcripts (i.e. transcripts of the semi-structured group interviews, semi-structured individual interviews) as well as the participants' personal journals of their Teacher Collective (TC) experiences. I identified the themes from these information and data sources, and included verbatim quotations from the transcripts to support interpretations of the data.

This chapter provides a brief overview of the study and reports the conclusions and recommendations that resulted from this study. The question that guided investigation and development of this study is:

- How does a teacher professional development strategy, referred to as a teacher collective, contribute to development of Mathematical Knowledge for Teaching of Foundation Phase Mathematics teachers?

5.2 OUTLINE OF THE STUDY

As indicated in chapter one, participants in the current study indicated their dissatisfaction with the poor performance of their grade three learners in the subject Mathematics. They (the participants) formed a Teacher Collective (TC) amongst themselves in an attempt to address their concerns. Unfortunately, their innovative attempt at the finding solutions to their problems soon floundered. They became disillusioned with the effectiveness of their self-initiated TC at addressing their concern. Participants' firm belief in the potential of a TC as the best possible Teacher Professional Development (TPD) approach for them that could enable them to address challenges facing them in teaching Mathematics caused them to seek outside facilitation. They expected this facilitation to provide some direction for their TC, thus enabling them to move forward in a more constructive and effective manner. To strengthen their teacher collaboration,

a Lesson Study (LS) approach was used as a focus idea around which to build collaboration (Ono & Ferreira, 2010). Acknowledging the potential benefits of their TC, and the role that their participation might play in generating a set of guidelines to assist other teachers who might want to also explore the potential of a TC to enhance their practice, the participants agreed to take part in this study. In consultation with the participants, the facilitator formulated research questions that would lead to the attainment of their aim of improving their praxis. This study set out to explore the influence of a TC as a Teacher Professional Development (TPD) strategy necessary to promote Foundation Phase Mathematics teaching within the context of a Teacher Collective.

To accomplish the aim of the study, it became necessary to formulate a research question (stated in paragraph 5.1 above) that would lead to attainment of the research objective.

The literature around the influence of a Teacher Collective in the development of Mathematical Knowledge for Teaching (MKT) for teachers turned out to be of importance during the literature review conducted for the current study. A case study approach was used as an attempt to explore a small group of grade three teachers' experiences of, and reflections on a TC that employed a particular strategy (Lesson Study) to develop teacher MKT. Through the use of a semi-structured interviews instrument developed for this study and personal journals, data were collected which addressed the research problems posed in the first chapter of this dissertation. This current chapter draws all the themes together to draw some sort of conclusion as to whether a TC, using a Lesson Study approach has the potential to be an effective TPD strategy to develop grade three Mathematics for teachers' MKT.

5.3 CONCLUSION DRAWN FROM THE FINDINGS

The findings of this study broadens the view of Weber (2011) highlighted in paragraph 2.2.4 (chapter 2) regarding potential implementation and sustainability strategies for promoting a Teacher Collective by providing practical guidelines for teachers who wish to initiate and lead their own Communities of Practice in the form of a TC.

5.3.1 Underlying principles

The following principles served as the fundamental source of conduct that might help members of the group to function as a collective.

5.3.1.1 Voluntary membership

One of the fundamental principles of the TC explored in this study is voluntary membership. According to Wenger et al. (2002), this form of a cooperative group can evolve naturally as a result of the participants who share a common need or same idea. It is open to individuals who are willing to accept the responsibilities of membership.

5.3.1.2 Democratic member controls

A TC is a controlled by its members. Members became actively involved in drawing up policies or terms of reference, or memorandum of understanding for their TC. All members of the group have equal rights in decision making.

5.3.1.3 The power of face-to-face interaction in building trust leading to self-efficacy

Face-to-face interaction applied from the beginning of the TC provided members an incentive to stay engaged and facilitate a healthy-relationship between members of their Community of Practice. Social interactions that emerged in this study strengthened the relationships among members of the TC and enabled them to pursue interests of their domain with ease. A Lesson Study approach required participants to meet on several occasions to discuss strategies needed to perform their tasks and to carry out activities as a collective. Such engagements strengthened collaboration and trust between members of the collective. Participants believed on the reliability of the lesson observation feedback presented by the observers pertaining to both learners' performance and presenter's participation.

