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Mathematics Teachers' Reflective Practices within the Lesson Study Context

by

Dumisani Simon Maphanga

Submitted in fulfilment of the requirements for the degree of

PHILOSOPHIAE DOCTOR

in the Faculty of Education

at the

UNIVERSITY OF PRETORIA

Supervisor: Dr R.D. Sekao
Co-supervisor: Prof U.I. Ogbonnaya

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Declaration

I, Dumisani Simon Maphanga (Student number: 22821831), declare that the dissertation titled **Mathematics teachers' reflective practices within the Lesson Study context,** which I hereby submit for the degree in Philosophiae Doctor at the University of Pretoria, is my work and has not previously been submitted by me for a degree at this or any other tertiary institution.

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The author, whose name appears on the title page of this dissertation, has obtained the applicable research ethics approval for the research described in this work.

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Dedication

I would like to dedicate this degree to my Lord and Saviour Jesus Christ for enabling me to persevere till the end; to the Maphanga family for their understanding and patience in allowing me to study further; to the Gauteng Department of Education, where I am currently employed; and to the Church of End-Time Gospel, in which I currently serve.

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Abstract

The ability of teachers to reflect upon teaching and learning processes has become the key factor for professional development (PD) in recent times. In my qualitative case study research, situated within the interpretivist paradigm, I explored Mathematics Teachers' Reflective Practices within the Lesson Study (LS) setting. Six teachers who constituted an LS team were purposively and conveniently selected based on their experience using LS in their school and being willing and accessible to participate in my study, respectively. My study was guided by two theoretical lenses: Social Constructivist Theory (SCT) and Gibbs' Reflective Cycle. Data were collected through lesson observation, document analysis and semi-structured interviews to answer the primary research question: How do mathematics teachers acquire learning through post-lesson reflection in LS? The following main findings were revealed: (a) teachers follow a structural format of doing reflections; (b) teachers reflect on pedagogical and content knowledge as part of their learning experiences; (c) teachers conduct post-lesson reflection based on the observation tool to gauge the achievement of the lesson objectives; (d) teachers benefit in doing post-lesson reflection regarding how learners respond to different teaching methods which leads to their understanding of the mathematics concepts and lesson improvement; and (e) although teachers demonstrated a fair understanding of conducting reflection, there were hindrances regarding the quality of their reflections which lacked mathematical rigour. I propose a modified LS model with an easy-to-follow reflective cycle to enhance structured and focused reflection.

Keywords: Lesson study, reflective practice, post-lesson reflection, critical reflection, professional development.

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Date of Completion: 22 October 2024, which marks the finality and closure of Busy Bee Editing's involvement in the proofreading and editing process of the PhD Dissertation, provides reassurance of the thoroughness and completion of our work.

List of Abbreviations

ATP	Annual Teaching Plan
ANA	Annual National Assessments
DBE	Department of Basic Education
FET	Further Education and Training
GET	General Education and Training
GDE	Gauteng Department of Education
HEI	Higher Education Institution
ITERP	Initial Teacher Education Research Project
IP	Intermediate Phase
JICA	Japan International Cooperation Agency
LS	Lesson Study
PCK	Pedagogical Content Knowledge
PD	Professional development
PLC	Professional Learning Communities
PLR	Post-lesson reflection
PSC	Problem-solving cycle
PSA	Problem-Solving Approaches
RQ	Research question
SA	South Africa
SACMEQ	Southern and Eastern Consortium for Measuring Education Quality
SCT	Social Constructivist Theory
SMT	School Management Team
SP	Senior Phase
SRQ	Secondary research question
TD	Teacher development
TIMSS	Trends in Mathematics and Science Study
TOT	Teacher observation tools
UP	University of Pretoria
US	United States
ZPD	Zone of Proximal Development

Description of Key Terms

Critical reflection challenges assumptions and beliefs about how certain mathematical concepts have always been taught based on how the learners have responded to the lesson (Gutierez, 2015).

Lesson Study—*jugyoukenkyuu* in Japanese—is a teacher development model in which teachers plan a lesson together, identify common learning challenges, and observe one teacher presenting in class. They then reflect on improving the lesson (Takahashi & McDougal, 2016).

Mathematical thinking is the display of mathematical procedures and connections in solving a mathematical problem using mathematical language, especially in problem-solving. These include procedural fluency, conceptual understanding, and adaptive reasoning (Tohir et al., 2020).

Professional development is structured professional learning that changes teacher knowledge and practices, improving learner performance (Darling-Hammond et al., 2017).

Reflection is thinking about an action before, during, or after it has happened to understand it better (Tan, 2021).

Reflective practice is a regular action of examining one's teaching philosophy about teaching and learning about the actual lesson to be presented before, during, and after it has taken place (Olteneanu, 2017).

Teacher learning (teachers' learning) is the active participation of teachers focusing on how the content can be taught to develop their pedagogical knowledge (Shuilleabhain & Clivaz, 2017).

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CHAPTER 1: GENERAL ORIENTATION OF THE STUDY

1.1 INTRODUCTION

The issues about mathematics achievement among learners in South Africa (SA) compared to their international counterparts (i.e. within and outside the African continent) have sparked concerns and attracted criticism from numerous institutions and individuals. The Trends in Mathematics and Science Study (TIMSS), the Southern and Eastern Consortium for Measuring Education Quality (SACMEQ), and the now defunct Annual National Assessments (ANA) provided reliable information about the health of mathematics achievement internationally, regionally, and locally.

SA has participated in TIMSS at the level of Grade 8 since 1995 and at the Grade 9 level since 2003 (Mullis et al., 2015). TIMSS 2003 included Grades 8 and 9 learners, allowing for a performance trend measure from 1995 to 2019. The South African performance in TIMSS 2019, of the 39 countries which took part, was 389 in mathematics and was far below the average score of 500 points (Reddy et al., 2022). The TIMSS 2011 Highlights Report (Reddy et al., 2012) and the TIMSS 2015 Highlights Report (Zuze et al., 2017) provided the details of the achievement scores over the years.

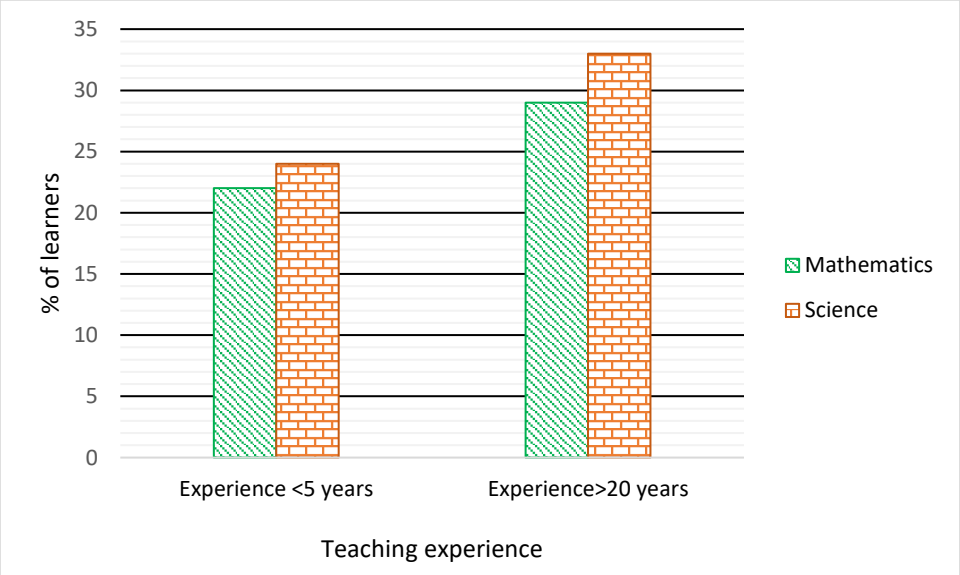
Reddy et al. (2012) revealed that the higher TIMSS marks can determine which learner has a better chance of making it in Grade 12 exams. This implies that TIMSS Grade 8 scores are a good indicator for learners to choose pure mathematics as a subject in further education and training (FET). Hence, learners who attend a secondary school with higher Grade 8 mathematics marks can better pass mathematics in FET.

However, learners' good performances also depend on the expertise and experiences of their teachers.

The TIMSS 2019 report (Reddy et al., 2022) revealed that the minimum teaching experience for mathematics teachers is 14 years and for science teachers 15 years. On the other hand, teachers who have less than five years of teaching experience taught 22% of mathematics and 24% of science learners (see Figure 1.1).

Figure 1.1

Percentage of learners taught according to teachers' experience (Reddy et al., 2022)



On the other hand, teachers with over 10 years of experience taught most learners (57% mathematics and 64% science). However, the report further stated that there was no significant association between the years of experience and achievement, which led to the conclusion that teachers with more experience would have preferred to have their learners achieve better scores. This is concerning since the more

experienced teachers would have had more PD opportunities to improve their teaching than the less experienced teachers. Reddy et al.'s (2022) report recorded that in SA, even though teachers attended many professional courses for professional development (PD), their learners' mathematics and science achievements did not improve.

There is evidence of low levels of mathematical proficiency among teachers. Venkat and Spaull (2015) cited that 79% of South African Grade 6 mathematics teachers were identified as having lower mathematical knowledge levels than those of Grade 6 learners. Taylor (2019) also confirmed from the SACMEQ data that most Grade 6 teachers were found wanting regarding the basic concepts of arithmetic: addition, subtraction, multiplication and division. The SACMEQ report showed low levels of mathematics knowledge among teachers at the Initial Teacher Education Research Project (ITERP). ITERP scrutinised the composition and value of initial teacher education programmes at Higher Education Institutions (HEIs) and the ability of such programmes to satisfy the needs of the South African education system.

ITERP looked at Intermediate Phase (IP) modules in five HEIs on the concepts taught and the tools for evaluating the teaching practice in mathematics studies and discovered that in about four out of the five HEIs, the mathematics content in their courses was based mainly on the content that South African learners encounter in the IP (Grades 4 to 6) and Senior Phase (SP) (Grades 7 to 9), but usually at a much higher level than what was needed at school. Hence, even though the teachers' training was efficient, they were unable to ensure that their learners mastered basic concepts in mathematics. Also, teachers' knowledge seemed to have dwindled after leaving the HEIs and started teaching at schools.

The results of the 2014 ANA indicated that the performance of learners in the SP in mathematics was far lower than the minimum promotion requirements of 40% and 50%, respectively (DBE, 2014). The average performance in mathematics at a national level was 10,8 % in Grade 9. The diagnostic report cited various challenges that learners encountered in certain mathematics concepts, including how to address difficult topics, due to ineffective teaching methods employed by teachers. ANA results and diagnostic reports exposed severe problems in teaching and learning mathematics throughout the system. Thus, serious questions can be raised regarding the nature of PD teachers receive and how it can translate into improved learner attainment in mathematics.

Teachers' ability to reflect upon their teaching practice and learning processes has recently become the key factor for PD (Ningrum et al., 2020). This is because each time learners perform below the expected and acceptable levels, especially in mathematics, debates about which effective methods to use to improve learners' performances begin to appear (Cobb et al., 2020). Consequently, school managers and teachers teaching mathematics have come under severe pressure from most national departments to increase learners' performances in mathematics (Bozkurt & Yetkin-Özdemir, 2018).

The implications regarding the effectiveness of current PD in assisting teachers seem to suggest a need for new approaches that will yield more favourable results. Teachers' reflective practice has attracted research interest over the years (Posthuma, 2012; Daniel et al., 2013; Pretorius & Ford, 2016; Olteneanu, 2017; Bozkurt & Yetkin-Özdemir, 2018; Fox & Poultney, 2020). Bozkurt and Yetkin-Özdemir (2018) stated that it was necessary to investigate teachers' reflective abilities as part of PD to improve

their pedagogical content knowledge. Olteneanu (2017) cited that reflective teaching means that teachers must pay attention to their underlying philosophies about teaching and learning. Teachers must align these beliefs with classroom practice before, during and after a lesson.

To guide teachers on how to reflect effectively, McGlinn and Chung (2014) used Schön's reflective cycle to share insights into how teachers should reflect during and after their lessons. Connelly et al. (2020) revealed that reflection is about more than just thinking about the events of the lesson; it also includes deriving a deeper interpretation of viewing such events with a critical perspective. In my study, I sought the wisdom of authors like Gutierez (2015), who explained that critical reflection challenges the usual methods that have always been used while one is searching for more effective ones. My problem statement section will explain this further.

The benefit of engaging in reflection is that teachers constantly evaluate lessons' progress at each stage to verify whether the lesson is moving towards achieving the intended objectives. If not, they can then make necessary adjustments. Furthermore, Olteneanu (2017) stated that teachers should recognise learners' actions or responses to a learning encounter and quickly redirect them towards achieving lesson objectives. Though teachers can reflect individually, research suggests that reflection is more effective in a community of practice (Fox & Poultney, 2020). Thus, in a community of professionals, teachers learn about how other teachers perceive certain methods of teaching that might not match their own. Then, they might adopt new methods to improve their teaching.

The concept of reflection can be traced back to the Deweyan era (Schön, 1992; Williams, 2017). As an educator, John Dewey felt that people can successfully

confront life's challenges through education and collaborative engagement. His beliefs and philosophy about education and learning transformed many educators and learning theories that could have affected their PD. In understanding reflective practice, Dewey explained that reflection focuses on deeper understanding, personal growth and one's ability to contribute to a collective endeavour (Holdo, 2023).

Widjaja et al. (2017) indicated that reflection or post-lesson discussion is a major component when teachers engage in Lesson Study (LS). Research has revealed that LS has become one of the effective tools in teacher PD because it promotes the phenomenon of reflective practice in a community of professionals (Fox & Poultney, 2020). I will discuss LS in further detail in Chapter 2, but briefly, LS is when a group of teachers plan a lesson together, after which one of them will present it while being observed by the group members; after the lesson, they get together to discuss aspects of the lesson to improve learning outcomes (Huang et al., 2017; Iskandar & Suratno, 2010).

This collaborative work afforded by the LS context can potentially improve teachers' PD in mathematics because an enabling environment to reflect on the lesson is encouraged. Thus, in this study, I have focused on how reflective practice becomes an enabler for teacher development (TD). This reflective practice challenges how current PD models must be adjusted to achieve better outcomes, especially in mathematics teaching and learning (Burleson & Chipidza, 2017). In the literature review, I have highlighted evidence from international research that shows that although there are many studies on developing lessons on how to teach mathematics, there has not been much research that explores teachers' learning through reflection,

including in LS, and how to improve the teaching of mathematics through reflective practice (Widjaja et al., 2017).

Sekao (2023, p. 98) explained critical reflection as the “most insightful and rigorous reflection and portrays the epitome of LS.” Firstly, teachers begin to challenge their assumptions about teaching and learning, and secondly, if teachers alter their teaching strategies, that could lead to better learning objectives. Thirdly and lastly, reflective practice could reveal why learners solve problems the way they do, thereby offering a window into learner thinking and understanding of mathematical concepts. Hence, this insight into learner thinking could also explain the root cause of their challenges.

In setting the scene, I clarified the poor performances of learners in TIMSS, SACMEQ, and ANA. Teachers’ reflective practices and background regarding LS will be discussed in greater detail in my literature review and theoretical framework (Chapter 2 and Chapter 3). Lim-Ratnam et al. (2019) asserted that LS (*jugyoukenkyuu* in Japanese) was acknowledged extensively as an effective engagement for teachers as active learners for their PD. Fujii (2014) and Yin and Fishbein (2019) explained that LS had become known outside of Japan through the “*Teaching the Gap*” publication of TIMSS results, where it was discovered that Japanese learners were performing at the top level in TIMSS assessments due to their teachers’ engagement in LS.

1.2 PROBLEM STATEMENT

Mathematics teaching and learning requires teachers to reflect upon each lesson carefully to achieve the lesson’s objectives (Adler & Alshwaikh, 2019). Sadly, for many teachers, there is an educationally risky assumption that as long as they have given plenty of mathematics exercises to learners, learning will take place without the

learners carefully reflecting on their teaching and how learners learn. Connelly et al. (2020) discovered that for many teachers, the art of reflective practice had been falsely viewed as something they claimed to be doing, but without any written evidence, thus exposing their limited understanding of reflection and what it entailed.

Research from most sources pointed out that most teachers, including those in teacher training institutions, do not engage in reflective exercises to gauge the success of their teaching (Adler & Alshwaikh, 2019; Posthuma, 2012; Pretorius & Ford, 2016; Widjaja et al., 2017). LS makes provision for teachers to reflect on the lessons taught. In fact, as one of the LS stages, post-lesson reflection is an important attribute and a mandatory process of the LS cycle that features all the variations of LS globally. However, the actual process of reflection is often implicit within the LS setting, leaving it up to teachers' discretion on how to conduct post-lesson reflection.

Teachers inevitably tend to focus on the periphery regarding the breadth of reflection and just scratch the surface regarding the depth of reflection. The type of reflection depicted as peripheral and superficial is dubbed descriptive reflection. As its name suggests, descriptive reflection is concerned with describing instructional actions without requiring plausible explanations for such actions (Gutierez, 2015). This starkly contrasts with critical reflection – the highest level in the reflection hierarchy, which is very intense regarding rigour and robustness. It demands that teachers justify their views by answering the why and how questions (Sekao, 2023).

The lack of explicit guidance on reflection within the LS context risks undermining teacher learning – the main outcome for which post-lesson reflection is intended (Fen et al., 2017). The main shortcomings regarding reflective practice in LS, which gravitates towards critical reflection, is that very little guidance is provided on the key

attributes and how to exploit them systematically during post-lesson reflection. The challenges regarding reflection within the LS context are well documented (Burleson & Chipidza, 2017; Posthuma, 2012; Sekao & Engelbrecht, 2022). For instance, often when teachers conduct reflection within the LS context, they focus on trivial issues that may not add value to improve the teaching of mathematics instead of engaging in *critical reflection* to improve their practice and change the methods in which certain concepts have always been taught (Gutierez, 2015).

The work of Sekao and Engelbrecht (2022) revealed that although some teachers acknowledged the usefulness of post-lesson reflection within the LS setting, they still experienced challenges with the execution thereof due to “insufficient knowledge and skills of conducting reflections” (p. 13). Widjaja et al. (2017) observed that little research had focused on the post-lesson reflection stage of LS. By undertaking the current research study, I intended to contribute towards filling the void created by the lack of explicit guidance regarding post-lesson reflection.

1.3 THE RATIONALE FOR THE STUDY

Considering the issues raised in the problem statement, mathematics teachers’ reflective practice requires an in-depth exploration to improve their teaching practice. Such self-introspection and self-regulatory perspective could lead to effective post-lesson reflection with an open mind (Widjaja et al., 2017). Though models of PD have been implemented widely by many education departments, they have not yielded their intended objectives due to the continual poor performance of learners in mathematics (Zuze, 2017).