As Ono and Ferreira (2010), in the post-lesson discussion because the talk was not centred on the choices the individual participants made. The group planned the lesson, determined the lesson tasks/activities and agreed on sequencing of activities together. Meaning that, all

members of the group thus have a stake in the success of the lesson. In situations where the lesson was problematic, they determined together how to change the task to be more effective for facilitating learners' understanding. This builds on the notions that through collaboration, teachers can build self-efficacy or individual's belief that they can succeed or accomplish certain tasks. Interdependency was evident when participants worked collaboratively as a Community of Practice to discussed and solved problems that confront their colleagues in teaching as a collective. They became facilitators of best practice as they can gather evidence through interactive planning, lesson observation and post lesson discussion to support each other. Knowledge was generated in a socio-cultural setting and view learning as participation in a social activity. Cheng (2011) came to a conclusion that a culture of trust cultivates a shared vision and identity of the group.

Seemingly, activities of the Teacher Collective were built on mutual respect and trust. Thus, engagement in activities of the TC inspired willingness to teach in front of colleagues, share ideas, ask questions and listen carefully. For example, in chapter 4, paragraph 4.4.2.2, T5 said "*at the beginning, I did not want to appear as stupid in front of my colleagues"*. However, she further indicated that observing lessons presented by her colleagues and listening to constructive observations of her own teaching boosted her self-esteem and self-confidence. Social interaction, sense of belonging and engagement, and trust that developed kept members of the TC together.

5.3.1.4 Sustainability: Resilience and assertiveness

The results of this study revealed determination and the firm belief of the participants on their TC initiative, regardless of its shortcomings. Initially, their TC lacked structure as there was no action plan in place and no goals, resulting in an ineffective functioning group. The resulting frustration within the group at getting what they thought was a 'good idea' working effectively led them to seek out facilitation assistance. However, working collaboratively was still their chosen option to address the challenges they faced in teaching Mathematics. Their resilience led to the introduction and application of the items adapted from Ronfeldt et al. (2015) survey question about collaboration in instructional teams. Thus, participants were able to articulate the functions of their TC with confidence. As stated by Wenger et al. (2002), these participants pursued interests of their domain by planning and doing activities collaboratively as a team.

Participants' determination and resilience to see their TC working and helping them to their intended outcome, led to adoption of a Lesson Study, regarded by its Japanese developers and South Africans implementers as a tool used to strengthen teacher collaboration and the development of both Pedagogical and Subject Content Knowledge for Teaching (Ono & Ferreira, 2010). In the adoption of a LS, they identified one of its three implementation phases known as lesson observation presented in Ono and Ferreira (2010) as a hurdle that could result in possible failure of the TC. For instance, they identified lesson observation as one of the key developmental factors, but doing that during school hours was not allowed in their school contexts. This TC, out of its own initiative set up school-based teams (see chapter four) and collaboratively agreed to have a coordinator (from each member-school). One of the duties of the coordinator was to be a liaison between the School principal and the school-based team (SMT). They negotiated and got their principals permission to observe lesson presentation during normal teaching time. Their principals together with the school management teams accepted school-based lesson observations during teaching time. To cultivate and nurture the culture of collaboration, school principals and SMTs negotiated and found parent-volunteers as teacher-replacements for the duration of lesson observation (see paragraphs 4.2.1.2 and 4.3.1 in chapter 4). Results of this study reveal that an effective TPD opportunity (as this TC was) motivated individual participants to sacrifice and spend their own free time planning and talking about their classroom experiences. For example, T2 wrote in her personal journal,

> *These days, I find myself spending my 'break time' talking with my colleagues about my classroom experiences. Sometimes, I bring learners work to show my colleagues. My engagement in a Teacher Collective helped me to open up, and talk freely about my classroom experiences. Before participation in a teacher collective, I did not want other teachers to know my inadequacies and pretended as if all goes well. My participation in a teacher collective and my engagement in a Lesson Study taught me to ask question, to study curriculum and feel free to talk about my own teaching*.

In this case, as indicated in chapter 2, paragraph 2.2.5 neither bureaucratic ideologies nor external forces hampered their decisions or derailed creative solution to challenges (Cheng, 2011). Instead, it was the participants themselves who decided about the nature and future of their social-interactions. Interaction with and development of a wider network of colleagues, school management teams and parental involvement was the sufficient reason for these

participants to belong (sustain their membership) to a Teacher Collective and continue with their professional development activities (see paragraphs 4.2.1.2 and 4.3.1 in chapter 4).

As identified in Ono and Ferreira (2010) and Doig and Groves (2011), participants in this study viewed classroom or lesson observation as important component of teacher professional growth. Lesson observation did not only provide participants with the first-hand information necessary for post-lesson presentation. It provided opportunities for content knowledge and skills development. Constructive feedback was modelled as one of the building blocks for trust and positive self-esteem in professional development. The self-confidence of the teachers was boosted, in that, before the LS they were reluctant to teach in front of their colleagues but after the LS exercise, they displayed a new level of confidence. The source of the new level of confidence was trust and the interdependent nature of the LS approach in that the individual knew that they were not presenting individually planned lessons but those of the collective. Members of the TC allowed their classrooms performance to be open to collaborative enquiry and comment. Now, teaching became a public activity (Doig & Groves, 2011).

5.3.2 Guidelines

The following guidelines that emerged during the process of data analysis provides a framework for establishment and facilitation of a TC. However, these guidelines are not intended to be prescriptive and cannot be applied as a blanket approach as various forms of Teacher Collectives may differ according to their specific purposes and membership.

5.3.2.1 Purpose: Formation of a Teacher Collective

During formation or establishment of a Teacher Collective, at its initial stages (or at the first meeting) members of the collective should brainstorm and agree on the purpose of their collaborative. In chapter 2, paragraphs 2.2.2 and 2.2.5 reflect a common view of Cheng (2011) and Wenger et al. (2002) of the purpose and definition of the Community of Practice. They described a Community of Practice as professional development platforms where members gain intellectual and practical skills from their colleagues, in a reciprocal process. This view was expressed by the participants of the current study (chapter 4, paragraphs 4.2.2.1) that they wanted to learn from each other. Promotion of equity was an outstanding view of the participants (see chapter 4, paragraphs 4.2.2.2). Members of the group should work as a collective when crafting and defining their specific goals, drawing a programme and deciding

about the tools of communication for their collaborative structure. Thus a TC can be defined as group of participants sharing a common of purpose, who agree to work together to share knowledge and cultivate best classroom practice. They also work together to solve problems facing them.

5.3.2.2 Setting goals as collective

Collective goal setting should be the desire for every cooperative structure to be successful in its undertakings. Weber (2011) showed that without a clear sense of direction collaborations of all shades begin to flounder. The TC initiated by a group of grade three teachers in this study suffered from the exact same frustrations highlighted by Weber when the collective attempted to function without clearly articulated goals. As indicated in in paragraph 1.2 of chapter 1, the TC in this study was unable to survive and prosper without having a sense of direction, in its initial stages. One of the initial challenges of the TC was that participants felt that their collective was not progressing, possible because of their inability to formulate clear goals. That was an indication of a need for identification of the goals that would give direction to the members of the team.

After collective involvement of participants in crafting and reaching an agreement about the goals of their TC, signs of determination and commitment of the members of the TC were observable and uttered with confidence. Members of the TC were all striving to achieve their collective goals. Participants described the benefits of their collective goals as the back-up tool whenever things go wrong, when one of them said, *"our goals will be used as a point of reference when things go wrong"* (T1). In this view, goals are regarded as the fundamental aspect of the collaborative. Collective goal setting exercise necessitated the formation of a shared identity underpinned by goals and values thus making the group appear as a unique (Bandura, 1997; Weber, 2011; Wenger et al., 2002). Conception of the TC initiative was based on the assumption that collaboration will help participants to be responsible for their professional growth by strengthening their instruction through interaction. The main aim was to find and familiarise themselves with a professional development approach that will help them to improve the quality of Foundation Phase Mathematics for teaching.

One of the approaches to identifying goals for a TC is to identify the problem. In this study, the problem started out as being the poor performance of grade three learners in Mathematics,

and as the participants identified this they became aware of potential holes in their own MKT. While considering this aspect of their own expertise, the participants realised the need to get outside help. Findings of this study depict collective goal-setting exercise as a way of describing what the TC wished to accomplish. Thus this exercise should be regarded as the ends toward which the efforts of the group are directed and might change from time to time depending on the needs of the group. Decision about the goal of the TC led to identification and conceptualisation of structural activities.