It is of the utmost importance that my study should inform the education sector, through research, of the affordances of reflection so that they can review their PD programmes

and incorporate reflective practices into their teacher training. These types of teacher training might cause the education sector not to continue running workshops in their current form, which has not yielded the desired results. Hence, my study was necessary to explore how reflection can assist in providing effective PD. To contribute to the research community on teachers' reflective practice through LS, I have conceptualised a model for effective reflection that could be built into the current LS model in SA.

The proposed integrated conceptual model could provide much-needed details regarding the attributes of critical reflection and its implementation within the LS context (Gutierez, 2015). Adler and Alshwaikh (2019) revealed that teachers must begin reflecting on their teaching practices since doing so will improve their teaching and consciousness in every step of their lesson delivery.

Moreover, in this study, I critically analysed, uncovered and addressed hindrances to reflective practice. Overcoming these hindrances to reflection will empower teachers to engage in reflective practice as a normal activity within the community of practice (Nawab et al., 2021). My study suggests new ways of conducting PD by incorporating LS prescripts and reflective practice.

By noting hindrances encountered when engaging in reflective practice, teachers will, in advance, understand how to deal with such problems. However, there is a need to continuously engage in deeper reflection about improving the teaching and learning of mathematics and challenge the status quo of how PD has always been staged.

1.4 RESEARCH PURPOSE AND THE RESEARCH QUESTIONS

The main purpose of my study was to explore mathematics teachers' reflective practice through LS. This exploration was achieved by gaining insights into (a) how teachers conduct post-lesson reflection in mathematics, (b) teachers' learning experiences during post-lesson reflection, (c) the alignment between the information collected during lesson observations and post-lesson reflection, (d) teachers' use of their learning experiences to improve their teaching practice and (e) hindrances to mathematics teachers' reflective practice. The main purpose was realised by addressing a specific primary research question: How do mathematics teachers conduct post-lesson reflection within the LS setting to enhance their teaching practice? The secondary research questions (SRQ), which guided me in collecting data within the context of LS to respond to the primary research question, are presented in the following paragraphs. Underneath each question, I have provided an annotation to situate each question within a particular context to understand their purpose:

SRQ1: How do mathematics teachers conduct post-lesson reflection in LS?

Post-lesson reflection as a PD model needs to follow certain procedures to be well structured and meaningful for teachers since research reveals that not enough guidance is given to teachers on how it should be conducted (Gutierez, 2015). Hence, this research question was posed to investigate how teachers conduct post-lesson reflection in LS and to understand certain steps and procedures conducive to effective reflective practice. Such procedures were necessary to guide teachers to participate rigorously within defined engagement parameters.

SRQ2: What learning experiences do mathematics teachers gain from post-lesson reflection in LS?

It is well documented that if post-lesson reflection is conducted effectively in terms of rigour and depth, it promotes teacher learning, thereby improving teaching practice (Widjaja et al., 2017). The purpose of SRQ2 enabled me to gain insights into teachers' learning experiences during post-lesson reflection as an element of TD within LS. These experiences, after having been well documented, then form part of lesson improvement so that the next time teachers teach the same topic, they can refer to them and thereby improve their teaching practice.

SRQ3: How does the information mathematics teachers collect during lesson observations inform their post-lesson reflection?

From the LS perspective, both the teacher who presents the lesson and those observing the lesson ought to note certain key teaching and learning episodes that emerge from the lesson presentation. Therefore, this SRQ was needed because it assisted me in gaining insights into how the information gathered during the lesson presentation stage permeated into the post-lesson reflection stage. Post-lesson reflection depends on lesson observations, without which there is nothing to reflect on (Myers, 2012).

SRQ4: How do mathematics teachers use their learning experiences to improve their teaching practice after conducting post-lesson reflection in LS?

Daniel et al. (2013) asserted that feedback discussions, as in post-lesson reflection, resulted in teachers contributing meaningfully to their PD, which improved their teaching practices. This means that post-lesson reflection creates an enabling environment for critical reflection, possibly even sustained. Hence, this question was

necessary for me because after teachers have conducted post-lesson reflection, their learning experiences would improve their teaching.

SRQ5: What factors, if any, hinder mathematics teachers' reflective practice in LS?

Since post-lesson reflection in LS is a new practice in SA, it is bound to encounter challenges. Teachers have not yet learnt how to engage in constructive post-lesson reflection (Sekao & Engelbrecht, 2022). This question explored hindrances affecting teachers' ability to reflect on their teaching. As a precautionary measure to this new reflection phenomenon for improving teacher PD, it became necessary to investigate the hindrances needed to conduct post-lesson reflection effectively and identify possible solutions.

1.5 LITERATURE REVIEW

The literature review aims to gather and synthesise relevant research information for a study (Snyder, 2019). The benefit of the literature review chapter is that I was able to consult a range of literature that assisted me in understanding reflective practice in the teaching and learning of mathematics. The range of authors I referred to assisted me in developing and establishing my argument based on existing literature about reflection and displaying a coherent summary. I organised the literature review chapter under the following main headings: Traditional TD methods, PD approaches for contemporary teachers, LS as a progressive TD model for contemporary mathematics classrooms, reflective practice as an inherent feature of LS, improving teaching practice through post-lesson reflection, and lesson observations as a prerequisite for conducting post-lesson reflection within a LS setting. Although the complete account

of the literature review is provided in Chapter 2, the snippets of each heading that constitutes the literature review are presented next.

1.5.1 Traditional Teacher Development Methods

Traditional has been referred to as the lecture-based approach, refers to methods of training where knowledge is transmitted from one individual to a group that receives the information passively with little or no interaction (Waddell & Vartuli, 2015). Lecture-based workshops lack sufficient participation to teach recipients skills they can practise in various contexts. Waddell and Vartuli stated that traditional PD happens only once in a while, such as once a term, to cover a wide range of skills, a process that lacks an in-depth understanding of teachers' needs. Darling-Hammond et al. (2017) revealed that traditional training sessions are usually disconnected from the reality of teachers as what is presented may not necessarily be what the teachers require at that moment to assist their learners.

Eranki and Moudgalya (2016) also stated that when the workshops were over, support for the teachers also stopped, which meant that teachers did not receive assistance if they needed support in applying the skills they had learnt. By implication, traditional PD does not allow teachers to reflect on what they have learnt or how they have been teaching so that they can be persuaded to adopt and sustain new ways of teaching mathematical concepts. Thus, teachers would continue to attend such workshops as often as they can but achieve no significant results in their teaching and in their learners' performances. This observation is in line with the TIMSS 2019 report which showed that even with more experienced teachers who have had more opportunities for PD, their learners' performances were not much higher than those of the less experienced teachers (Reddy et al., 2019).

1.5.2 Professional Development Approaches for Contemporary Teachers

Recent theories of learning on how schooling should happen have brought new training approaches based on classroom practice, and they often require the establishment of professional learning communities (PLC) (Nawab et al., 2021). Williams (2017) described various characteristics of John Dewey's theory of learning such as experiential learning, social learning and social interaction, collaborative learning, critical reflection, curriculum integration, world experience, questioning or inquiry-based learning and emotional responses. Although these characteristics have been addressed in detail in Chapter 2, I have shared a synoptic view of some of them in the following paragraphs:

- Experiential learning advocates that learners must be actively involved in their learning by doing the tasks they have been taught about (Dewey, 2022). Dewey was against teaching methods that supported rote learning as in traditional approaches. Hence, in Dewey's time, the characteristics of traditional PD in which teachers attended workshops and listened passively to the presenter were prevalent. One of Dewey's endeavours was to narrow the gap between the experiences of a learner and the kind of skills instilled into him or her.

- Social learning and social interaction emphasise that learning should occur within a social context whereby learners or teachers work collaboratively and contribute to each other's academic development (Latasha, 2020). Dewey advocated for schools to be social institutions for learners and for classrooms to provide learning opportunities that allowed learners to engage in appropriate social interactions with their peers. The presenter in traditional mathematics workshops should not

be the only source of knowledge. However, participating teachers can generate progressive ideas to empower themselves, mainly when discussing different mathematics methodologies. Traditional PD centres around the presenter and leaves little or no room for active involvement among mathematics teachers.

- Questioning or inquiry-based learning contends that learning should be a democratic process in which learners are not dominated in expressing their solutions about learning or questioning the teachers' methods (Hildebrand, 2022). Based on the principle of active participation, learners' views about what they learn are self-directed and self-managed. In applying this principle to PD, mathematics teachers should also decide on the mathematical content they need to be developed in. In traditional workshops teachers are not part of decision makers regarding the contents of their workshops.

Borko et al. (2015) identified a contemporary model of PD called high-quality PD and its characteristics, which, among others, features a PD that has a problem-solving cycle and uses technology. Moreover, Darling-Hammond et al. (2017) identified characteristics of effective teacher PD. These involved modelling relevant teaching strategies, engaging teachers in active learning, and establishing PLCs (Song et al., 2018).

The above differs from the traditional approach of PD, in which teachers do not get opportunities to model what they have learnt but are nevertheless instructed to implement it in their classrooms (Conlan, 2019). This model of training is necessary when teachers must teach using methods that are different from those they were initially taught or even how they currently teach. This is crucial in my study since during

post-lesson reflection, teachers will learn different methods to teach content to change the status quo, as in critical reflection (Gutierez, 2015). Two features of high-quality PD are the problem-solving cycle and the use of technology. The problem-solving cycle (PSC) is an iterative, long-term approach to TD, aiming at increasing teachers' content knowledge of mathematics for teaching and improving their pedagogic knowledge and that of their learners (Borko et al., 2015).

After teachers teach a concept, they gather to reflect on their observations. This allows them to form an effective PLC that supports reflection. The use of technology in PD includes online discussion forums, typical of synchronous discussions, such as chatrooms where teachers are connected simultaneously and give feedback to each other electronically. Virtual learning platforms comprising asynchronous interactive opportunities, such as bulletin boards, empower teachers to engage in discussions at any time or place, thus fostering collaborative learning.

In addition to the high-quality PD proposed by Borko et al. (2015), Darling-Hammond et al. (2017) identified seven characteristics of effective PD, which I discussed in further detail in Chapter 2. However, brief descriptions of the seven characteristics are as follows:

- **Content-focused:** It has to be subject-related and deal with specific aspects of challenging content that teachers struggle with so that after the training, they are confident enough to teach it, such as fractions or straight-line graphs in mathematics (Conlan, 2019). Darling-Hammond et al. (2017) advocated for a PD that would address particular learners' challenges that teachers can address. For example, learners underperform in topics like fractions and

decimals, and one of the reasons is that teachers struggle to teach these topics.

- **Active learning:** Because adults use their original knowledge capacity and life journeys to aid their learning, mathematics teachers, as adult learners, are much better suited to steer their PD than learners (Budnyk et al., 2023). McConnell et al. (2017) revealed that active learning promotes critical thinking as participants engage with what they are being taught. In mathematics, an investigative teaching approach to teaching is better suited and promotes such learning as teachers engage meaningfully with their development. Through learning, self-discovery among teachers develops in them the confidence in implementing what they have learnt.

- **Support collaboration:** When teachers formulate small group PLCs as explained by Nawab et al. (2021), that these can act as support groups where one or two experienced teachers can coach novice teachers or teachers struggling to teach certain content (Song et al., 2018). Hence, if PLCs can be appropriately managed within the school, especially by the school management team (SMT), these support structures will ensure that the implementation of what teachers were trained on is achieved. This kind of collaboration is a critical factor within LS in which teachers plan a lesson together. After observing how one of them presents the lesson in class, they converge to reflect on the lesson and how it was taught, thereby learning from other teachers.

- **Job-embedded contexts:** Teachers should consider the context of individual teachers, which is their schools and the kind of learners they teach so that they can easily implement new teaching strategies (Conlan, 2019). The LS context happens at the school level, where teachers deal with the contextual teaching challenges of their learners. This means that progressive PD is not a one size fits all approach to teacher training, as in traditional PD, in which all teachers from different contexts are expected to use similar strategies or methods. It is clear that such a method might not work for all teachers. Some of the examples that used in training teachers might not be relevant to their contexts since some teachers come from different schools and with learners from different socio-economic backgrounds as in rural, townships and town schools.

- **Models and modelling of effective practice:** In the LS context, during lesson presentations and observations, teachers model their best teaching methods in the classroom while others learn to implement those methods in their teaching (Borko et al., 2015). On the other hand, the traditional approach offers a lecture method of PD in which the presenter delivers the workshop that does not allow for modelling by participating teachers who perhaps could inspire their colleagues to teach like them and thus be encouraged to implement what they have learnt when they return to their various schools.

- **Provides coaching and expert support:** It must offer avenues for feedback and reflection. This feature is typical of LS post-lesson reflection, whereby after one of the teachers has taught a lesson, teachers meet to reflect in the presence of a knowledgeable other, and expert support is given. As alluded to earlier that in LS, the presence of the knowledgeable others among teachers

reflecting on the lesson, will allow for modelling of effective practice. The availability of a coach who will model good practice at the school level could be worthwhile. This coaching feature among teachers working together and supporting each other at a school level will guarantee the efficiency of they have learned.

- **Sustainable:** The availability of experienced teachers at a school who can coach other teachers and model good teaching is of the utmost importance if, after the workshop, teachers must sustain the methodologies they have learnt. This means that teachers will be able to implement what they have been taught and of their own initiative, develop one another at school level without external support (Budnyk et al., 2023). Many teachers who attend the traditional PD workshops, which are only held once a term or semester, may not able to sustain their learnt knowledge because within the school they may not further support one another (Waddell & Vartuli, 2015).

1.5.3 Lesson Study as a Progressive Teacher Development Model for Contemporary Mathematics Classrooms

In gaining more insight into reflection within the context of LS, I needed to share holistic insights into LS as a TD model. Lim-Ratnam et al. (2019) asserted that LS (jugyoukenkyuu in Japanese) is acknowledged extensively as an effective engagement for teachers as active learners, to improve their PD. Fujji (2014) stated that LS has been practised in Japan for more than a hundred years, and for Japanese teachers, it has become a normal practice. During LS, teachers focus on content and, even more significantly, on how learners learn that particular content. Coenders and Verhoef (2019) had stated that in LS, teachers collaborate in selecting a topic to

prepare a lesson called a research lesson. One of the teachers then presents the research lesson while other teachers observe the learners in class, followed by teachers discussing their observations from the lesson.

Fujii (2014) also warned that educators outside Japan have had to learn about LS in a way that is not as natural, thereby, possibly losing important features of it. Lewis and Perry (2014) conducted LS with teachers to support them in teaching fractions in the United States of America (USA). The USA model of LS required teachers to conduct a cycle of actions - study–plan–do–reflect, which enabled them to bring valuable change into their teaching. Dudley et al. (2019) stated that, after discovering Japan's usage of LS as a tool to improve learner results, teachers had to adapt and adjust LS to suit the UK. De Vries (2016) explained that LS was a relatively new approach to teacher learning in the Netherlands that was spreading rapidly.

In the following paragraphs I briefly discussed how LS has evolved in different countries:

- Indonesia: Lesson Study in Indonesia was formulated around the Plan, Do and See cycle, whereby teachers planned lessons together and made class presentations while other teachers' observations took place. Teachers would then collaborate by reflecting on the teaching that had taken place (Nurwidodo et al., 2018; Iskandar & Suratno, 2010).

- Singapore: Teachers follow specific steps to achieve teaching efforts through collaborative lesson planning in LS. These included defining the problem to guide their study planning and the research lesson. Jiang et al. (2020) stated that teachers identify challenging concepts that learners are experiencing, then

draw up a mathematics lesson plan in which teachers dedicate time to plan a lesson, bringing in different resources to address learning challenges.

- The Philippines: In its adjusted model, LS was implemented in the Philippines in a cycle of Plan, Do and See (Ebaeguin & Stephens, 2014). Ebaeguin and Stephens (2014) encountered challenges implementing LS as a TD model due to societal differences between Japan and the Philippines (Fujii, 2014). In this cycle of Plan, Do and See, during the Plan or planning stage, teachers group themselves to identify a particular goal they want to achieve in their teaching. They then research relevant information to achieve their goals while anticipating how learners will respond to some of their activities and ponder about misconceptions that learners may have.

- China: Huang et al. (2017) revealed that over 100 years ago, in Tianjin, Shanghai and other places in China, most educational reforms showed essential characteristics of LS. From the 1950s onwards, LS became an instrument for professional learning and assisted in inculcating a culture of learning and teaching within Chinese schools (Gao et al., 2024). Zeng (2023) stated that the LS process in China consisted of pre-class, in-class, after-class, and reflections. The team members would have done empirical studies or related research to guide the lesson research in line with lesson development. PD or findings from publications of research papers and the presentation of research reports would be compulsory. Therefore, team members are encouraged to improve their professional knowledge and build a higher-level knowledge base.

- Netherlands: Coenders and Verhoef (2019) explained that LS teachers performed four phases or stages of the quality circle study: plan, conduct, and reflect. During the lesson observation stage, the other teachers write down the learners' responses and thought processes and describe how learners answered or solved the exercises. At the end of the lesson, the observing teachers discuss and give feedback on how learners attempted the exercises during the lesson and how they also decided how the topic could be effectively taught to learners.

- South Africa: The LS cycle, predominantly practised in SA, comprises five stages: diagnostic analysis, lesson planning, lesson presentation, post-lesson reflection and lesson improvement (Sekao & Engelbrecht, 2022). LS stages adopt an iterative process from one stage to another. However, it must be noted that what happens in one stage sometimes differs from what happens in another.

Though LS has evolved and spread to different countries and regions and has had made a significant impact in the PD of teachers, I have highlighted its benefits and challenges. Benefits includes increased content knowledge among teachers, pedagogical enhancement, knowing learner's cognitive demands, professional noticing, understanding learners' mathematical thinking, selection of appropriate problem-solving tasks, selection of teaching materials, etc. The challenges that have confronted the implementation of LS includes: systemic challenges within the education sector; cultural difference; time constraints; poor reflective comments, etc.