5.3.2.3 Taking actions as a collective

In a TC, participants should identify and develop shared practice and tools of engagement. A collective might set up projects or tasks that would help to achieve the goals of their collaboration. They (participants) should engage purposeful actions that would help to carry out their projects. An example of one of the tools of engagement is provided below:

5.3.2.3.1 A Lesson Study as a tool necessary to enhance teacher collaboration

The individual participants described the LS experience as a well organised collaborative exercise. They were exposed to a series of activities, such as joint planning, studying curriculum and deciding about suitable teaching and learning strategies, lesson observation, etc. This finding links with the literature that depicts a Lesson Study's potential to build shared understanding about the curriculum, classroom teaching and thinking about learners' participation (Bocala, 2015; Doig & Groves, 2011; Ono & Ferreira, 2010). During both group and individual interviews, the importance of the LS exercise to the teacher collaboration identified by Ono and Ferreira (2010) was prominent. In this study, a LS proved to be a suitable approach to promote teacher collaboration and the classroom practice.

5.3.2.4 The Domain: Development of Mathematical Knowledge for Teaching

This section of the study was used to set a context for the development of a TC. The focus was on two aspects of Mathematical Knowledge for Teaching, namely Subject Content Knowledge (SCK) and Pedagogical Knowledge for Teaching (PCK). Mathematics tasks prepared and used in this section were not meant to examine participants understanding or SCK. Instead, the aim was to understand the knowledge participants have about common conceptions and

misconception that learners bring to the classroom or develop as they learn a subject (Ball et al., 2008), since one of reasons for setting up a TC (by the participants) was to enhance learner performances in Mathematics. Before engagement in the LS approach, participants showed, what can be described as a 'correct answer or one single method approach', but after engaging in a collaborative exercise, the individuals displayed a more in-depth analysis of learner solution strategies. For example, they were able to think about the source of the learners' errors. They became more innovative in implementing the solution strategies in that they were not looking at learners' answers as just correct or incorrect but were able to analyse errors and establish proof for solutions and explain procedures effectively. They were accommodative of the learners' innovative strategies of arriving at the (correct/incorrect) solution. Similarly to the findings of Ball et al. (2008), these participants displayed an ability to size up the cause of the mathematical error and provided factual analysis of learner solutions.

According to (Ball et al., 2008, p. 397), "skilful teaching require being able to size up the source of a mathematical error". Teachers are expected to always be alert and quick to spot errors done by learners in their classroom. Teachers of Mathematics are advised to solve the problems and familiarise themselves with all possible answers, solutions strategies and errors that learners might make, be the act of teaching (Ball et al., 2008). Seeing an answer just as correct or incorrect does not empower the teacher with detailed Mathematical Knowledge for Teaching needed to understand and skilful support the learners need to solve such problems. Thus, SCK and KCT are crucial for a teacher to be in a position to analyse errors, establish proofs for solutions and explain procedures efficiently and effectively (Ball et al., 2008). Hence, a LS approach discussed in chapter 2, deemed appropriate (TPD strategy) to promote collaboration in detailed study and understanding of the subject matter.

5.3.2.5 Facilitation strategy

One of the possible reasons for the initial failure of the participants to sustain their TC was their inexperience in such or similar projects. Their only experience of TPD was that of the DBE, which was mainly externally initiated and driven, involving short-term and sometimes ad hoc actions. Examples of such models of TPD are: the Cascade model discussed in paragraph 2.2.1 of chapter 2 and Cluster model discussed in 2.2.3 of chapter 2. A TC by its very nature, is meant to be sustainable for a long period and this require participants' motivation, resilience and good strategic planning. Teachers such as those in this study

possessed the motivation and resilience, but lacked experience in planning strategic TPD. In is in this context that external facilitation is useful.

In teacher development, facilitation strategies should allow for active involvement of the participants. From my experience during this study, I believe that facilitation should be a shared activity that seeks to empower all those involved. The ultimate goal is for teachers to be able to establish and sustain their own TC, but to achieve this goal may require short –term external facilitator. One of the roles of a facilitator is to bring into the group ideas and activities designed to address the problem. In this study, the introduction of a specific strategic approach to tackle the problem, known as the Lesson Study provided such a practice changing perspective.