1.5.4 Reflective Practice as an Inherent Feature of Lesson Study

Dewey (1933) described reflection as a purposeful act of examining an event to identify beliefs, philosophies, and the knowledge on which that event is based to gain a better understanding. Gibbs' Reflective Cycle (Sekarwinahyu et al., 2019) avers that reflection follows certain stages and prescripts. Olteneanu (2017) explained that reflective teaching means looking at one's deeper beliefs and philosophies regarding teaching and learning and conforming to real classroom practice before, during, and after a lesson is taught. Thus, in a community of professionals, teachers learn about how other teachers perceive certain teaching methods that might not match theirs, and perhaps they may decide to adopt such new methods to succeed in their teaching. Schön (1992) differentiated between reflection-in-action and reflection-on-action. Reflection-in-action occurs when the teacher realises that he or she possesses knowledge and skills that can be used to overcome challenges that emerge during the teaching process. Olteneanu (2017) stated that reflection-in-action, as a dimension of reflection, occurs during learning encounters wherein a teacher notices certain learner actions and quickly implements a solution to achieve the lesson's objectives. Olteneanu (2017) explained another dimension of reflection: reflection-for-action, which is done when thinking about future actions to improve a situation. Olteneanu (2017) stated that this reflection requires teachers to be proactive about what will happen during a lesson. Referring to critical reflection (Gutierez, 2015, p. 322) stated that "Teachers share insights that their approaches to teaching can either contribute to or hinder the success of lesson implementation. As such, they viewed their practices as a factor in the social outcome of their pedagogical actions." In other words, they also took responsibility for why learners understood or did not understand the content.

In LS, during the stage of post-lesson reflection, teachers think deeply about how the lesson could have been planned and taught differently and then identify reasons why individual learners responded in a particular way. They further reflect on the purposeful activities they could have used to affect the observable learning outcomes and change the status quo of poor performance. Sekarwinahyu et al. (2019) asserted that reflective thinking motivates teachers to be more active and assists them with expressing their views in a more democratic environment, which then becomes the groundwork for learner-centred learning, which could lead to improved performances.

1.5.5 Improving Teaching Practice through Post-lesson Reflection

The main purpose of engaging in post-lesson reflection is to improve teaching. Scholars such as Iskandar and Suratno (2010), Daniel et al. (2013), Gutierez (2015), Widjaja et al. (2017) and Shuilleabhain and Clivaz (2017), who have conducted research in their countries, such as Indonesia and Australia, all assert that feedback discussions ensured that teachers contributed to critical efforts to renew the qualities of their teaching practices. Post-lesson reflection creates an environment for improving teaching practice. It assists with the PD of teachers through rigorous discussions about learner thinking and responses, resulting in deeper learning for the teachers involved, and reflection then prompts teachers to change their beliefs about their learners' problem-solving abilities and the teachers' abilities to change their teaching methods to improve learning outcomes.

Nyaumwe and Mtetwa (2011) discovered that post-lesson reflection had been recognised as an important enabler for student teachers to improve their teaching. In their study it was revealed that reflection could provide a context for student teachers to use to support their decision-making skills, understand their learning contexts,

evaluate learner knowledge gaps, and find ways to reduce them. While also, effective decision-making during teaching enabled student-teachers to determine other alternative methods of presenting a lesson so that all the different cognitive levels of learners in a class could be catered for.

1.5.6 Lesson Observations as a Prerequisite for Conducting Post-lesson Reflection within the LS Setting

The stage of doing post-lesson reflection in LS follows the lesson observation stage in a LS cycle (Dudley, 2014). Thus, the success of post-lesson reflection depends on how effective the lesson observations were. Widjaja et al. (2017) explained that the ability of mathematics teachers to engage in meaningful post-lesson reflection after lesson observations would offer more opportunities for PD among them and improved learning by learners. In my study, meaningful alignment in the lesson observation stage was an enabler for post-lesson reflection.

The study on student-teachers making lesson observations by Myers (2012) found evidence that observations were worthwhile experiences to enable teachers to prepare, recognise and identify key teacher and learner behaviours in the learning context. In preparation for post-lesson reflection, lesson observations provided a platform to build upon so that what is reflected is recorded systematically. During the lesson observation stage, teachers think deeply about the lesson content and the learners' responses they need to reflect upon.

In the Philippines, Gutierez (2015) conducted a study about teachers' reflective practices in LS and revealed that during post-lesson reflection, teachers mostly paid attention to the analysis of their teaching practices and not so much to the learners' responses. In a similar study by Sekao and Engelbrecht (2022), there was a need to

combat the challenges experienced by teachers who had observed insignificant aspects during lesson observations, which made the post-lesson reflection less effective. This meant that as I was to undertake my study, I was cognizant of the misalignment between these two stages of LS, and thus, I decided to ensure that similar events would not be repeated. Further insights regarding these issues will be provided in Chapter 2.

1.6 THEORETICAL FRAMEWORK

Theoretical frameworks are generally based on theories that can explain certain phenomena to extend such theories (Varpio et al., 2020; Lederman & Lederman, 2015). The significance of a theoretical framework is that it makes provisions for a systematic method of examining beliefs and assumptions within certain boundaries and thus provides a structure that can support a research study (Kivunja, 2018). My study was guided by two theoretical lenses: Social Constructivist Theory (SCT) (Vygotsky, 1978) and Gibbs' Reflective Cycle (Sekarwinahyu et al., 2019).

1.6.1 Social Constructivist Theory

My study about reflection is based on Vygotsky's SCT, a theoretical basis for LS, which happens in a social setting. Adam (2017) stated that Vygotsky emphasised the social setting as an enabler of PD and learning. Vygotsky (1978) stated that people must rely on others during PD because the sociocultural setting confronts numerous challenges. Being guided by SCT means that during post-lesson reflection in LS, teachers are seen as active, interdependent agents for their learning. Vygotsky's SCT welcomes the connections among teachers, learners, and activities and presents a learning perspective resulting from group engagement.

Vygotsky's SCT included viewing social interactions as critical, knowledge being co-constructed between two or more individuals, and self-regulation being developed through internalisation (developing an internal representation) of actions and mental operations that occurred in social engagements (Klimkowski, 2019). Vygotsky's SCT advocates for learning "not through interaction, but in interaction" (Adam, 2017, p. 3). The Zone of Proximal Development (ZPD), as part of Vygotsky's SCT, can also be clarified as the difference between the actual level of development as determined by independent problem-solving and the higher level of potential development as guided by problem-solving under guidance or in collaboration with more capable peers (Vygotsky, 1978). The term proximal, which means nearby, alludes to the fact that the assistance provided by peers goes slightly beyond the learners' current competence but supports and builds on their current abilities (Shabani et al., 2010).

The ZPD provides a platform for individual teachers to learn, in a social setting, from the views of other teachers, which they need to improve their teaching (Smagorinsky, 2018). The notion of the ZPD, according to Adam (2017), stresses that people develop higher thinking levels when the gaps in their thinking and problem-solving are assisted by adults, peers, or more capable others. This support, according to Smagorinsky (2018), is called scaffolding. The social environment supports development because what can be done collaboratively can be accomplished later.

1.6.2 Gibbs' Reflective Cycle

Dennison (2009) revealed that Graham Gibbs developed his reflective cycle based on Kolb's reflective model or learning cycle, which had four stages: concrete experience, reflective observation, abstract conceptualisation and active experimentation. Gibbs' Reflective Cycle has been widely used in the medical field for student nurses as a

theoretical framework that requires reflective writing of medical reports on patients (Sekarwinahyu et al., 2019). Sekarwinahyu further explained the stages of Gibbs' Reflective Cycle by giving guidance on conducting reflection through the cycle. LS has reflection as one of its major components, but guidance is given on how to reflect effectively.

Therefore, I needed to search outside LS to acquire more knowledge about reflection. I had to choose Gibbs' Reflective Cycle because it assisted me when dealing with reflection within LS. This meant that I viewed post-lesson reflection through the lenses of the six stages of Gibbs' Reflective Cycle: description, feelings, evaluation, analysis, conclusion and action plan. Gutierez (2015) also described critical reflections as inherent in post-lesson reflection. I have briefly discussed the stages of Gibbs' Reflective Cycle in the next paragraphs:

- Description: during this stage new perspectives or experiences for describing particular instances that took place during the lesson are discussed. During the lesson observation stage, Sekao (2023) suggested that according to LS prescripts, the facilitator of the reflection session ought to allow the lesson presenter to describe the lesson presentation session. The initial conversations should be used to set a more relaxed environment where everyone can openly express their views without fear.
- Feelings: Bishop and Blake (2007) stated that teachers recall and explore the things or emotions that were going on in their mind while teaching, i.e. why did this event stick to their mind, including thoughts of how they felt when the event started; what were they thinking about at the time; how did it make them feel. In the context of LS, it may include how the teacher who taught the lesson in

the presence of other teachers feels or how he or she felt about the outcome of the lesson. Furthermore, emotions may be experienced that lead to self-development, empowerment, and knowledge.

- Evaluation: During the third stage of Gibbs' Reflective Cycle, the evaluation stage, teachers would evaluate or judge what happened. They would consider what was good or bad about the teaching experience. In the context of my study, the evaluation stage the observing teachers will discuss what worked or did not work during the lesson without attaching reasons. This stage resonates more with Vygotsky's Social Constructivist Theory, in which teachers construct knowledge as they learn from each other using learners' responses and the presenter's methodologies.
- Analysis: During this stage teachers break the events down into their parts so that those events can be explored separately (Bishop & Blake, 2007). During the analysis stage, alternative solutions, such as analytical reflection, would be suggested to improve the lesson (Gutierez, 2015). It is further expected that teacher learning will occur because what teachers thought was always right to do when teaching the same lesson will be questioned for the first time to challenge the status quo, as in critical reflection (Gutierez, 2015).
- Conclusion: During this stage, teachers involved should ask themselves what they could have done differently, as in critical reflection (Gutierez, 2015). In this stage teachers summarise the main comments and key findings made by the panel members and the knowledgeable others based on what was learnt. A conclusive report will be written and kept for further referencing by the teachers (Sekao, 2023). Dewey (1933) noted that humans are both emotional

and intellectual beings, and these aspects influence their decision-making processes.

- Action plan: This is the stage in which those involved look forward to reencountering the event and plan well to ensure improvement. The action plan is the final stage of Gibbs' reflection cycle, which is based on the report, the key findings, and decisions that will be made on how to improve the lesson in case it needs to be re-taught (Sekao, 2023).

More details regarding my theoretical frameworks was discussed in Chapter 3.

1.7 RESEARCH METHODOLOGY

The study's research methodology followed the research onion metaphor, as explained by Saunders et al. (2015), who stated that the onion comprises the following layers: research philosophy, research approach, methodological choice, research strategy, time horizon, data collection, and data analysis. I have provided more insight into the research methodology in Chapter 4. However, I have provided snippets of each layer of the research onion, as shown in the following paragraphs.

1.7.1 Research Philosophy

I adopted an interpretivist philosophy (Creswell, 2014). The interpretivists assert that reality is viewed from multiple perspectives in a subjective stance to affect change (Putnam & Banghart, 2015). Interpretivists' philosophy avers that there can be multiple truths to explain one phenomenon, i.e. one interpretation of an event cannot be conclusive since knowledge can be interpreted from different perspectives. The ontological perspective of interpretivism allowed me to be subjective when collecting data from multiple perspectives, from both the teacher's perspective and his own

(Creswell, 2014). Moreover, I used multiple data collection strategies, such as observations and interviews, to gain information from multiple perspectives. Creswell (2014) stated that the epistemological perspective is about what can be known. In this study, I had to immerse myself and become part of the teachers in the environment where I was collecting data. The interpretivist philosophy is relevant to the study because it views teachers as active rather than passive. I collected valid data as interpretivism focuses on personal meanings and motivations. I interpreted the phenomenon of post-lesson reflection within the classroom context. In addition, the interpretivist philosophy enabled me to immerse myself in the environment where teachers were practising reflection.

1.7.2 Research Approach

Saunders et al. (2015) stated that a research approach refers to inductive, deductive or abductive data. An inductive approach guided the study because I was not testing or applying a theory. However, instead, I immersed myself in the classroom environment where data was collected to gain insights into the activities to be reflected upon. In line with the interpretivism philosophy, I looked at numerous realities necessary for post-lesson reflection after lessons, which I used to make inferences (Khuntia et al., 2016). The study was inductive even though I already had some knowledge about what happens in reflection sessions as I was using Gibbs' Reflective Cycle of reflection.

1.7.3 Methodological Choice

Saunders et al. (2015) referred to methodological choice as qualitative, quantitative or mixed. However, other researchers use the term research approach to refer to the methodological choice (Tuffour, 2017). I aligned myself with Saunders et al. (2015) by

adopting the term methodological choice. The methodological choice for the study was qualitative (Mulhall, 2003). Generally, in a qualitative study, the data is in a descriptive form using written words and is analysed using qualitative data analysis techniques according to themes (Onwuegbuzie et al., 2012). A qualitative approach is relevant for this study because it aligns with the interpretivist philosophy in which descriptive data from different perspectives is constructed during post-lesson reflection.

1.7.4 Research Strategy

Saunders et al. (2015) referred to research strategies as survey experiments, archival research, ethnography, action research, case studies, etc. This research strategy was a case study because it aligned with interpretivist philosophy and Constructivist Theory, in which I sought to gain an in-depth understanding of how teachers conduct post-lesson reflection and how they learn from such reflections. Flyvbjerg (2011) stated that a case study is a deeper analysis of a person or community focusing on developmental issues regarding their contextual situation.

1.7.5 Time Horizons

Khuntia et al. (2016) stated that time horizons can be longitudinal or cross-sectional. Furthermore, they explained that in a longitudinal study, research findings are collected over a few years to ascertain changes after specific inputs have been done. On the other hand, the findings of a cross-sectional study in this study were taken during a single once-off event of a few days. Hence, my choice for this study was to undertake a cross-sectional time horizon.

1.8 TECHNIQUES AND PROCEDURES

Techniques and procedures cover sampling, data collection, and data analysis.

1.8.1 Sampling

I used purposive and convenient sampling in the study. I justified using purposive sampling because I needed a school where teachers were practising LS. To conduct/convenient sampling, as an official of the department, it was easy for me to access schools within the province of Gauteng. I needed an information-rich sample to suit my study's contextual appropriateness, yielding useful information. To fulfil this purpose, I chose a secondary school from one of the districts in the Gauteng Province in SA with a team of teachers who were familiar with and were practising LS in the SP (Grades 7 – 9). Although I chose one school for data collection, the teachers constituting the LS team comprised six local secondary school members who were also familiar with and practised LS.

1.8.2 Data Collection

I collected data through observations, document analysis and interviews. However, I did not predetermine the mathematics topic that would be the focus of data collection since reflections can be done on any mathematical topic. Data collection was done over a period of 5 days in which lesson observations were held and thereafter post-lesson reflection took place. I immersed myself in the classroom where data was collected. Regarding the methodological assumptions of interpretivism, justification for using observations, document analysis and interviews were given in the research philosophy section in 4.2 (Cudziło et al., 2018). Also, appropriate interpretations of data from different data sources assisted me in identifying common trends and triangulating the data (Morgan, 2022).

1.8.2.1 Observations

Couper (2017) and Mowat (2022) stated that observations involve the observer writing down notes of actions taken and words spoken during the observation session. Since I had specific research questions to be answered and specific attributes outlined in the Gibbs Reflective Cycle, I used a structured observation protocol and video-recorded the lesson sessions. I used the observation protocol (Annexure A) to collect data during the LS stage of lesson presentation and observation. In contrast, during the stage of post-lesson reflection, I used a different observation protocol (Annexure B). The fact that I was present in the classroom in which I made observations and was part of the lesson proceedings made it easier to comply with the ontological and the epistemological assumptions of my research to gain insight into SRQ1 (secondary research question 1), which is about how teachers perform lesson observations in LS.

1.8.2.2. Document Analysis

Couper (2017), Davie and Wyatt (2021) defined document analysis as a data collection technique in qualitative research that utilises a systematic procedure to analyse data from documents to answer specific research questions. My research included teachers' lesson observation instruments, whereby, according to the prescripts of LS, I observed teachers developing and using instruments to document issues about learners' mathematical thinking. The teachers' lesson observation instruments were analysed to see how well their observations informed their reflection during post-lesson reflection in LS. According to interpretivist methodological assumptions, my interpretation of the findings from document analysis would be appropriate since the tools had clear guidance on what to look for when teachers were observing the lessons (Putnam & Banghart, 2017). Their observation tools assisted me with capturing

findings from the lesson presentations and observations, as they observed one teacher at a time who presented a lesson.

1.8.2.3 Interviews

I chose to use semi-structured interviews because they are rich in data (Chauhan, 2022; Mowat, 2022), and although I drafted some guiding questions to ask, I needed to have an opportunity to probe further if there was a need for that. I interviewed teachers based on the data collected during the third and fourth stages of the LS cycle, lesson presentation observations and post-lesson reflection. Throughout the interviews, I corroborated the observed data collected during the stages of LS. Since LS emphasises collaborative practice among teachers, the interviews took the form of whole group interviews involving six teachers and not individual or focus groups. The interview sessions were video recorded so I could transcribe the verbatim data into written texts afterwards. Moreover, using a video recorder afforded me a favourable environment whereby the participants and I could concentrate on the questions without any confusion regarding note-taking by the interviewer.

1.9 DATA ANALYSIS

The process of data analysis, the identification of themes and the emerging themes were all guided by Braun and Clarke (2006).

1.9.1 Analysis of Data Collected through Observations

The study analysed the observed data using deductive and inductive thematic analysis. Being guided by Braun and Clark (2006), my SRQ informed the main themes while the sub-themes emerged from the data that was aligned with the research questions. From the video recordings of the lessons, I transcribed the data into

documents to label and identify emerging themes. Although the main themes were preconceived (deductive) and derived from my SRQ, the sub-themes were not preconceived (inductive) because they emerged from the data (Braun & Clarke, 2006).

Braun and Clarke (2006) identified six phases of data analysis: Phase 1 involved getting familiar with the data; Phase 2 meant generating codes; Phase 3 involved searching for themes; Phase 4 required reviewing themes; Phase 5 involved defining and naming themes; and Phase 6 meant producing a report. The following paragraphs provide a brief description of the phases:

(1) Getting familiar with the data: I completed this phase by watching the lesson videos, the post-lesson reflection, and the interviews. I then had to transcribe the videos into Word documents. I then started reading the teacher observation notes, the lesson transcripts from the videos, and those from interviews. As I read, I recognised similar phrases to identify emerging themes.

(2) The generation of codes: I grouped and coloured common excerpts containing similar ideas or phrases. For instance, comments regarding teachers' feelings, such as "I felt confident," "it was sad," etc., formed part of the theme of descriptions and feelings.

(3) Searching for themes: The main themes emerged from SRQ, e.g., In SRQ1, the sub-theme that emerged was "description and feelings", which aligned with the inductive approach of the interpretivist assumption.

(4) Reviewing of themes: From the original themes, I had to verify whether the phrases belonged to a particular theme.

(5) Defining and naming themes: I had given certain names or labelled (colour-coded) exceptions with a name, e.g., “methodology”, however, I discovered that I had to be specific by renaming the theme “teaching methods”.

(6) Producing a report: This phase was accomplished when, after identifying similar excerpts, I needed to explain the interpretations I had drawn from the transcribed conversations.

1.9.2 Analysis of Data Collected through Documents

Document analysis is a method of data collection which entails analysing content from written documents to make certain conclusions, as guided by the research questions (Braun & Clarke, 2006; Couper, 2017; Davie & Wyatt, 2021). I analysed teachers’ written notes from their observation instruments. I identified common patterns or trends supporting the sub-themes that emerged from the data. The sub-themes were then colour-coded and labelled according to the names of the sub-themes on the documents. I gave each conversation an excerpt number for easier identification.

1.9.3 Analysis of Data Collected through Semi-structured Interviews

Interview analysis was done to make sense of the respondents' stories (George, 2022; Chauhan, 2022; Mowat, 2022). It corroborated the essential aspects of teachers’ learning that had been recorded earlier through observations. Since I had video-recorded the interview sessions, I could transcribe the data into written text. I used the transcripts to look for common patterns or trends from teachers' various views, and these were added to the emerging sub-themes identified during the observation analysis.

1.10 QUALITY CRITERIA FOR QUALITATIVE STUDIES

The quality criteria that are applicable to qualitative studies include credibility, transferability, dependability and confirmability.

1.10.1 Credibility

Credibility is the assurance of the facts derived from the research findings (Anney, 2014). It verifies whether the research findings constitute correct information captured by the participants. My study ensured credibility by capturing data over five days, and a recording was used as a backup.

1.10.2 Transferability

Stalmeijer et al. (2024) explain that transferability refers to the extent to which the results of qualitative research can be transferred to other contexts or settings with other respondents. I ensured transferability by using thick participant descriptions, thus comprising purposeful sampling. Hence, the data I captured from post-reflection discussions in one school would be similar to those from another, thus providing data within a similar context.

1.10.3 Dependability

Dependability assesses the stability of the findings over time (Gunawan, 2015). It encompasses the participants' evaluation of the findings and how they can be interpreted. I used a code-recode strategy on the captured data to ensure dependability, as I had done in the excerpts. This ensured that other researchers could verify the findings we had arrived at and show how such findings were interpreted.

1.10.4 Confirmability

Anney (2014) explained that confirmability allows other researchers to confirm the study's results using triangulation. My findings were derived from the data collected to ensure that other researchers conducting a similar study could validate and confirm my research results.

1.11 ETHICAL CONSIDERATIONS

Ethical considerations in research comprise the ethical principles that I undertook to show that my research study was conducted truthfully, fairly and honestly (Ketefian, 2015). I complied with the ethical conditions for collecting data for my study in the following ways:

- I obtained approval from the ethics committee at the University of Pretoria (UP) to proceed with the data collection process.
- I received permission from the Gauteng Department of Education, the District office and the school principal.
- I sought consent from the teachers and parents/guardians since learners are minors; and lastly.
- I recorded the learners' assent to participate in the study.

As explained by Khan (2015), I observed the following ethical practices regarding the participants: (1) participation was entirely voluntary, meaning that I did not force or coerce any of the participants into doing anything they did not want to do, and I informed them that they could excuse themselves from my study at any time if they so wished. (2) confidentiality: I informed the participants that I would not disclose their particulars to anyone. (3) anonymity: I used pseudonyms instead of their real names

to protect their identities. (4) informed consent: I fully described in a letter what the study was about before I collected data from them. (5) safety: I explained to the teachers that they would not be exposed to dangerous conditions, which could be risky to them, as the data would be collected in their natural classroom environment. After collecting the data, the UP-ethics approval committee issued an ethics clearance certificate confirming that I had complied with all ethical requirements for conducting research. More information regarding the methodology will be discussed in Chapter 3.

1.12 OUTLINE OF THE CHAPTERS

Chapter 1: General Orientation of the Study

This chapter provided an overview of the entire study. Chapter 1 detailed the problem statement, purpose, rationale, and research questions. However, since Chapter 1 is meant to inform the reader about the entire study, I also presented snippets of the other sections.

Chapter 2: Literature Review

In this chapter, research information relevant to my study is presented and discussed in detail. I organised this chapter according to the SRQ that guided my study so that only relevant findings from the research literature could be documented. The authors that had published information that was relevant to my study included Iskandar and Suratno (2010), Posthuma (2012), Gutierez (2015), Widjaja et al. (2017), Adler and Alshwaikh (2019), Sekao and Engelbrecht (2022), and others. Further information pertaining to this chapter is discussed in greater details in Chapter 2.

Chapter 3: Theoretical Framework

The theoretical framework provides the lenses through which I viewed my research study (Luft et al., 2022). The framework is based on theories that assisted me with understanding and planning my research. Hence, in this chapter on the theoretical framework, I discussed two theoretical frameworks that guided my study: Vygotsky's SCT and Gibbs' Reflective Cycle (Adam, 2017; Bishop & Blake, 2007; Sekarwinahyu et al., 2019). More details regarding to this chapter is discussed in greater details in Chapter 3.

Chapter 4: Research Methodology

The research methodology of a study is a comprehensive pathway that reveals a credible research philosophy. It also underpins the choice of methodology, the research strategy, the data collection techniques and analysis procedures (Saunders et al., 2015). It identifies the most relevant design to the study (Malhotra, 2017). Further discussions pertaining to the methodology are in Chapter 4.

Chapter 5: Presentation of the Findings

This chapter presents the findings regarding how teachers learn and develop using post-lesson reflection - the fourth stage of the LS cycle. The purpose of the chapter is to provide evidence from the findings arrived at during the research study (Morgan, 2022). I analysed and documented my data, guided by Braun and Clarke (2006), in terms of thematic analysis, which assisted me in providing coherent discussions from the data guided by themes. Further information pertaining to this chapter was discussed in greater details in Chapter 5.

Chapter 6: Discussions and Recommendations

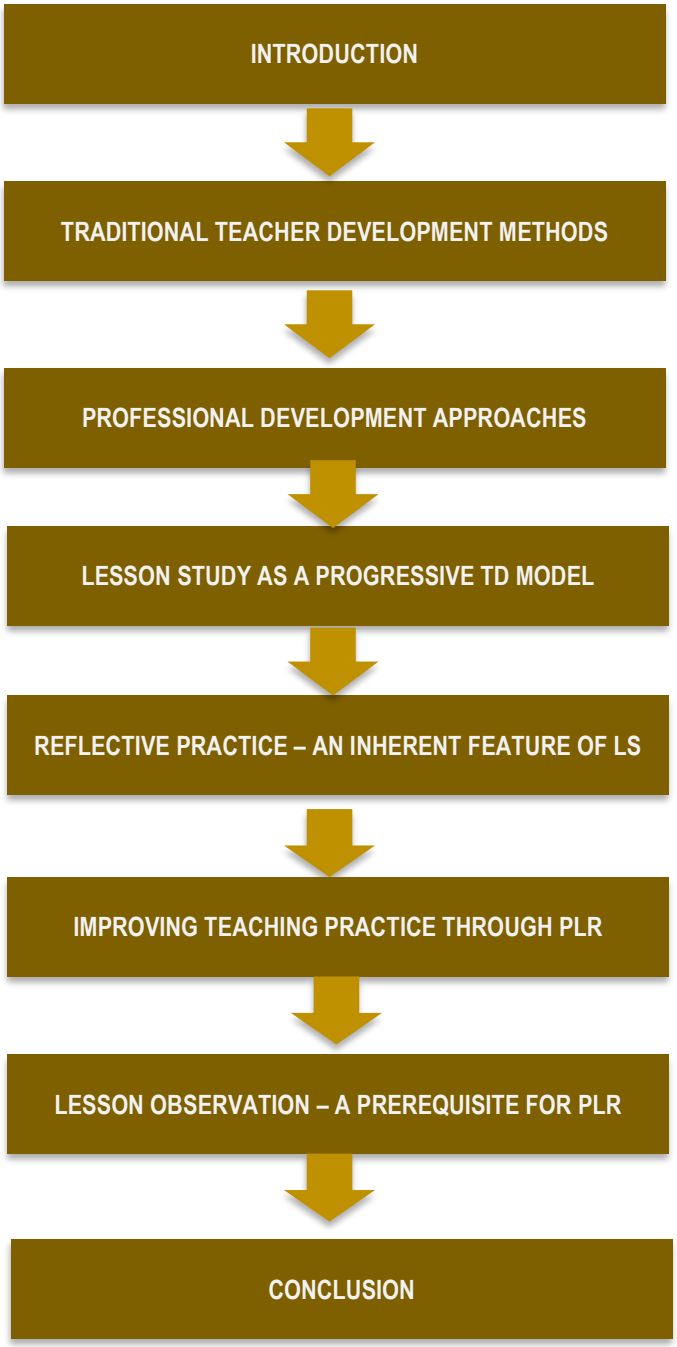
In this chapter, I discussed the research findings from the study and answer the research questions (SRQ). The SRQ was answered, and consequently, the study was able to make valuable contributions to research in the field under review and arrive at critical conclusions. The chapter was divided into sections, such as the answers to the SRQ and the main themes and sub-themes that emerged from the data (Braun & Clarke, 2006). More details regarding to this chapter was discussed in greater details in Chapter 6.

CHAPTER 2: LITERATURE REVIEW

I have presented an overview of the current chapter in Figure 2.1.

Figure 2.1

The structure of Chapter 2 - Literature Review



2.1 INTRODUCTION

Randolph (2019) stated that a literature review summarises the sources relating to a particular study to address research questions. A literature review identifies influential researchers and explores their views on the phenomena being explored (Lingard, 2018). I critically reviewed the literature relevant to my study to understand the issues regarding reflective practice in general and reflection as a construct that, in particular, characterises LS. I decided to present my literature review in terms of different subtopics, which assisted me in answering the research questions.

The sections include:

- **Traditional teacher development methods:** In this section, I discuss teacher training methods in which knowledge is transmitted from one individual to a group that receives the information passively with little or no interaction. This section was meant to reveal the former and most dominant methods of TD, which yielded little or no effectiveness. I then contrast these with the progressive TD models incorporated within LS.

- **Professional development approaches for contemporary teachers:** In this section, I have discussed the genesis of progressive education—the Deweyan era as an inflection point. I refer to theories and models of PD that offer new training approaches based on classroom practice in contrast to traditional PD strategies.

- **Lesson Study as a Progressive Teacher Development Model:** I reviewed how teachers learn through collegial efforts, thereby unpacking the attributes of

LS that render it relevant for contemporary teachers. I have also briefly discussed models of LS in Japan, China, the Philippines, Indonesia, the Netherlands and Singapore.

- **Reflective practice as an inherent feature of the Lesson Study:** I will outline the LS stages, focusing on the post-lesson reflection stage, where teachers challenge the status quo through critical reflection on how certain content has always been taught.

- **Improving teaching practice through post-lesson reflection:** In this section, I will share evidence from post-lesson reflection on learner responses that resulted in teachers changing their teaching philosophies regarding how learners learn and, consequently, how their teaching methods have had to change and

- **Lesson observations:** I argue that post-lesson reflection within the LS setting has to be based on what teachers have observed during the lesson observations stage as a prerequisite for conducting post-lesson reflection.

2.2 TRADITIONAL TEACHER DEVELOPMENT METHODS

Traditional teaching, sometimes called the lecture-based approach, refers to the methods of TD training where knowledge is transmitted from one individual to a group that receives the information passively with little or no interaction between teachers and learners (Waddell & Vartuli, 2015). Lecture-based workshops do not allow recipients to learn skills they can practice in various contexts. This means that

teachers attending such workshops leave with no confidence to practise what they have been taught since they were not allowed to try the techniques they were taught, and likewise, they cannot even learn from their mistakes. Traditional PD happens once in a while, once a term, to cover various topics, and it shows a lack of in-depth understanding of teachers' needs (Suell, 2005; Darling-Hammond et al., 2017).

Traditional PD sessions are usually disconnected from teachers' realities, as what is presented may not necessarily be what the teachers require at that time to assist their learners. Hence, traditional PD is not tailor-made for individual teachers' needs; it is a mere blanket or one-size-fits-all approach. Therefore, traditional PD does not address teachers' realistic difficulties in their contexts. Harfitt and Chow (2018), and Jang and Horn (2017) indicated similar challenges, such as teachers' failure to teach in the same way the workshop presenter had done because the presenter was far removed from the teachers' natural settings. When the workshops are over, teacher support also stops, meaning they will not receive assistance if they need support applying the skills they have learnt. (Waddell & Vartuli, 2015).

Traditional PD does not allow teachers to reflect on what they have learnt or how they have been teaching to persuade them to adopt different methods of teaching new concepts. Hence, traditional PD cannot measure the impact it seeks to make on teachers' PD; it only assumes that perhaps teachers' skills have been developed based on many hours spent in workshops (Jang & Horn, 2017). Teachers must attend such workshops often but achieve no significant positive results in learners' performances. This seems to resonate with the TIMSS 2019 report that showed that even with more experienced teachers who have had more opportunities for PD, their learners' performances were not much higher than those of the less experienced

teachers (Reddy et al., 2019). Given the limitations of traditional PD, this calls for contemporary PD for teachers to address the needs of 21st-century classrooms urgently.

2.3 PROFESSIONAL DEVELOPMENT APPROACHES FOR CONTEMPORARY TEACHERS

In this part of my discussion, I have presented the origins of progressive education from the Deweyan era (Williams, 2017), with John Dewey as the pioneer for professional development. I have discussed the characteristics of contemporary teacher development practices.

2.3.1 The Genesis of Progressive Education – the Deweyan Era as an Inflection Point

Progressive education, as an innovation to learning and teaching, can be referred to the Deweyan era (Williams, 2017; Schön, 1992). John Dewey felt people can succeed in life's challenges through education and collaboration. His beliefs and philosophy about education and learning have transformed many educators and learning theories that focus on PD. As Williams (2017) described, John Dewey's theory of learning comprises various characteristics such as experiential learning, social learning and social interaction, collaborative learning, critical reflection, curriculum integration, world experience, questioning or inquiry-based learning and emotional responses. Based on the context of my study, I paid attention to the characteristics which I have discussed in the following paragraphs.

(a) Experiential learning

Learning through experience means that learners must be actively involved in their learning by doing the task they have been taught about (Dewey, 2022). At the time,

Dewey was against teaching methods which promoted rote learning. Hence, in Dewey's time, the characteristics of traditional PD in which teachers attended workshops and listened passively to the presenter were prevalent. One of Dewey's endeavours was to narrow the gap between the experiences of a learner and the kind of skills instilled into him or her, which means that in the case of mathematics teachers, what they are taught in workshops should be directly linked to how best to teach in their mathematics classes.

(b) Social learning and social interaction

Learning should occur within a social context whereby learners or teachers work collaboratively and contribute to each other's academic development (Latasha, 2020). Dewey advocated for schools to be social institutions for learners and for classrooms to provide learning opportunities that allowed learners to engage in appropriate social interactions with their peers. The presenter in a mathematics workshop is not the only source of knowledge. However, participating teachers can generate progressive ideas to empower themselves, mainly when discussing different mathematics methodologies. In contrast traditional PD centres around the presenter and leaves little or no room for active involvement among mathematics teachers. Hence, Dewey's ideas of progressive education to change traditional PD was essential.

(c) Questioning or inquiry-based

Because mathematics is an inquiry-based subject, learning should be a democratic process in which learners are not dominated in expressing their solutions about learning or questioning the teachers' methods (Hildebrand, 2022). Based on the principle of active participation, learners' views about what they learn are self-directed and self-managed. In applying this principle to PD, mathematics teachers should also

decide on the mathematical content they need to be developed in. In line with his educational theory and philosophy, Dewey believed that teachers have a crucial role in creating an environment that fosters inquiry and exploration to encourage learner involvement and development—Dewey's views aligned with 21st-century skills, which included creativity and critical thinking. The 21st century resonates with the skills that Darling-Hammond et al. (2017) proposed for progressive teachers as a PD model. Dewey's philosophy challenged earlier models of teaching, which relied on authoritarianism and rote learning. Dewey was searching for progressive education, asserting that learners must be allowed to direct and influence their learning. Dewey's ideologies were similar to the proposed PD for contemporary teachers, described by Borko et al. (2015) and Nawab et al. (2021).

2.3.2 Contemporary Teacher Development Practices for Contemporary Mathematics Classrooms

Darling-Hammond et al. (2017, p. 2) defined "effective professional development as structured professional learning that results in changes to teacher knowledge and practices and improvements in student learning outcomes." There has been a growing need for improved teaching methods to assist learners in understanding content. This has led many researchers to investigate how teachers' PD can be improved, from teacher training institutions to teacher workshop support and mentoring at the school level (Darling-Hammond et al., 2017). Also, teaching 21st-century teaching skills is needed to develop 21st-century learners. These include collaboration, critical thinking, complex problem-solving and effectiveness (Geisinger, 2016). Hence, if teachers' PD is irrelevant to current educational needs, teachers might be disempowered from developing future citizens who can contribute meaningfully to a changing world with its complicated knowledge demands. In recent years, there has been a drift from in-

service training workshops in which teachers are taught specific skills, following a rigidly defined traditional process to a PD system for contemporary teachers (Borko et al., 2015; Nawab et al., 2021). Traditional teacher training workshops are often offered to teachers as a once-off experience away from their school, hoping they can easily incorporate the knowledge when teaching their learners.

Borko et al. (2015) revealed that such training is far removed from teachers' actual classroom practice, and thus, teachers cannot implement the content and methodologies gained. Harfitt and Chow (2018) and Jang and Horn (2017) indicated similar disadvantages and shortcomings, such as teachers' inability to emulate experts away from their teaching environment. Recent theories of learning and schooling have introduced new training approaches based on classroom practice, which often require the establishment of PLC (Nawab et al., 2021). Nawab et al. (2021) revealed that learners' achievement is closely associated with the quality of teachers, hence the need to enhance the quality of PD.

While the one-size-fits-all or blanket approach to PD, which is not sustainable, has been ideal for administrators to record high numbers of teachers being trained, recently, PLC structures have been recommended instead due to their need-based support. PD literature emphasises providing sustainable long-term, close-to-practice, teacher-led and teacher-centred workshops to support them as they collaboratively develop the professional knowledge needed to teach in different contexts (Thompson & West, 2013). Hence, the PLC formations tend to empower teachers as classroom practitioners in their schools and subjects to engage in relevant teaching skills and knowledge (Avidov-Ungar, 2016). This means that the PD content is situated in the

practice of teaching, which assists with ensuring that what teachers are learning is easily implemented and relevant to their classroom practice.