The LS allowed for purposeful facilitation methods that were agreed upon and appreciated by the collective. Such facilitation helped to counteract domination and promote a balanced power relation between members of the TC and their external facilitator, which was also discovered in a study of Weber (2011). The same view of purposeful facilitation was strongly recommended in a study done by Ronfeldt et al. (2015), Thus, I regarded such facilitation as the key component of the TC activities that helped to bring about a sense of ownership; self-reliance and interdependence among members of the team. I came to a conclusion that a carefully structured TPD programme offered through a Lesson Study approach and sought to address the needs of the participants can promote quality of Mathematics Teaching at the Foundation Phase.

5.4 CONCLUDING REMARKS

The potential for a TC as a supplemental or alternative TPD strategy to that of the traditional DBE approaches has been foregrounded by this study. The use of the Lesson Study approach as the primary activity in a TC context appeared to enhance the professional expertise of these participants in this their unique context. This small-scale case study, while being useful in generating some principles and guidelines for a TC did not take into account, or attempt to investigate the concept of an effective TC within the reality of the many different teaching contexts in South Africa. It might be of value to replicate this study in some of these other contexts, e.g. rural schools.

In this study, the MKT of the participants provided a context. Within the TC participants made reference to another aspect of teaching mathematics to the grade threes: the language of teaching and learning that might fruitfully be used as topic the Teacher Collective. Although the language of learning and teaching (LOLT) aspect was not part of this study, it emerged as a challenge that contributes to poor performance in Mathematics of grade three isiXhosa speaking learners. Foundation Phase teachers are expected to teach Mathematics in the learner's home language, which in this case is isiXhosa, but there is not enough literature to support them. In addition, when translated into isiXhosa some of the concepts are not familiar to both the learners and the teachers due to different regional dialects.

Finally, more research is needed to understand the impact of a TC on learner performances because this study focussed only on strengthening the TC and also the development of Mathematical Knowledge for Teaching, in particular how to approach learner solutions in number sense development.

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APPENDIX A: PERMISSION GRANTED BY THE DEPARTMENT OF BASIC EDUCATION

Province of the
EASTERN CAPE
EDUCATION

Port Elizabeth District
Ethel Valentine Building • Sutton Road • Sidwell • Port Elizabeth • Eastern Cape
Private Bag X3931 • North End • Port Elizabeth • 6056 • REPUBLIC OF SOUTH AFRICA
Tel: +27 (0)41-4034400 • Fax: +27 (0)41-4510193 • Website: www.ecdoe.gov.za

Enquiries: Dr Nyathi Ntsiko Email: nyathi.ntsiko@edu.ecprov.gov.za

Ms T. Hlam
Researcher
c/o Dr L. Meiring
Supervisor
Nelson Mandela Metropolitan University
Port Elizabeth
Email: leslie.meiring@nmmu.ac.za // thandiwe.hlam@nmmu.ac.za

Dear Ms Hlam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN DEPARTMENTAL SCHOOLS: PORT ELIZABETH

I refer to your letter dated 13 July 2015.

Permission is hereby granted for you to conduct your research on the following conditions:

1. Your research must be conducted on a voluntary basis.
2. All ethical issues relating to research must be honoured.
3. Your research is subject to the internal rules of the school, including its curricular programme and its code of conduct and must not interfere in the day-to-day routine of the school.

Kindly present a copy of this letter to the principal as proof of permission.

I wish you good luck in your research.

Yours faithfully

DR NYATHI NTSIKO
DISTRICT DIRECTOR: PORT ELIZABETH
/ab

20 July 2015

building blocks for growth

PGDP EASTERN CAPE 2004 - 2014
Ikamva eliqaqambileyo!

APPENDIX B: PERMISSION GRANTED BY NMMU FACULTY OF EDUCATION

FACULTY OF EDUCATION
Tel. +27 (0)41 504 2125
Fax. +27 (0)41 504 9383

26 August 2015
Dr L Meiring / Ms T Hlam
Education Faculty
NMMU

Dear Dr Meiring / Ms Hlam

A teacher collective as a professional development approach to promote Foundation Phase Mathematics teaching

Your above-entitled application for ethics approval was approved by the Faculty Research, Technology and Innovation Committee of Education (ERTIC) at the meeting held on 4 August 2015.