Borko et al. (2015) identified a contemporary model of PD called high-quality PD and its characteristics, among other things, that feature PD that has a PSC and uses technology. Moreover, Darling-Hammond et al. (2017) identified characteristics of effective teacher PD, which I will discuss later in this section. Borko et al. (2015) defined two features that are critical as content characteristics of high-quality PD: (a) that the content teachers learn must be situated in practice, and (b) that the content should focus on how learners learn. I explain these two features in the following paragraphs:

(a) The content teachers learn must be situated in practice

This means that PD must be subject-related and able to deal with relevant aspects of challenging content, such as difficult concepts in mathematics. The first stage of LS is diagnostic assessment, whereby teachers identify challenging topics they struggle to teach or concepts that learners struggle with after conducting an assessment—for example, 2-dimensional shapes in mathematics. Because different teachers experience different challenges, PD should consider the context of the individual teachers and even their school contexts so they can easily implement new teaching strategies. The LS is an organic process in the school context where teachers deal with the contextual teaching challenges of their learners. The advantage here is that teachers are better able to implement new teaching methods since they are related to their practice.

(b) The content should focus on how learners learn

As explained, the LS context is where teachers model their best teaching methods during lesson presentations and observations while others learn to implement them. The focus is always on learner's thinking as they complete their mathematics exercises, which purposefully addresses learning gaps. Focusing on how learners learn mathematics is necessary because if teachers are developed on unsuitable teaching methods, they cannot assist their learners effectively. The advantage is that once educators are familiar with how learners learn, they will teach them appropriately. An example of using mathematics software to teach mathematics could be appropriate because learners love using technological devices, similar to playing computer games while learning. The advantage of this high-quality PD, as presented by Borko et al. (2015), is that it involves processes such as modelling relevant teaching strategies, engaging teachers in active learning, and establishing PLCs (Song et al., 2018). This is different from the traditional approach of PD, in which teachers do not get opportunities to model what they have learnt so that they can be empowered to implement it in their classrooms.

In this high-quality PD, with teachers as lifelong learners, teachers ought to model teaching strategies among themselves as PD participants and then impart them to learners. This model of training is necessary when teachers must teach using methods that are different from those they were taught to use or even how they currently teach. This characteristic is essential in my study since, during post-lesson reflection, teachers will learn different methods to teach particular content to change the status quo, as in critical reflection. In contrast, the traditional approach advocates traditional methods of teaching, which had always been used, as opposed to new ones.

A PSC training model requires developing and implementing a mathematics PD (Borko et al., 2015). It is an iterative, long-term approach to TD, aiming at increasing teachers' content knowledge of mathematics for teaching and improving their pedagogic knowledge and that of their learners. This model is iterative, meaning that after teachers teach a concept, they come together again to reflect on their observations. Teachers can then correct their mistakes and reteach their lessons until their learners understand the content better. This enables teachers to build a supportive PLC that encourages reflection. A traditional approach to PD does not work well in a supportive structure, such as a PLC, because it assumes that once teachers have been trained, they will be able to teach well without any assistance. This model fits my study by exploring how teachers learn through post-lesson reflection in a social setting. Technological trends are influencing the field of teacher PD (Borko et al., 2015). These include digital libraries, web-based virtual learning environments, and online and electronic conferencing features. These online discussion forums are typical of synchronous conversations, such as chatrooms where teachers are present during the session and can respond electronically to each other. Virtual learning platforms that characterise asynchronous interactive tools, such as bulletin boards, empower teachers to engage in conversations at any time and place, thus fostering collaborative learning. Such empowerment is not a feature of a traditional PD, in which teachers are trained in a seminar style and receive training through one presentation mode, regardless of the available technological methods that can save time and money. The need for better strategies to assist learners in understanding content has led many researchers to investigate how teachers' PD can be improved, ranging from teacher training institutions to support teachers and mentoring at the school level (Darling-Hammond et al., 2017). 21st-century teaching skills are in high demand to

enhance 21st-century learning. These include collaboration, critical thinking, metacognition, complex problem-solving, and effective communication (Geisinger, 2016). Darling-Hammond et al. (2017) identified seven characteristics of effective PD which I have elaborated in the next paragraphs.

(a) Effective PD must be content-focused

This means that PD must be subject-related and deal with specific aspects of challenging content that teachers struggle with in order for them to be confident enough to teach it well after the traditional training is over. As referred to above, some of the current PD models are traditional because teachers are trained on concepts they may lack knowledge of, and thus, they become irrelevant. Because teachers struggle to teach certain content, Darling-Hammond et al. (2017) advocated for a PD that would address particular learners' challenges and that teachers can address. For example, learners underperform on fractions and decimals, and one of the reasons is that teachers struggle to teach them well; therefore, training teachers on such content will become more relevant and will ensure that they are developed enough to teach it and get positive learning outcomes from the learners.

(b) Effective PD must incorporate active learning

Adults use their knowledge base and life experience to aid their learning. This means that adult learners can channel their development better than learners can. This is opposed to traditional PD, in which teachers attend a workshop and are taught like learners, ignoring their teaching experiences in teaching that specific content. McConnell et al. (2017) emphasised that active learning promotes critical thinking as participants engage with what they are being taught. In mathematics, an investigative approach to teaching is better suited to promote such learning as teachers engage

meaningfully with their development. Through learning, self-discovery develops confidence in implementing what has been taught.

(c) Effective PD must support collaboration

Teachers formulate small groups in PLCs that function as support structures during the collaboration. One or two experienced teachers can coach novice teachers or teachers who struggle to teach certain content (Sai & Siraj, 2015). Hence, if appropriately managed within the school, especially by the school management team (SMT), this support structure will ensure that the implementation of what teachers were trained on is achieved. Collaboration is a key characteristic of LS when teachers plan a lesson together. After observing how teachers present teaching content in class, the teachers converge to reflect on the lesson and how it was taught, thereby learning from other teachers. The traditional approach does not encourage teacher collaboration since, after attending a workshop, it is assumed that the teachers can teach workshop content without further support at the school level (Waddell & Vartuli, 2015).

(d) Effective PD must be applied in job-embedded contexts

Workshops should consider the context of the individual teachers and their school contexts so they can easily implement new teaching strategies. This is so because when teachers are trained within their familiar environment, they can easily assimilate and adapt to new teaching strategies (Piaget, 1976). Since teachers from different schools teach in different contexts, it is unimaginable that one teaching approach can assist them all. Most LS models are organic and happen at the school level, where teachers deal with the contextual teaching challenges of their learners. Hence, progressive PD is not a blanket approach to teacher training, as was the case during

traditional PD, in which all teachers from different contexts are expected to use similar strategies or methods. However, it might not work for all teachers. An example in mathematics is using examples like pizzas when teaching fractions to learners from semi-rural dwellings where they may not have even seen a pizza. Hence, teachers must adjust such scenarios to relate to their learners.

(e) Effective PD must use models and modelling of effective practice

Progressive PD uses models to display good practices to teachers so that after observing what others are doing, they can emulate them. This method develops confidence in the teacher, who may not be sure they can apply new teaching methods. An example of this in mathematics is asking an expert teacher in a workshop to demonstrate how to teach congruent triangles by presenting an investigative method to explain the construction of triangles. When other teachers observe such examples, they may be persuaded to implement the same approach in their classes. Modelling is very suitable for most LS models, wherein during lesson presentation and observation, the presenter presents their best teaching methods in the classroom. In contrast, others learn to implement them in their teaching. Unfortunately, the traditional approach offers a lecture method of PD in which the presenter delivers the workshop that does not allow for modelling by participating teachers who perhaps could inspire their colleagues to teach as they do and thus be enabled to implement what they have learnt when they return to their schools.

(f) Effective PD must provide coaching and expert support

PD must offer opportunities for feedback and reflection. This feedback and reflection on what teachers have developed becomes necessary to address challenges that

might be experienced regarding implementation. Also, it will be appropriate that when teachers have been developed, the presenter would like to know how the training may have unfolded so he/she can give further assistance in case something has to be clarified. As was always the case in modelling effective practice, the availability of a coach who will model good practice at the school level could be worthwhile. This coaching feature is typical of LS models wherein after one of the teachers has taught a lesson, teachers meet to discuss and reflect as a collective in a social setting to identify key lessons focusing on learning and lesson improvement.

A key member of the learning community of jugyoukenkyuu is the knowledgeable other (Takahashi, 2014). Although the knowledgeable other is generally an external specialist who might be older educators or university professors who would have observed many lesson presentations, they can provide better guidance and feedback from previous encounters while observing lessons from other schools (Takahashi, 2014).

Knowledgeable others are, therefore, critical for imparting socio-constructivist learning to the broader community of teaching practice beyond the school's boundaries. These LS sessions with mathematics experts should be encouraged as formal PLC.

(g) Effective PD must be sustainable

Sustainable PD means teachers can implement what they have been taught and develop one another at the school level without external support. The availability of experienced teachers at a school who can coach other teachers and model good teaching is of the utmost importance if, after the workshop, teachers must sustain the methodologies they have learnt. Many teachers execute the traditional PD workshops, which are only held once a term or semester (Waddell & Vartuli, 2015). This happens

because such workshops are costly and thus are not sustainable. Also, there is no guarantee that the methodologies learnt during these workshops will be implemented in the classroom because teachers are not monitored after the workshop to verify implementation. In a LS model of PD, teachers can sustain the new methods they have learnt because, after workshops, they can collaborate and plan lessons together.

2.4 LESSON STUDY AS A PROGRESSIVE TEACHER DEVELOPMENT (TD) MODEL FOR CONTEMPORARY MATHEMATICS CLASSROOMS

The discussion that ensues focuses on the definition of LS from various researchers, how LS has evolved over the years since its inception in Japan as it gained prominence and adapted in different countries to suite their various contexts.

2.4.1 What is a Lesson Study?

Lim-Ratnam et al. (2019) stated that LS is acknowledged extensively as an effective interaction among teachers as active participants in their PD. While in many countries, such as SA, external workshops are planned for teachers, LS allows teachers to be responsible for their development within schools. Dudley (2014) stated that LS is a highly organised form of classroom action research focusing on TD and content knowledge. It had been implemented in Japan since the 1870s. Coenders and Verhoef (2019) observed that LS started in Japan and had features of effective PD among teachers as active participants.

In LS, teachers focus on content and, even more significantly, on how learners learn the content. Coenders and Verhoef (2019) stated that in LS, teachers collaborate in selecting a topic to prepare a lesson called a research lesson. One of the teachers then presents the research lesson while other teachers observe the learners in class, followed by teachers discussing their observations from the lesson. Widjaja et al.

(2017) offered further insight regarding LS by revealing that research has identified valuable contributions made through LS regarding both learners' understanding of mathematics and teachers' PD. During LS, attention is placed on the mathematics content and learners' mathematical knowledge, with opportunities for teachers to give and receive relevant feedback and critically observe and evaluate the lesson and teaching in class. Widjaja et al. (2017) regretfully noted that although LS is a long-standing tradition in Japan and has spread throughout various nations, it is still poorly documented by research.

Fujji (2014) stated that the history of LS (jugyoukenkyuu in Japanese) spans more than a century in Japan. Therefore, for Japanese teachers, LS is so entrenched in their educational practice that it has become routine. These measures include defining the problem beforehand to steer lesson preparation and then planning the lesson. One teacher teaches the lesson, and others observe; then they analyse and think deeply about the lesson; the lesson is then revised, and once again, one teacher reteaches while others observe the revised lesson; they then evaluate and reflect on the revised lesson for a second time; and finish the cycle by sharing the findings from reflections. Fujii explained that lesson studies in Japan could be hosted at different levels, including at schools and prefectures or regional levels, and sometimes even at the national level. All these levels form part of engaging in LS cycle, which can continue for a year. This is possible because Japanese teachers involved in LS prepare their lessons daily while continuing their regular professional duties of teaching or administering activities. LS research topics are decided and planned early in the year, while each research lesson and its post-lesson discussion occurs in a day. During post-lesson reflection, teachers write down what they had observed and learnt

from the research lesson. The research lesson also focuses on problem-based learning when teaching mathematical concepts.

2.4.2 The Evolution of Lesson Study

In this literature review section, I demonstrated how LS has evolved over the years across many countries. Insight into how LS has spread so widely and rapidly will assist readers in gaining a deeper understanding of its value for the PD of teachers worldwide. Countries like the Philippines, Indonesia, China and Singapore are examples of good practices regarding LS. Countries such as the UK, the USA, and the Netherlands have also successfully adapted LS for their contexts to develop their teachers. One key feature that can be seen in all the models is that they all engage in reflection, discussions or feedback sessions, which are critical for teacher PD.

Fujji (2014) realised that LS had come to the attention of teachers outside Japan using publications such as Teaching the Gap (Hiebert et al., 2005) publication of the TIMSS (1999) video in which research was done regarding eighth-grade mathematics lessons involving US, Germany and Japan. It was also discovered that Japanese learners were the top performers in TIMSS assessments, and hence, many researchers were keen to investigate what this achievement could be attributed to.

Dudley et al. (2019) stated that after discovering Japan's usage of LS as a vehicle for teachers to improve learner results, teachers persuaded school authorities to adopt, adjust and implement LS in the UK. This was shown to be an effective tool for teacher PD. Dudley (2014) explained that LS was becoming well-known in the UK while recognising the success attributed to the method by US researchers in enhancing teacher knowledge of methodology and mathematics content among Japanese teachers. In that way, teacher PD among Japanese educators had been translated

into improved learner performance. De Vries (2016) defined LS as a teacher PD model whereby teachers collectively plan a research lesson, then observe the lesson being taught, collect data through classroom observations and analyse them together as a group, reflecting on the lesson presentation to improve their learning as well as that of the learners. De Vries (2016) emphasised that LS was constituted by active participation and research, and it was practice-based, learner-oriented and teacher-led, with features typical of those derived from PD in PLCs. Lim-Ratnam et al. (2019) stated that LS effectively engaged teachers as active learners for their PD. While external workshops are planned for teachers in many countries, such as SA, LS allows teachers to be responsible for their development within the school.

Fujii (2014) stated that the history of LS had been spread further and more broadly beyond the borders of Japan for a long time. Therefore, LS was part of Japanese teachers' PD and had become part of their standard educational practice. This occurred because LS had been institutionalised in their schools as a normal activity, often received and practised to develop teachers. Fujii also reminded those outside Japan that since they were not in Japan, where the LS context was institutionalised within schools, they might lose important features of LS. This was the case when Lewis and Perry (2014) conducted LS with teachers to support them in teaching fractions in the USA. They used a guiding kit to introduce LS across the US, especially among higher institutions with student teachers. LS was introduced because the USA had no system to improve teaching then. Lewis and Perry (2014) explained that the USA model of LS required teachers to conduct collaborative study–plan–do–reflect inquiry cycles formulated to improve teaching.

In the next paragraphs, I discussed the various LS models from different countries:

(a) Lesson Study in Indonesia

Lesson Study in Indonesia was formulated around the Plan, Do and See cycle, whereby teachers planned lessons together and made class presentations while other teachers' observations took place. Teachers then collaborated by reflecting on the teaching that had taken place (Nurwidodo et al., 2018; Iskandar & Suratno, 2010). In institutionalising LS in Indonesia, Iskandar and Suratno (2010) realised that improving mathematics and science education could be achieved by collaborating with teacher education institutions as pre-service providers, pilot schools, and mathematics teachers. They identified the teaching and learning methods used in workshops and discussed how they could be enhanced (Hendayana, 2014). They also designed and developed teaching resources, including lesson plans, worksheets, etc., to test these teaching resources in classroom situations. It was confirmed that reflection played a critical role in fostering PD despite the cultural challenges which had been experienced (Fujii, 2014). Suratno and Iskandar (2010) alluded to the fact that affordances of conducting reflections in LS is that there is more focus given to the mathematics and learners' mathematical learning, more opportunities to provide and receive critical feedback, and opportunities to critically observe and analyse learning in classrooms However, Iskandar and Suratno (2010) in their LS work in Indonesia realised that teachers had difficulty discovering lessons learnt from their own reflections and hence were unable to make connections and this meant that such challenges could be overcome as teachers consistently reflect on their teaching as a regular practice.

(b) Lesson Study in Singapore

Cheng and Yee (2012) studied in Singapore following the Japanese LS model. Teachers follow specific steps to achieve teaching efforts through collaborative lesson planning in LS. These included defining the problem to guide their study planning and the research lesson. Jiang et al. (2020) stated that teachers identify challenging concepts that learners are experiencing; for example, in Grade 7, learners struggle with integers. This is followed by drawing up a mathematics lesson plan in which teachers dedicate time to plan a lesson, bringing in different resources and possibly teaching aids (Nashruddin & Nurrachman, 2016).

After completing the lesson plan, one of the teachers teaches the lesson while being observed by others. After the lesson has been taught, teachers critique and reflectively discuss the lesson after classroom observations (Jiang et al., 2020). They revise the lesson to reteach it, and other teachers observe the revised lesson. This means that teachers dedicate time to revise the lesson, ensuring all their views are incorporated into a new lesson. Teachers then decide to reteach and observe the lesson again while other group members observe, focusing on lesson improvement on the initial lesson that was taught.

This is followed by lesson feedback, reflections on the lesson for the second time, and sharing the results. At the end, the chairperson from the mathematics department organises a meeting in which they share the results of the LS cycle with the other teachers in the school. Singapore LS has been instituted as a school-based TD model or a PLC programme in certain schools. From 2009 onwards, some schools implemented LS across all subjects, not just mathematics (Nashruddin & Nurrachman, 2016). Cheng and Yee (2012) revealed that teachers in Singapore had learnt the

importance of paying attention to learners' responses during lesson observations. The findings showed that using rich, purposeful tasks for learners in LS positively affected teachers' PD through critical reflection. However, there were concerns regarding the time available since LS had not been part of the teaching timetables in their schools. The critical feature of reflection was also evident in Singapore.

(c) Lesson Study in the Philippines

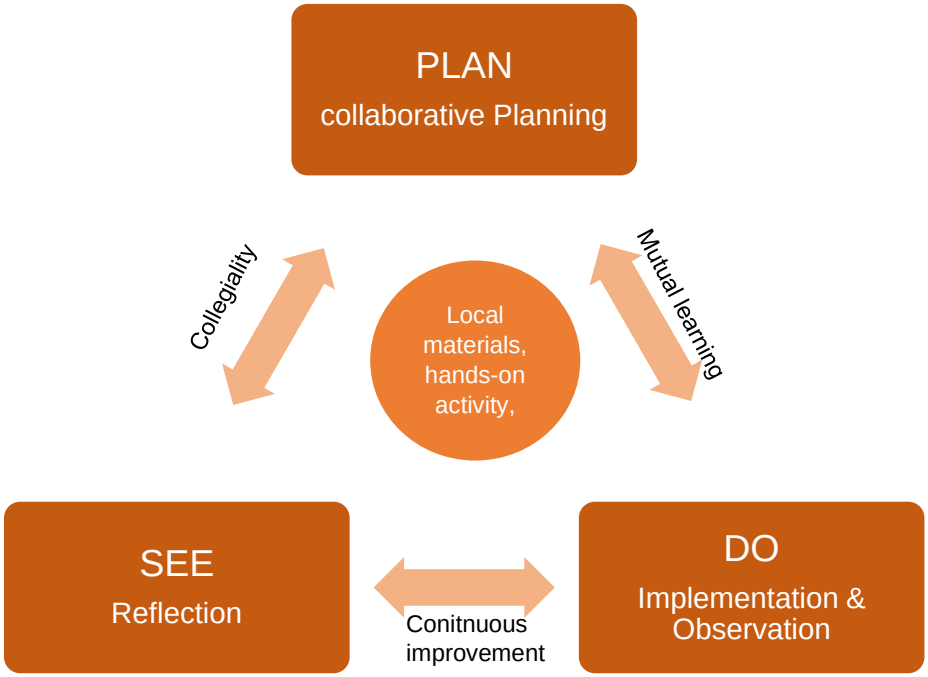
Gutierez (2015) stated that LS principles matched the concept that learning is a collaborative endeavour in the Philippines. Regarding teachers, classrooms provide a natural setting for teachers to engage and develop their teaching practices. In its adjusted model, LS was implemented in the Philippines in a cycle of Plan, Do and See (Ebaeguin & Stephens, 2014). Ebaeguin and Stephens (2014) encountered challenges implementing LS as a TD model due to societal differences between Japan and the Philippines (Fujii, 2014). In this cycle of Plan, Do and See, during the Plan or planning stage, teachers group themselves to identify a particular goal they want to achieve in their teaching. They then research relevant information to achieve their goals while anticipating how learners will respond to some of their activities and ponder about misconceptions that learners may have.

During the Doing stage, teachers observe the live lesson while taking notes of learners' activities and interactions, and sometimes, some external observers act as experts. Based on teachers' recorded observations, the seeing stage involves discussions about what happened during the lessons. Discussions evolve around what worked well and what did not and how to improve it. These discussions include feedback sessions or reflections on the observed lesson; rewriting the research lesson (which is not compulsory); teaching the revised research lesson (optional or whenever

necessary); and discussing ideas about the outputs of the research lesson or post-lesson reflection and discussions. Figure 2.2 below shows the LS model from the Philippines.

Figure 2.2

Lesson Study Model in the Philippines (source: Ebaeguin & Stephens, 2014)



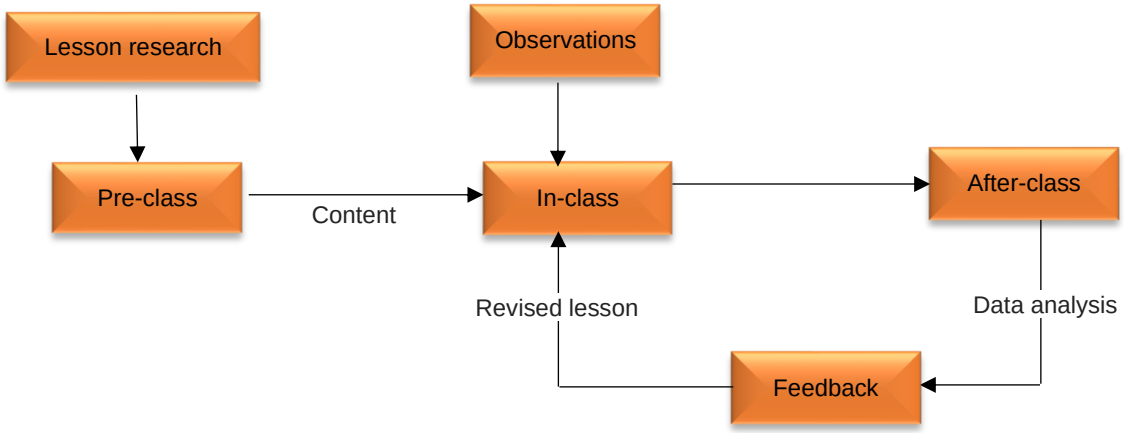
(d) **Lesson Study in China**

Huang et al. (2017) and Gao et al. (2024) indicated that China, with its large numbers of teachers worldwide, has a long-standing tradition of practising LS, which has been incorporated into the PD of their teachers. Furthermore, Huang et al. (2017) revealed that over 100 years ago, in Tianjin, Shanghai and other places in China, most educational reforms showed essential characteristics of LS. From the 1950s onwards,

LS became an instrument for professional learning and assisted in inculcating a culture of learning and teaching within Chinese schools (Gao et al., 2024). Zeng (2023) stated that the LS process in China consisted of pre-class, in-class, after-class, and reflections. In the pre-class stage, a research team comprises professional and administrative support. Figure 2.3 shows the LS model from China.

Figure 2.3

Lesson Study Model in China (Zeng, 2023)



The team comprises many teachers who come from a relevant academic profession. The team members are sometimes engaged in studies that support learning and teaching. This implies that team members would have done empirical studies or related research to guide the lesson research in line with lesson development. PD or findings from publications of research papers and the presentation of research reports would be compulsory. Therefore, team members are encouraged to improve their professional knowledge and build a higher-level knowledge base. When team members have been identified, they succinctly stipulate agreed-upon procedures

designed for their operations. In this period, lesson concepts, lesson plans, and teaching methods are developed based on the course syllabus, including long-term and short-term goals. Relevant ideas regarding the lesson plans and teaching are shared. In addition, relevant questions regarding lesson concepts are formulated to provide feedback support for teachers and observers. Teachers may alter their methodologies, expressions, and teaching styles based on feedback to enhance learners' understanding of the reviewed topic. The observers gather relevant data based on the lesson concepts, planned lessons, and how the subject will be taught to ascertain or confirm their plan's success and allow learners and teachers to comprehend the overall plan better.

Zeng (2023) clarified that in their innovations regarding lesson delivery and PD, Chinese teachers get involved in teaching research - referred to as "jiaoyan" in Chinese, which is a form of LS which incorporates school subjects and is applied by teaching research groups called "jiaoyanzu" in Chinese; in all their schools. Hence, LS is a shared endeavour among Chinese teachers who continuously engage in collaborative planning, studying and analysing numerous lessons regularly. Many scholars believe that Chinese learners' achievement in international assessments is due to the Chinese style of teaching, research activities and the system they follow (Gao et al., 2024; Zeng, 2023; Doig & Goves, 2011).

(e) Lesson Study in the Netherlands

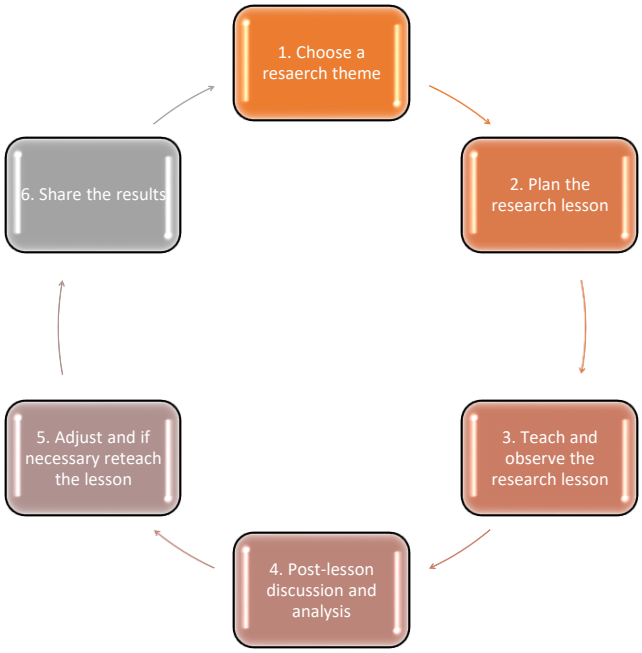
LS was introduced in the Netherlands by a consortium of institutions consisting of seven Dutch universities in 2016 (https://lessonstudynl.online/lessonstudynl/). The LS cycle used in the Netherlands comprises six stages which includes determining the

goal/theme, planning the lesson, teaching and observing, post-lesson discussion, lesson adjustment and re-teaching (if necessary), and sharing the results (Figure 2.4).

Although the LS cycle practiced in The Netherlands has six stages, the key stages of plan, conduct, and reflect are still evident (Coenders and Verhoef, 2019). Apart from the six stages as a distinguishing feature of LS in The Netherlands, another unique feature is the option of reteaching the research lesson (stage 5).

Figure 2.4

Lesson Study cycle for The Netherlands (source https://lessonstudynl.online/lessonstudynl/)



As is customary with traditional Japanese lesson study cycle, the first stage of the LS cycle in The Netherlands starts with determining the goal of the research lesson. According to Schipper et al., (2020), teachers determine the goal of the research lesson devoting themselves to consulting, reading and studying literature such as published articles, curriculum documents and other references. This process which is

known as “kyozaikenkyuu” in Japanese is quite involving and meticulous (Takahashi & McDougal, 2016).

Teachers then design and plan the research lesson (stage 2). They collectively plan, design or choose methodologies best suited for learners. In stage 3, one of the teachers then teaches the lesson while other LS team members, together with the invited expert, observe the lesson (Takahashi & McDougal, 2016; Murata, 2011). During the lesson observation stage, the other teachers write down the learners’ responses and thought processes and describe how learners answered or solved the exercises. At the end of the lesson (stage 4), the observing teachers discuss the research lesson, analyse the collected data and share insights into how learning unfolded with specific focus on learners’ thinking. In other words, how learners solved the problems given to them during teaching. The findings emanating from stage 4 guide the adjustment of the research lesson for improvement, as well as, if necessary, deciding whether the research lesson should be retaught (stage 5).

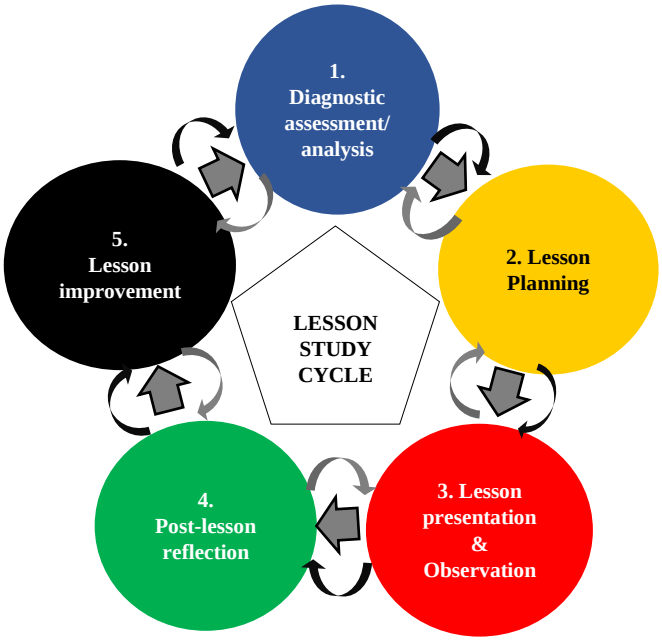
Coenders and Verhoef (2019) argued that LS is not just a series of procedures to be followed. For Coenders and Verhoef the LS characteristics require collaboration among groups of teachers, common methods of teaching to be used, the lesson planning that teachers attempt by themselves, and the learning processes of their learners focusing on their subjects, and the longer period of the cyclical course. These characteristics are similar to what recent reviews define as contemporary and progressive PD to improve the quality of teaching (Conlan, 2019; Darling-Hammond et al., 2017; Eranki & Moudgalya, 2016; van Driel & Berry, 2012).

2.4.4 Lesson Study in the South African setting

As seen above, LS, as a model for PD, was adopted globally by various countries, of which SA is no exception. The LS cycle, predominantly practised in SA, comprises five stages: diagnostic analysis, lesson planning, lesson presentation, post-lesson reflection and lesson improvement, as seen in Figure 2.5 (Sekao & Engelbrecht, 2022). LS stages adopt an iterative process from one stage to another. However, it must be noted that what happens in one stage sometimes differs from what happens in another.

Figure 2.5

Lesson Study Cycle (Sekao & Engelbrecht, 2022)



(a) Diagnostic assessment and analysis

The unique feature of the LS cycle in SA is diagnostic assessment and analysis, during which teachers identify a problematic topic for teachers or learners in a particular subject (which, in the current study, is mathematics). Stage 1 (diagnostic assessment/analysis) happens after teachers have analysed learners' diagnostic tests or exercises in which they identify patterns of common misconceptions emanating from learners' responses from learners' scripts or written work. That indicates specific problems in the topic that should be addressed during the collaboration planning of the research lesson. Also, teachers who belong to a LS cluster can identify a problematic topic that challenges their teaching abilities and even learners and use it to plan a research lesson. Sekao and Engelbrecht (2022, p. 6) stated, "As part of the localisation process, diagnostic analysis is a distinguishing feature in the LS model used in public schools in SA."

(b) Lesson planning

In the second stage, called lesson planning, teachers investigate ways to address a problematic topic using necessary teaching resources. This rigorous lesson planning process requires all teachers' contributions so that all teachers own the produced lesson (Schipper et al., 2020). Sekao and Engelbrecht (2022) stated that during this stage of lesson planning, teachers had to agree on an observation tool which would guide aspects of the lesson to be observed. During the lesson planning stage, teachers gather as a team to discuss various methods and techniques that can be used to teach the specific topic. Before the lesson planning session, teachers must gather textbook resources, teaching aids, and other supporting materials on how to teach the suggested topic (Kriewaldt et al., 2021). Careful selection of resources is

made to prepare the lesson and effectively study mathematics concepts and curriculum resources called kyozaikenkyu in Japanese Kim et al. (2021).

(c) Lesson presentation and observation

In the third stage, lesson presentation and observation, one teacher volunteers to present the lesson to a class. Others observe and make notes about learners' mathematical thinking. A teacher observation tool (TOT) that teachers have agreed upon is recommended. The aspects or criteria to be observed in the lesson must be clearly stated and understood by everyone before the lesson so they can make notes as they observe. These aspects can include (a) lesson objectives, (b) lesson introduction, (c) lesson presentation methods used, (d) learner responses, activities and tasks (the observer may take a photo of these without disturbing the learner's work), (e) teaching and learning aids – manipulatives, (f) lesson conclusion, (g) how were the objectives achieved or not achieved, (h) noting different ways in which certain aspect of the lesson could have been taught, (i) aspects of bansho, neriage, and kikanshido (Kriewaldt et al., 2021). These Japanese terms are explained later in this chapter. Extra notes outside these criteria should be provided to enrich post-lesson reflection. The teachers observing the lesson use the teacher observation tool to write their observations. It should be distributed before the lesson is presented and lesson observations start occurring (Ebaeguin & Stephens, 2014). The observation notes should not target the weaknesses of the presenting teacher but should instead focus on learner thinking, as guided by Iskandar and Suratno (2010). These written notes will be critical for the following stage of LS. Other knowledgeable external officials (such as district officials or from higher education offices, including the

universities) who were not part of the lesson development could also be invited to observe the lesson presentation (Sekao & Engelbrecht, 2022).

(d) Post-lesson reflection

The fourth stage of LS is post-lesson reflection, in which observations made during the lesson presentation and lesson observation stage will be discussed to improve the lesson. Takahashi (2014) suggested that one of the observers or knowledgeable others could facilitate the post-lesson reflection session. Zeng (2023) suggested that the presenter should also give feedback and comment or present reflections on the lesson. Emphasis on the post-lesson reflection session should be on the activities that led to achieving the lesson objectives.

Sekao and Engelbrecht (2022) asserted that during this stage, reflections are made regarding all aspects of the lesson to improve it if it is to be re-taught. Comments should be developmental, specific, and relevant to the content or stage of the lesson that has been reached. Shimizu and Kang (2022) stated that these comments should not be a personal attack, a finger-pointing exercise, or a fault-finding mission targeting the presenting teacher because the presenting teacher was a mere vessel through which the group's ideas were conveyed, as his/her role was to make himself or herself available to represent the group. Hence, if certain aspects of the lesson do not go well, the entire group will have to take collective responsibility and make developmental changes for the future. Shuilleabhain and Clivaz (2017) explained the need for teachers to engage in conversations, as in post-lesson reflection, as if they were the learners and should begin to reflect on the mathematics from the side of learners' thinking, as opposed to that of teachers. This kind of teacher learning enables teachers to understand learners' mathematical thinking. Widjaja et al. (2017) stated that as part

of a self-introspection exercise, it is essential for teachers to reflect on their teaching to develop themselves. After that, developing their pedagogical content knowledge (PCK) will positively impact their learners' understanding of mathematics (Ní Shuilleabhain, 2016).

(e) Lesson improvement

Sekao (2023) described the fifth and final stage of LS as the lesson improvement stage in which all the inputs discussed and agreed upon by all teachers, from the post-lesson reflection stage onwards, would be factored into the lesson. This ensures that if the same lesson were to be delivered by any of the teachers in their teaching, they would know what to do differently to get better outcomes from the learners. Hence, the purpose of conducting LS is to help teachers become lifelong learners through collegial efforts (Dudley, 2014). Researchers widely acknowledge that LS fosters teacher learning for improved teaching (Widjaja et al., 2017; Gutierez, 2015; Iskandar & Suratno, 2010).

These critical features of PD, as conveyed by Darling-Hammond et al. (2017), such as content-focused, active learning through collaboration and job-embedded, are evident in the LS cycle (Lewis & Perry, 2017), thus highlighting the collaborative nature of LS and the sense of community it fosters among educators.

2.4.5 Benefits and Challenges of Lesson Study

The first part of the discussions that follows pertains to the benefits of LS as it applies to PD in enhancing teaching and learning performances (Webb et al., 2014). Due to the fact that LS is still recent in our country, South Africa, I have also indicated

challenges that have experienced nationally and internationally as alluded to by Fujii (2014).

2.4.5.1 Benefits of Lesson Study as part of teachers' experiences engaging in effective reflective practice

In this section, I explored literature to gain insights into the benefits of LS from different perspectives, including the benefits occasioned by teachers' participation in reflective practice.