We take pleasure in informing you that the application was approved by the Committee.

The ethics clearance reference number is **H15-EDU-ERE-019**.

We wish you well with the project. Please inform your co-investigators of the outcome, and convey our best wishes.

Yours sincerely

Ms J Elliott-Gentry
Secretary: ERTIC

APPENDIX C: INFORMATION AND INFORMED CONSENT

NELSON MANDELA METROPOLITAN UNIVERSITY
INFORMATION AND INFORMED CONSENT FORM

RESEARCHER'S DETAILS	
Title of the research project	A teacher collective as a professional development approach to promote foundation phase Mathematics teaching
Principal investigator	Thandiwe Lillian Hlam
Address	173 Aspen Court, 1 Cranwell Drive, Humewood Ext, Port Elizabeth (6001)
Postal Code	Same as above
Contact telephone number (private numbers not advisable)	Landline: 041 504 4305 Cell: 079 291 4566

A. DECLARATION BY PARTICIPANT		**Initial**
I, the participant and the undersigned	(full names)	

A.1 HEREBY CONFIRM AS FOLLOWS:		**Initial**
I, the participant, was invited to participate in the above-mentioned research project		
that is being undertaken by	Thandiwe Hlam	
From	Faculty of Education of the Nelson Mandela Metropolitan University.	

THE FOLLOWING ASPECTS HAVE BEEN EXPLAINED TO ME, THE PARTICIPANT:					**Initial**
2.1	**Aim:**	The investigator is studying towards Masters in Education The information will be used for teacher education			
2.2	**Procedures:**	I understand that the data will be generated and collected at three levels: Level 1: Semi-structured (group) interviews Level 2: Intervention programme – workshops, lesson presentation, and group discussion Level 3: Semi-structured (individual) interviews			
2.3	**Risks:**	Not for seen or established yet.			
2.4	**Possible benefits:**	As a result of my participation in this study I might learn more ways of working in collaboration with others and take responsibility for my own professional growth and that of my colleagues			
2.5	**Confidentiality:**	My identity will not be revealed in any discussion, description or scientific publications by the investigators.			
2.6	**Access to findings:**	Any new information or benefit that develops during the course of the study will be shared as follows: • Teacher professional developments sessions • Reports published at conferences and teacher education journals			
2.6	**Voluntary participation/refusal /discontinuation:**	My participation is voluntary	YES	NO	
		My decision whether or not to participate will in no way affect my present or future employment.	TRUE	FALSE	

3. THE INFORMATION ABOVE WAS EXPLAINED TO ME/THE PARTICIPANT BY:									**Initial**
Mrs Thandiwe Hlam									
in	**Afrikaans**		**English**	X	**Xhosa**	X	**Other**		
and I am in command of this language, **or** it was satisfactorily translated to me by									
Mrs Hlam									
I was given the opportunity to ask questions and all these questions were answered satisfactorily.									

4.	No pressure was exerted on me to consent to participation and I understand that I may withdraw at any stage without penalisation.	
5.	Participation in this study will not result in any additional cost to myself.	

A. I HEREBY VOLUNTARILY CONSENT TO PARTICIPATE IN THE ABOVE-MENTIONED PROJECT:		
Signed/confirmed at	on	20
Signature or right thumb print of participant	Signature of witness:	
	Full name of witness:	

B. STATEMENT BY OR ON BEHALF OF INVESTIGATOR(S)									
I,	Thandiwe Hlam							declare that:	
1.	I have explained the information given in this document to							Participant:	
2.	He / she was encouraged and given ample time to ask me any questions;								
3.	This conversation was conducted in	**Afrikaans**		**English**	X	**Xhosa**	X	**Other**	
	And no translator was used OR this conversation was translated into								
	IsiXhosa		by	Thandiwe Hlam					
4.	I have detached Section D and handed it to the participant					YES		NO	
Signed/confirmed at			on					20	
Signature of interviewer			Signature of witness:						
			Full name of witness:						