(a) Benefits related to teachers' content learning

Studying curriculum materials, *such as kyozaikenkyuu in Japanese, becomes necessary for teachers to develop* a research lesson within LS (Kim et al., 2021; Takahashi & McDougal, 2016). Selecting relevant materials directs teachers to a curriculum design process, as teachers carefully consider materials relevant to their classroom contexts. Teacher professionalism in developing the skill to critique and approve different textbooks uplifts teachers' status as curriculum developers responsible for their PD (Shield & Dole, 2013).

The careful selection of exercises to develop learners' mathematical thinking through relevant activities from various textbooks should be encouraged so that reflections can be made regarding the impact of such exercises (Melville, 2017). Using different textbooks and workbooks when planning a research lesson greatly benefits teachers, who often do not discuss their teaching resources (Kriewaldt et al., 2021). Teachers rarely engage in such an activity on their initiative but are almost persuaded to do so in LS.

Perusing different textbooks is necessary for identifying and designing purposeful instructional tasks and activities that should address learners' content challenges (Melville, 2017). This rigorous activity happens mainly when teachers plan a lesson by looking at their diagnostic analysis to identify learners' conceptual challenges. Hence, the objectives of the research lesson should be well-defined. Materials selected for teaching are not limited to textbooks alone but include other teaching aids such as worksheets for learners, manipulatives such as mathematical instruments for measuring angles, teaching charts such as diagrams of fraction walls, terminologies, and examples (Kim et al., 2021). Furthermore, based on learners' responses during lessons, teachers reflect on the usefulness of selected materials regarding their positive or negative effects during lesson presentations (Mizoguch & Shinno, 2019).

This process ensures that the next time they teach the same topic, they can refer to relevant resources that have proven to work better than using old materials, which may limit their learner's understanding of concepts (Shield & Dole, 2013). For example, in an investigative lesson to discover that the exterior angle of a triangle is equal to the two opposite interior angles, learners do not need to be told this mathematical fact by using a narrative teaching method. However, they can understand and apply this mathematical fact by measuring the angles of a triangle and its exterior angle and even cutting out interior angles and fitting them into the exterior angle.

(b) Benefits related to pedagogical enhancement

The advantage of engaging in LS is the significant enhancement of pedagogical knowledge that can be achieved through collegial engagement. One of the key benefits teachers gain through LS is the ability to organise their teaching activities on

a board to depict a logical flow of conceptual ideas as the lesson progresses from the introduction to the main presentation (Asami-Johansson et al., 2023). In Japanese, this organisation is called bansho (Tan, 2021). Bansho is the art of displaying or presenting words and diagrams on a board - or it could be a whiteboard nowadays (Tan et al., 2023). Most teachers neglect this aspect of planning by using writing systematically on a chalkboard so that learners can see a logical flow in lesson activities, from simple to complex or from mental maths to the introduction and examples leading to the main lesson's classwork activities. Learners who are required to engage in classwork activities perceive a sense of conceptual development in lesson activities and understand the content being taught better, thereby stimulating their intellectual curiosity and growth. In summary, below are the characteristics of *bansho:*

- To ensure that the lesson is recorded correctly – the teacher could assist in a post-lesson reflection session, which would be held in the same class the lesson was taught so that teachers could point directly at the relevant lesson activity and explain how it was dealt with. {as teachers explore how learners learn, the information becomes readily available on the board}.
- To assist learners in remembering the lesson flow – some learners need to write notes logically so that they can remember content easily when they study at home.
- To assist learners in focusing on the important parts of the lesson – as part of conceptual development, including understanding.
- To display ideas presented by learners – displaying learners' solutions on the board facilitates this comparison.

- To structure learner thinking and discover different solutions – if other learners do not understand the solution, their thinking is enhanced by seeing other solutions (Asami-Johansson et al., 2023).
- Encourage learners to write notes as the teacher displays their work on the board, and they write it in their exercise books for simplified referencing.

The other pedagogical benefit teachers acquire through LS is the presenter's mobility around the classroom when learners engage in tasks (Banky et al., 2014). This is called *kikanshido* in Japanese. Japanese teachers use it in their classrooms to monitor and support learners who have worked out exercises. This will also enable teachers to ascertain interesting strategies learners have used to solve exercises (Kriewaldt et al., 2021). Kriewaldt et al. (2021) revealed that teachers' monitoring and guidance during a lesson could redirect learners' understanding during inquiry-based learning. Engaging in *kikanshido* offers the teacher an effective pedagogical tool to intervene when learners are about to make serious mistakes and develop misconceptions (Banky et al., 2014). Hence, this intervention addresses learners' needs as they progress through their tasks. Teachers in LS should note that to sharpen their classroom awareness skills, they should examine their learners' progress to discern when to intervene or leave learners to work independently. Doing so will assist learners in catching up with the pace of the lesson and will give them time to participate in problem-solving activities and whole-class discussions (Asami-Johansson, 2021). Often, struggling learners are left without attention being paid to them, and they then lose interest in the lesson on that day, thus leading to further content gaps in their mathematics studies.

Kriewaldt et al. (2021) further explained that how teachers initiate their interactions with learners and subsequently interact with them are critical pedagogical events in which the teachers have to decide what to do and when to intervene to move forward with the lesson. For example, when learners are directed to calculate an unknown angle in the triangle, the first step is to identify a theorem or mathematical fact to set up an equation. In this case, it refers to the fact that the sum of the interior angles of a triangle adds up to 180^0. Sometimes learners struggle to set up this equation, and the teacher moves on with the lesson without verifying by himself or herself by looking into the learners' workings or first steps that the learner is falling behind. In such cases, the teacher may continue with the algebraic manipulation of the equation, which confuses and frustrates learners who have failed to keep up. It is also essential for the teacher to be aware of the different methods learners use to solve problems and even allow some of them to explain their solutions to their classmates. In the company of other educators, teachers may become aware of various methods that they use to teach the same topic. They may then have an opportunity to evaluate their methods and choose to change or strengthen them—as happens in critical reflection (Gutierez, 2015). Pedagogical enhancement happens mainly when teachers plan a lesson, including purposeful activities. In contrast, during lesson presentations, the presenter applies the relevant pedagogy, and during post-lesson reflection, discussions are held around how the pedagogy can be improved. The literature reveals that LS sometimes assists researchers with formulating relevant teacher knowledge of methodology, thus facilitating content knowledge among educators (Dudley, 2014).

(c) Benefits related to knowing learners' conceptual needs

Posthuma (2012), who did her research work in SA, noted that there were benefits from engaging in LS regarding teachers knowing their learners' conceptual needs. The study focused on the reflection aspect of teachers and on how post-lesson reflection could assist with improving teachers' lesson presentations the next time they teach their lessons. Teachers reported in her study that they had developed their lesson-planning abilities because of the influence of LS group planning sessions. This collaborative planning made them more assertive about their teaching abilities after seeing themselves teaching their lessons on video. Hence, they shared critical awareness regarding their learners' needs and how they should address them.

(d) Benefits related to professional noticing

Yang et al. (2019) reported that in recent times, a growing community of research in mathematics education has placed greater emphasis on investigating teachers' professional noticing. Yang et al. (2019) deduced that noticing was explained in numerous ways involving different aspects of teachers' instructional activities at certain times. Van Es and Sherin (2002, 2008) stated that teachers' noticing comprised (a) noting a relevant aspect that occurred during teaching (b) drawing connections between lesson events related to broader aspects of teaching and learning, and (c) the effect of knowledge regarding its context to understand classroom events better.

Teachers' professional noticing is one of the important skills that teachers engage in in classrooms, and it is a requirement for quality teaching, which has been developed in mathematics education, as well as in other subjects, including science education (Barnhart & Van Es, 2015; Van Es et al., 2017). Yang et al. (2019) purported that

teachers selectively notice classroom events as they happen in class. When teachers use their knowledge to understand certain events, professional noticing becomes critical to teaching expertise. Hence, it affects teachers' classroom activities and can even determine the overall quality of teaching mathematics. Eventually, it affects learners' mathematical proficiency. Professional noticing is similar to kikanshido in Japanese, which Japanese teachers have used in their classrooms for a long time to supervise and monitor their learners' workings to sift out interesting strategies that learners use to solve exercises (Kriewaldt et al., 2021). Noticing learners' work assists with discovering learners' thinking and is one of the focal points for LS during post-lesson reflection. Researchers such as Barnhart and Van Es (2015) and Van Es et al. (2017) highlighted that teachers' professional noticing is an important quality which simplifies the challenging aspects of teaching. Hence, it has become evident that a deep understanding of teachers' professional noticing will add value to comprehending the nature of teachers' tasks.

McGlinn and Chung (2014) explained that reflection-in-action during lesson presentations is critical for dealing with challenging events during the teaching process. Teachers must develop an ability to professionally notice and better assist their learners when they need support. However, Yang et al. (2019) noted that teachers' beliefs and knowledge, which includes their overall methodologies and the content of mathematical knowledge, had a direct effect on teachers' noticing abilities during teaching (Dreher & Kuntze, 2015; Meschede et al., 2017). Moreover, teachers' previous teaching experiences directly influences what teachers notice in their teaching (Ding & Dominguez, 2016). The implementation of LS as a model for TD seeks to uplift teachers' knowledge, beliefs, and experience, through reflective practice. Therefore, professional noticing is essential in devising PD strategies among

mathematics teachers. Yang et al. (2019) proposed models of professional noticing which covered the following three aspects of noticing: (1) how teachers perceive certain events during teaching, (2) how they interpret such events, and (3) taking necessary decisions as a response to learners' activities or suggesting different teaching methods. König et al. (2014) discovered that pre-service teachers' overall pedagogical knowledge can determine their abilities in interpreting classroom events. Meschede et al. (2017) also pointed out that teachers' noticing is significantly related to their PCK and philosophies about learning and teaching.

Another factor influencing teacher professionalism was teachers' experiences. It is expected that mathematics teachers with more experience in teaching and those with more content knowledge would have a greater ability to exercise professional noticing. As teachers engage more frequently in post-lesson reflection within LS, their ability to notice significant learning events will be enhanced because they will focus on events that lead to learner thinking (Amador, 2016). Furthermore, Yang et al. (2019) revealed that in terms of the development of teachers' noticing, and when taking into account the level of knowledge and previous teaching experiences certain teachers possess, engaging in LS could readily develop their ability because reflection is a significant aspect of professional noticing.

(e) Benefits related to understanding of learners' mathematical thinking

Since LS encourages the active involvement of learners, communication of mathematical concepts and procedures among them results in greater learning (Webb et al., 2014). Since mathematical concepts are interrelated, connecting with prior knowledge to understand the current topic is important (Pambudi et al., 2020). Learners are encouraged to present their solutions in groups to demonstrate their

reasoning skills. Also, it should facilitate the development of problem-solving skills among learners. One of the prescripts of LS is the focus on learner thinking through engagement in problem-solving tasks (Wahyana, 2023).

Natan Jr. and Ishii (2023) investigated how teachers facilitate a problem-solving session in mathematics classrooms with their learners, referred to as neriage in Japanese. Neriage is the art of soliciting correct responses from learners through careful questioning to lead them in a problem-solving exercise (Groves, 2013). In this way, a problem-solving session between a teacher and learners becomes a vehicle for developing mathematical thinking, as learners make connections between mathematical facts more readily. For most teachers, such discussions might derail their lessons. Thus, teachers engaging in LS should carefully consider whether they should use problem-solving exercises (Wahyana, 2023). Such exercises would likely ignite thoughtful discussions to deepen learners' understanding of mathematical concepts. Furthermore, according to Natan Jr. and Ishii (2023), when engaging in meaningful problem-solving that enhances learners' mathematical thinking, mathematics teachers should consider the above.

(f) Benefits related to selecting word problems for a specific lesson

The mathematics textbooks teachers use must support a structured problem-solving approach or at least have a range of activities that promote a structured problem-solving approach (Natan Jr. & Ishii, 2023). Such textbooks should contain various word problems that are open-ended, non-routine or have different ways of approaching solutions. Open-ended and non-routine questions will assist with developing learner thinking because they contain activities that align with classroom activities (Groves, 2013). Unfortunately, no textbook possesses these characteristics. Hence, the use of

a variety of textbooks to access such activities will promote the problem-solving approach.

(g) Benefits related to instructional materials used in presenting word problems

Instructional materials in the context of my study refer to resources used by the teacher during the lesson to assist learners with understanding the content better (Isola, 2019). Natan Jr. and Ishii (2023) pointed out that mathematics lessons in Japan typically follow a problem-solving approach in which teachers stress learners' problem-solving abilities and make efforts to teach the implications and use of mathematical concepts by thinking deeply about their solutions. Teachers in LS must engage in textbook analysis every year before procurement, especially when looking at the content and the flow of concepts from topic to topic.

(h) Benefits related to initiating an extensive discussion approach (neriage)

Natan Jr. and Ishii (2023) suggested that teachers start by asking learners to brainstorm whether their methods have similar ideas or strategies. Then, teachers should lead learners to decide whether each solution has benefits or limitations. Neriage is essential to a Japanese problem-solving lesson because teachers can teach their learners new mathematical ideas and concepts using other learners' solution strategies (Groves, 2013). Teachers start discussions with a method that every learner understands. The method allows the teacher to lead his learners through progressively more difficult strategies so that by the end of a lesson, almost all learners can attain the lesson objectives (Wahyana, 2023). This type of neriage

assists learners by starting discussions at a basic level that perhaps most learners understand, and the teacher's role is then to scaffold the learners' activities carefully.

(i) Benefits related to facilitating a structured problem-solving approach

Natan Jr. and Ishii (2023) listed other types of neriage whereby teachers compare their learners' solutions to open-ended exercises, for which many correct answers exist. Hence, by displaying these solution strategies, even side by side, for comparison and discussion, teachers in LS can reflect effectively on their learners' solutions and begin to teach them to think broadly. Tan (2021) explained that bansho implies the intentional use of board space to assist learning by saying that it is a valuable skill that enables teachers to assist learners in reflecting purposefully after the lesson. Hence, by displaying learners' solutions side by side, learners are challenged to think broadly, even when considering their solutions compared to their classmates. After teachers have discussed, read, and compared learners' responses, they can identify common problem-solving procedures for reflecting after the lesson. For example, using a simple problem-solving procedure used by learners, teachers can then deduce that struggling learners should start by presenting the exercise as a task of the day, giving them more time to think about the solution on their own, rather than by discussing it with their classmates to confirm their thought processes; thereby assisting each other if need be. Doing so would then be followed by neriage and then be completed by generalising and applying the strategy to other problem-solving tasks and activities. Shuilleabhain and Clivaz (2017) revealed that one of the benefits of practising LS was that it allowed teachers to engage in conversations, as in post-lesson reflection, as if they were the students and then to begin to think about the mathematics from the side of learners;

as opposed to just being teachers. This kind of teacher learning has enabled teachers to understand learners' mathematical thinking.

(j) Benefits related to engaging in neriage to support productive achievement of problem-solving tasks

Japanese researchers Natan Jr. and Ishii (2023) realised that teachers implemented a similar flow in teaching learners problem-solving strategies. Each lesson starts with previous lessons, followed by presenting the problem task for the current lesson and conducting individual work and teamwork. The teacher engages in kikanshido to facilitate neriage (Groves, 2013). Finally, the task is completed by making generalisations based on various solutions presented by the learners. This means that the learners must explain their solutions while the rest of the class decides whether the answers presented are correct. Then, the lesson is completed by writing down all the possible solutions to the tasks given in the lesson and verifying whether the solutions generated could be generalised to other situations. The benefit of this kind of lesson flow in LS is that it encourages teachers to develop their pedagogic abilities. Isoda (2010) highlighted that problem-solving approaches (PSA) are similar to those in Japan's mathematics curricula and that developing these approaches would have consistent benefits in LS. LS became well-known due to its (PSA) (Widjaja, 2017). This is because the iterative characteristic in LS allows teachers to discover new and better methods of teaching a difficult concept until a more appropriate one is found. As stated earlier, PSA combined, if coupled with LS, can offer better models of teacher training programmes to improve learners' performances. Thus, inculcating neriage in teachers' pedagogy would encourage interactive learning as learners work through problem-solving tasks. This is because learners' interactions promote mathematical discussions of their thought processes and solutions, improving their ideas and

thinking. When learners communicate with their classmates, who have different ideas, it assists in developing their thinking abilities. Through interaction, other strategies, which are easier to understand, can also be learnt, such as:

Improving/extending learning: Neriage supports multifaceted learning. Identifying other methods to solve the problem develops learners' thinking. This is because learners share and listen to other suggestions from their peers. They can learn different thinking styles and various solutions to one problem. Critical thinking will also be enhanced by comparing learners' ideas and answers.

Successful attainment of lesson goals: Engaging learners in deeper discussions assists in successfully attaining lesson goals. Properly organising learners' thought processes through neriage and bansho facilitates the discovery of simpler solutions. In addition, having deep discussions about multiple solutions cannot be achieved by an individual learner or teacher. Hence, through reflection in social settings, as in LS, teachers can find value in kikanshido, neriage and bansho.

2.4.5.2 The challenges of implementing Lesson Study – resulting in hindrances to reflection

It is necessary to note that LS is still a new concept in SA. Though efforts to implement LS have begun, they were confronted with different challenges, as detailed in this review section. I begin by discussing Ono and Ferreira's (2010) experiences through the Japan International Cooperation Agency (JICA) project in 2001. Though this initiative was supported by the two governments, Japan and SA, there were hindrances within the province and districts. Posthuma (2012) also made strides in implementing LS, in which she focused on reflecting based on video lessons by the teachers. Initially, challenges experienced pertained to how teachers did not reflect on

their lessons and were even estranged from learners' content challenges due to their failure to reflect on themselves to improve their teaching. Some hindrances Adler and Alshwaikh experienced (2019) the hindrance of the unavailability of time to reflect and the fact that teachers did not find it necessary to reflect on their lessons. Sekao and Engelbrecht (2022) undertook a comprehensive study in which teachers experienced hindrances, such as not knowing how to reflect on lessons, lack of confidence, and lack of collaboration. However, the efforts of Sekao and Engelbrecht (2022) have led to a South African model of LS. I have classified further hindrances in the paragraphs below.

(a) Systemic challenges

Ono and Ferreira (2010) explained that some of the challenges emerging from implementing LS were systemic due to the different education systems of Japan and SA. For example, LS in Japan is well structured, and it is an institutionalised practice in their education because it is part of every school, and teachers are expected to engage in lesson planning for the year (Seleznyov, 2020; Takahashi & McDougal, 2016). However, outside Japan, such as SA, LS is not part of the schools' planning process. The other systemic challenge experienced by Sekao and Engelbrecht (2022) included large class sizes, making it difficult for teachers to stage LS sessions in their schools. Long distances between schools that were in the same LS cluster were one of the common challenges. Geographic challenges were witnessed in the study by Sekao and Engelbrecht (2022) because schools were scattered in the Northwest circuits, and teachers could not travel long distances to attend LS sessions in rural areas. This led to other challenges, such as travelling costs and time wasted on public

transport. Consequently, these challenges resulted in teachers not attending the LS activities regularly.