C. DECLARATION BY TRANSLATOR (WHEN APPLICABLE)			
I,	Thandiwe Hlam		
Qualifications and/or	Bachelor of Education Honours Degree		
Current employment	Associate Lecturer		
confirm that I: Thandiwe Hlam			
1.	Translated the contents of this document from English into		IsiXhosa
2.	Also translated questions posed by	(name of participant)	as well as the answers given by the investigator/representative;
3.	Conveyed a factually correct version of what was related to me.		
Signed/confirmed at	on		20
I hereby declare that all information acquired by me for the purposes of this study will be kept confidential.			
Signature of translator	Signature of witness:		
	Full name of witness:		

APPENDIX D: WRITTEN INFORMATION GIVEN TO SCHOOL PRINCIPALS PRIOR PARTICIPATION

• PO Box 77000 • Nelson Mandela Metropolitan University
• Port Elizabeth • 6031 • South Africa • www.nmmu.ac.za

Nelson Mandela Metropolitan University
for tomorrow

17 September 2015

The Principal

Sir/Madam

RE: A TEACHER COLLECTIVE AS A PROFESSIONAL DEVELOPMENT APPROACH TO PROMOTE FOUNDATION PHASE MATHEMATICS TEACHING

Project Information Statement/Letter of Invitation to School Principals

My name is Thandiwe Hlam, and I am a M.Ed. student at the Nelson Mandela Metropolitan University (NMMU). I am conducting research on teacher education under the supervision of Dr Leslie Meiring of Nelson Mandela Metropolitan University. The Port Elizabeth District Department of Education has given approval to approach schools for my research. A copy of their approval is contained with this letter. I invite you to consider taking part in this research. This study will meet the requirements of the Research Ethics Committee (Human) of the NMMU.

Aims of the Research

This study aims to strengthen and explore viability and effects of a teacher collective initiated by FP teachers to promote quality of teaching of Mathematics.

Benefits of the Research to Schools

The Study aims to strengthen functioning of teacher collaboration as a professional development strategy to promote effective teaching of Foundation Mathematics. Participants will be exposed to the lesson study approach whereby teachers plan together, implement the plan, observe each other's lesson and reflect on their findings.

Target group:

Grade three teachers

Research Plan and Method

Semi structured (group and individual) interviews and personal journal writing will be used to collect data. Only those who consent will participate in the proposed study.

At the initial stage of the project, semi-structured (group) interviews will be conducted by the researcher. Semi-structured (group) interviews will be followed with workshops and lesson presentations scheduled to take place during the first and second week of each month. Workshops will be conducted after school. Mathematics Lesson will be presented during normal time (i.e. during Mathematics period). The programme of intervention will be followed with semi-structured (individual) interviews. Participants are required to keep a journal to record their experiences, during the programme of intervention

All information collected will be treated in strictest confidence. Neither the school nor individual teachers will be identifiable in any reports that are written. Participants may withdraw from the study at any time without penalty. The role of the school is voluntary and the School Principal may decide to withdraw the school's participation at any time without penalty.

Invitation to Participate

If you would like your school to participate in this research, please complete and return the attached form.

Thank you for taking the time to read this information.

Thandiwe Hlam
Researcher
NMMU

Dr Leslie Meiring
Supervisor
NMMU

APPENDIX E: INTERVIEW SCHEDULE

SECTION A: SEMI-STRUCTERED INTERVIEW

I would like us to talk about your teacher collective. As we have agreed, I will use audio tape recorder during interviews as I may not be able to write all your responses now. All members of the group should participate in the interview.

1. What are your expectations from a teacher collective?

2. Tell me: What are the intended goals of your teacher collaboration?

   Prompt:

   a. How will you ensure that your teacher collective achieves its intended goals?
   b. If you **have not decided** yet about the goals of your teacher collective:
      - Do you think it is important to set goals for your teacher collaboration? *Why do you think so?*
      - If you were to decide about setting goals for your group, what would be the most important goals of your teacher collective?

3. How does your group take charge for the effective functioning of your collective?
   Prompt: (Participants will be provided a copy of this prompt)
   a. Look at the table below as a group and indicate to what extent you agree or disagree with the following statements.

Matric Questions using Likert scale	Select and **tick** only **one box** in each row				
Your expectations can be achieved if your group collectively:	Strongly Agree	Agree	Not sure	Disagree	Strongly disagree
Formulate the goals of your teacher collectives					
Study curriculum and teaching material					
Draw up lesson plans and develop instructional strategies					
Visit each other's classroom to observe lesson presentation					
Reflect on lesson presentation and planning process					
Address classroom management issues					
Reviewing learners' classroom work					
Discuss the needs of the learners including challenges					
Reach a mutual agreement of nominating coordinators					

4. Which of the following activities do you think may strengthen and promote effectiveness of your mathematics teacher collective? Look and respond as a group

Activity	**Tick only those seem to be suitable**	**Tick to indicate your proposed frequency**			
		Weekly	**Monthly**	**Quarterly**	**Semester**
Workshop/ planning sessions					
Reflection and planning meetings					
Classroom-based support					
Other: (Specify)					

Prompt:

a. We have talk quite a bit about envisaged activities of your teacher collective. Will these collaborative activities enhance your mathematical knowledge for teaching? *Why do you think so?*

5. Tell me: Your colleague has a problem. Most of her learners find it difficult to apply the four basic operations on numbers bigger than 100. How will you help her?

Prompts:

a. How about inviting her/him to observe a lesson in your classroom?
b. Do you think will it be possible for you to visit each other's classrooms?
c. Have you thought of planning and conduct workshops for your group?
d. How about arranging meetings where you will sit as a group and reflect at your own teaching and on performance of your learners as well?

6. What are your views concerning your engagement in a teacher collective?

7. Statements provided below describe difficulties that may face a teacher collective and prevent your teacher collective from achieving its goals. Tick a box on the right next to a statement (or statements) that shows difficulties faced by your teacher collective.

	Tick
a. Resistance of teachers to adopt and apply suggested ways of teaching and learning	
b. Lack of social interaction: Working in isolated classrooms without creating opportunities to visit and observe your colleagues in their classrooms	
c. Lack of resources and facilities	
d. Lack of commitment of members of the group	
e. Poor communication	
f. Dependence on ('outsider') workshop facilitator and not learn to do things at our own	

Prompt: Why do you think so? Are there possible ways of addressing that?

8. Is there anything else that you would like to tell me about your teacher collective?

SECTION B: MARK WITH X OR CIRCLE THE MOST APPROPRIATE ANSWER

1. Ms. Walker's class was working on finding patterns on the 100's chart. A learner, Zola noticed an interesting pattern. She said that if you draw a plus sign like the one shown below, the sum of the numbers in the vertical line of the plus sign equals the sum of the numbers in the horizontal line of the plus sign (i.e., 22 + 32 + 42 = 31 + 32 + 33).

   Which of the following student explanations shows sufficient understanding of why this is true for all similar plus signs? (Mark ONE answer and give reasons for your answer in a box provided below)

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

	Yes	No	I'm not sure
i. The average of the three vertical numbers equals the average of the three horizontal numbers.	1	2	3
ii. Both pieces of the plus sign add up to 96.	1	2	3
iii. No matter where the plus sign is, both pieces of the plus sign add up to three times the middle number.	1	2	3
iv. The vertical numbers are 10 less and 10 more than the middle number.	1	2	3
Write your explanation here:			

2. Imagine that you are working with your class on multiplying large numbers. Among your students' papers, you notice that some have displayed their work in the following ways:

Learner A	Learner B	Learner C
26 x 13 78 + 26 = 338	26 x 13 78 + 260 = 338	26 x 13 18 60 60 + 200 = 338

   Which of these students would you judge to be using a method that could be used to multiply any two whole numbers? Give reasons for your answer in a box provided below

	Method would work for all whole numbers.	Method would work for all whole numbers.	I'm not sure.
i. Method A.	1	2	3
ii. Method B	1	2	3
iii. Method C.	1	2	3

3. Imagine that you are working with your class on multiplying large numbers. Among your students' papers, you notice that some have displayed their work in the following ways:

What mathematical steps would produce this error?	i. What is going on mathematically in each case below?		
	Learner 2	**Learner 3**	**Learner 4**
Learner 1: 307 - 68 = 169	307 - 168 - 1 - 60 200 = 139	307 - 168 = 139	307 - 168 3 30 107 = 139
Explain how you would approach such challenges in your classroom?			