Ono and Ferreira (2010) stated that the initial plan of LS for PD was well received in 2001. Unfortunately, teachers did not sustain their LS agreement with JICA to continue with workshops until 2007. This was because LS workshops scheduled in the initial stages of 2002 had to be cancelled due to the National Department of Education suspending all workshops during that year's first term. The matriculation results were poor in the province. A decision was then made that LS workshop sessions with teachers be rescheduled to be staged during school holidays. When JICA evaluated the project for continuity, it was found that only 15% of the schools involved conducted some kind of school-based development. Hence, very few LS sessions took place because teachers indicated it was impossible to do so. Ono and Ferreira (2010) felt that viewing the project as unsuccessful was unfair due to hindrances, other factors, and changes beyond their control.

Lim-Ratnam et al. (2019) realised that there was a positive response from principals in their intention to implement LS. However, when asked about their objectives for engaging their schools in LS, it was noted that only 16.03% of the principals felt that the importance of LS was to deliberate on school mission and goals.

According to Lim-Ratnam et al. (2019), this low percentage was a concern because the literature on LS suggested that the purpose of engaging in LS is also to evaluate how they were progressing in attending to the research theme or content topics. Sekao and Engelbrecht (2022) confirmed teachers' challenges regarding school management teams whereby school principals were unaware of or understand LS.

The principals' ignorance regarding LS prevented their teachers from attending the sessions.

(b) Cultural differences

Lim-Ratnam et al. (2019) and Fujii (2014) warned that jugyoukenkyuu (Lesson Study) is a sociocultural teacher practice implemented over 100 years in Japan, therefore some parts of LS are only natural to the Japanese education culture. Groves et al. (2016), Takahashi and McDougal (2016) and Warwick et al. (2016) have echoed the same sentiments. Some of LS's salient aspects would not be easier to implement in other countries, and taking jugyoukenkyuu into a non-Japanese culture would be a challenge (Fernandez & Yoshida, 2012). Although it would have been expected that LS could be adjusted to suit the educational practices of different cultures and contexts, there is still a challenge that varieties of adaptations of LS may lose the essence of jugyoukenkyuu. Such adaptations will eventually miss the relevance of LS in promoting teacher PD (Ebaeguin & Stephens, 2014).

(c) Time constraints

Adler and Alshwaikh (2019) noted that teachers often did not have time for post-lesson reflection due to work overload. After conducting lesson observations with teachers and agreeing to hold reflection sessions after school, teachers could not attend as they rushed to leave. They deduced that teachers were least interested in openly discussing their classroom practices and finding possible improvement solutions. Hence, Adler and Alshwaikh (2019) perceived that for such teachers, the classroom remained like a closed box that no one was allowed to open. This was because teachers felt intimidated if their teaching space was exposed and felt like they were being invaded—also, the concept of teachers as long-life learners did not appeal

to them. In a study done in Malaysia by Mon et al. (2016), they also found that time constraints and teachers' heavy workload of teaching many classes affected their participation in LS, as well as teachers' lack of confidence because they had insufficient content knowledge and were uncomfortable when being observed teaching. These were some of the hindrances associated with the implementation of LS.

(d) ***Reflective comments***

It was noted that some of the teachers' comments when engaging in reflective practice during post-lesson reflection sessions in LS were personal and did not focus on the lesson improvement and learners' thinking (Sekao & Engelbrecht, 2022). It was noted that during reflections, teachers tended to focus on the neglectable slips made in the lesson by the presenter, and their comments diverted the post-lesson session to irrelevant issues that were not constructive. Some teachers could not contribute meaningfully to any event observed during the lesson. The major challenge of collaboration was the free-riding effect, a debilitating tendency among group members who only wanted to benefit from the group efforts (Hall & Buzwell, 2013). This behaviour was even more prevalent during lesson planning meetings, whereby only a few teachers planned the lesson while the rest could do nothing. Further collaboration challenges were noted because the presenter would deviate from the original lesson as planned collaboratively after agreeing on how the lesson was presented. Since LS is a TD model, one challenging aspect is teacher confidence due to collegial efforts (Kimberly, 2002). Hence, the lack of teacher confidence should be a compelling reason for teachers to participate in the LS practice; however, the result was a withdrawal attitude (Mon et al., 2016). Lack of confidence was one of the challenges

that teachers experienced in the LS project. The study by Sekao and Engelbrecht (2022, p. 6) revealed that the most eminent confidence issue was that teachers were "uncertain about themselves when presenting a lesson in the presence of their colleagues regarding confidence, the reflection sessions proved somewhat problematic". Further observations made by Sekao and Engelbrecht (2022, p. 6) were that "since post-lesson reflection could result in robust debating, teachers tended not to find this stage of reflection useful". This was because of perceived personal attacks from other teachers, undermining their confidence (Schunk & DiBenedetto, 2016). Teachers struggled to do the reflection and were unhappy about being made the focus of reflection events instead of focusing only on the lesson. This challenge could be understandable since teachers at the initial stage of LS implementation would not know how to reflect on their lessons accordingly. Also, during post-lesson reflection, the focus is not on the lesson presenter but on the learners' thinking (Wahyana, 2023). Teachers were uncomfortable about their teaching abilities due to their lack of mathematical content, and their teaching methodologies were found wanting about the language of mathematics.

2.5 REFLECTIVE PRACTICE AS AN INHERENT FEATURE OF LESSON STUDY

2.5.1 What Is Reflection?

The conceptualisation of reflection as it pertains to education can be traced back to John Dewey – the American philosopher, psychologist and educationist (Rodgers, 2002). In understanding reflective practice, Dewey explained that reflection focuses on deeper understanding, personal growth and the ability to contribute to a collective endeavour (Holdo, 2023). Rodgers (2002) described four criteria for reflection. Firstly, reflection is a meaning-making process during which a teacher transitions from one

experience into the next with a deeper understanding and connections to other experiences and ideas. A teacher's limited interpretation of a broader perspective comes from other people's views. Secondly, reflection is a systematic, rigorous, disciplined way of thinking. Reflection should not be casual and unstructured, as doing so cannot offer an opportunity for improvement.

For example, according to Gibbs' Reflective Cycle (Sekarwinahyu et al., 2019), reflection follows certain stages and prescripts. These stages are descriptions, feelings, evaluations, analysis, conclusions and action plan. Thirdly, reflection needs to happen in a community. This is because, in a community, various perspectives of the same event are reflected upon comprehensively. In my study, this is afforded by the LS context in which teachers work collaboratively. Lastly, reflection requires attitudes that value one's personal and intellectual growth. In the heart of reflection is the need for change and to do things differently. Hence, the involvement of other teachers who make valuable contributions would assist their growth in content knowledge and pedagogical skills.

2.5.2 Reflective Practice in Mathematics Teaching and Learning

Olteneanu (2017) cited that reflective teaching involved looking at one's underlying beliefs about teaching and learning and understanding actual classroom practice before, during and after a lesson is taught. Thus, in a community of professionals, teachers learn about how other teachers perceive certain teaching methods that may not match theirs, and perhaps they may decide to adopt such new methods to succeed in their teaching. McGlinn and Chung (2014) explained Schön's reflective cycle in which Schön differentiated between reflection-in-action and reflection-on-action. Reflection-in-action happens during the teacher's self-awareness of certain

knowledge and skills to handle puzzles and problems during the lesson. This means that the teacher will constantly evaluate the lesson's progress in each stage to verify if the lesson is moving towards achieving the intended objectives, and if not, he or she will then take the necessary corrective actions. Olteneanu (2017) states that reflection-in-action, as a dimension of reflection, occurs during the learning encounter in which the teacher notices certain learners' actions and quickly implements a solution to achieve lesson objectives. Reflection-on-action happens after the lesson encounter to preview and better understand what exactly happened (McGlinn & Chung, 2014).

Olteneanu (2017) revealed another dimension of reflection: reflection-for-action, which is done when thinking about future actions to improve the situation. Olteneanu (2017) asserted that this kind of reflection requires teachers to foresee what will occur during a lesson and think deeply about their past encounters before a lesson is taught on a particular topic. In addition, Edwards (2017) described reflection-for-action as the reflection that happens when the teacher or mentor and student reflect in advance about the future learning event. For example, when planning a research lesson in LS, the teachers anticipate possible questions that learners may ask and then provide responses. This is a classic example of reflection for action. Iskandar and Suratno (2010) alluded to the fact that the affordances of conducting reflections in LS are that there is more careful attention given to the mathematics and learners' mathematical knowledge, more chances to provide and receive critical feedback, and opportunities to observe and analyse lessons in classrooms critically. While doing lesson observations, Adler and Alshwaikh (2019) discovered that working on mathematics lesson exercises enabled and empowered teachers and learners. This was seen from the reflection discussions that they conducted. Their lesson observations caused them to alter the learners' exercises. This caused learners' performances to improve. This

showed that effecting necessary changes as agreed upon during reflections could result in better understanding for learners.

Shimizu and Kang (2022) highlighted the value of observing learners' thinking from their written exercises, thus offering teachers an opportunity to find ways to assist their learners. Such evidence enriches the post-lesson reflection so teachers can improve their teaching practices. Another advantage of doing post-lesson reflection, as stated by Shimizu and Kang (2022), is the critical opportunity to interpret learners' work and better understand and think more deeply about curriculum issues. Subsequently, this would influence teaching methods and materials, benefiting learners' understanding of mathematics. Connelly et al. (2020) revealed that teachers who engage in reflective practice become aware of their positive effect on the learners they teach and can better provide them with the strategies they need to succeed. Van Rensburg et al. (2018) had earlier stated that reflective practice, especially in the context of LS, creates an environment for teachers to learn and develop strategies to implement in their teaching. It would appear, therefore, that better learning outcomes may not be achieved without effective reflective practice on the part of the teachers. In the absence of guidance for conducting reflective practice, the situation might even worsen.

2.5.3 Challenging the Status Quo Through Critical Reflection in Lesson Study

Gutierez (2015) described three types of reflections and shed light on how mathematics teachers did reflections in their lesson preparations. According to Gutierez (2015), in descriptive reflection, teachers focus more on themselves regarding what they will teach and how learners will learn. This kind of reflection is ignorant of why learners respond in the manner they would. It only focuses on the

observable aspects of teaching. The second type of reflection is analytical reflection (Gutierez, 2015, p. 322), in which “teachers were able to recognise the complexities of classroom dynamics in terms of patterns, relationships, and connections to deepen their understanding of their instructional practices”. Teachers would let go of their perspectives of what and how to teach, consider learners’ needs, and design the lesson accordingly. Though this kind of reflection assists teachers in deepening their understanding of their instructional practices, it does not unearth the real challenges that learners have in understanding content. Hence, even with new instructional practices, learners may continue to underperform since the cause of their lack of understanding may not have been identified.

In critical reflection Gutierez (2015, p. 322) stated that “Teachers share insights that their approaches to teaching can either contribute to or hinder the success of lesson implementations. As such, they view their practices as a factor in the social outcome of their pedagogical actions.” In other words, teachers also take responsibility for why learners understood or did not understand the content taught so they can then plan how to teach the same concept differently in the future so that the learners can achieve better understanding. Critical reflection can be likened to the iceberg model; as Webb (2017) explained, the root causes of learners' correct or incorrect answers are not always observable. The iceberg model was developed by Hall (1976), who applied it to organisational culture to identify the root causes behind organisational behaviour. It has been modified over the years, and researchers have put it into various contexts, including learning and teaching. Like an iceberg in the water, the model reveals that at the tip (upper part of the iceberg) is the observable behaviour of individuals. In contrast, beneath it (under the water) are the psychological and philosophical beliefs, likes, dislikes and values of why individuals behave as they do.

Like the iceberg model, critical reflection encourages a deepened understanding of the complicated issues behind appearances. Hence, when teachers engage in critical reflection during the post-reflection stage of LS, they look beyond learners' responses to explore the underlying thinking patterns and misconceptions that led to such responses.

Rahayu and Aljouhani (2023) applied the iceberg model to investigate why learners' performances in Israel were always low. Eventually, they decided to alter the problematic curriculum, which was the reason for the learners' underperformance. Thus, critical reflection, like the iceberg model, is a rigorous engagement that allows teachers to shift their perspectives from observable outcomes to underlying causes or symptoms of learners' responses or performances.

In LS, during the stage of post-lesson reflection, teachers think deeply about how the lesson could have been planned and taught differently and then identify reasons why individual learners responded in a particular way. They further reflect on the purposeful activities they could have used to affect the observable learning outcomes and change the status quo of poor performance. Sekarwinahyu et al. (2019) asserted that reflective thinking motivates teachers to be more active and assists them with expressing their views in a more democratic environment, which then becomes the groundwork for learner-centred learning, which could lead to improved performances. It is clear, therefore, that critical reflection, which happens during the stage of post-lesson reflection, challenges the status quo of the learning of both learners and teachers.

2.6 HOW TEACHERS USE THEIR POST-LESSON REFLECTION TO IMPROVE THEIR TEACHING PRACTICE

Daniel et al. (2013) asserted that feedback discussions ensured that teachers contributed to critical efforts to renew the qualities of their practices. Thus, through reflection, an environment of critical analysis is created and sustained. Although Iskandar and Suratno (2010), in their LS work in Indonesia, stated that teachers had difficulty understanding lessons learnt from their reflections and hence could not make connections, such a challenge would be overcome progressively, as teachers consistently reflected on their teaching as a normal practice.

In Australia, Widjaja et al. (2017) discovered that post-lesson reflection assisted teacher PD by employing collaborative planning skills, attention to learner thinking, and managing whole class discussions. During post-lesson reflection, the presenting teacher presented his/her reflections first to enhance everyone's content knowledge, methodology, and knowledge about learners' thinking. Consequently, the post-lesson reflection made teachers more vigilant and continuously reflected to improve their practice (Gutierez, 2015). Furthermore, Widjaja et al. (2017). revealed that post-lesson reflection on learner responses prompted teachers to change their beliefs about their learners' problem-solving abilities and the researcher's ability to conduct extended whole-class discussions to reflect on the learning that occurred or did not occur. Moreover, Sekao and Engelbrecht (2022) discovered that teachers discussed improving their mistakes in lesson presentations during post-lesson reflection. Such discussions during reflection ensured that teachers' future lesson delivery could be better when teaching the same topic. Regarding reflective practice as a critical dimension of the teaching and learning of mathematics, Posthuma (2012) felt that teachers needed grounded pedagogical knowledge about the mathematical content

they were reflecting on. She further asserted that teaching and teacher education were important for determining how to improve learner performance within collaborative lesson-planning sessions. Furthermore, when different teachers reflected on their lessons, they noticed certain aspects of the lesson that they had not realised initially (Shuilleabhain & Clivaz, 2017). In analysing teacher learning, Shuilleabhain and Clivaz stated that LS can develop teacher knowledge, especially when considering PCK. They further explained that teacher learning happens easily when teachers are active participants, focusing on the content and having an opportunity to reflect on their own and their learners' learning.

Post-lesson reflection has been recognised as an important enabler for student teachers to improve their teaching (Nyaumwe & Mtetwa, 2011). Their study discovered that reflection could provide a context for student teachers to use to support their decision-making skills, understand their learning contexts, evaluate learner knowledge gaps, and find ways to reduce them. Effective decision-making during teaching enabled student teachers to determine other alternative methods of presenting a lesson so that all the different cognitive levels of learners in a class could be catered for.

Furthermore, Nyaumwe and Mtetwa (2011) asserted that post-lesson reflection improved questioning techniques and guided the lesson's pace and the activities' suitability to enhance learner understanding. It becomes clear, therefore, that post-lesson reflection in mathematics can improve teachers' daily practice and ensure that when reflecting, the focus is more on learners' responses (Widjaja et al., 2017; Gutierez, 2015).

2.7 LESSON OBSERVATIONS AS A PREREQUISITE FOR CONDUCTING POST-LESSON REFLECTION WITHIN THE LESSON STUDY SETTING

The stage of doing post-lesson reflection in LS follows the lesson observation stage in a LS cycle (Dudley, 2014). Thus, the success of post-lesson reflection depends on how effective the lesson observations were. Widjaja et al. (2017) explained that the ability of mathematics teachers to engage in meaningful post-lesson reflection after lesson observations offers more opportunities for PD among them and improved learning by learners. This means that there must be meaningful alignment between the lesson observation stage as an enabler for the post-lesson reflection.

In her study on student teachers making lesson observations, Myers (2012) found evidence that observations were worthwhile experiences to enable teachers to prepare to recognise and identify key teacher and learner behaviours in the learning context. In preparation for post-lesson reflection, lesson observations provided a platform to build upon so that what is reflected is recorded systematically. During the lesson observation stage, teachers think deeply about the lesson content and the learners' responses they need to reflect upon. Furthermore, Myers (2012) revealed that lesson observations possessed the potential to be a powerful tool for facilitating teacher growth. This growth includes increased content knowledge and understanding of curriculum, methodology, learning by learners, and developing habits of critical observation and post-lesson reflection.

In the Philippines, Gutierez (2015) conducted a study about teachers' reflective practices in LS and revealed that during post-lesson reflection, teachers focused more on evaluating their teaching practices and not on the learners' responses. In a similar study by Sekao and Engelbrecht (2022), there was also a need to correct the

challenges experienced by teachers who observed insignificant aspects during lesson observations, which made the post-lesson reflection less impactful. Hence, a systematic method must be employed as an observation tool to guide all observers. This tool would state the exact aspects to be observed for comments focusing on learner responses (Widjaja et al., 2017), such as learners' procedural fluency, mathematics language and syntax, application of mathematical facts, axioms, and mathematical thinking.

Posthuma (2012) related an incident during the lesson observations focused on the teacher's lesson presentation and the learners' content knowledge. In one teacher's class, learners could not transpose the constant term to the other side of the equation when using the additive inverse, and as a result, the amount of work covered in 45 minutes was much less. The teacher's struggle happened because they did not understand the learners' thinking and could not encourage them to explain and justify it. There was one event in which the teacher asked one of the learners to solve the linear equation $32 + \mathrm{x} = 34$ on the board. Seeing that the learner was struggling, the teacher, instead of assisting the learner, told the learner to ask their classmates to assist, but unfortunately, that did not solve the problem. This incident happened because the teacher could not perceive the learners' content knowledge level when solving equations. Only afterwards, during post-lesson reflection, when the teacher could reflect on their teaching, did they realise how the situation could have been dealt with amicably.

From the above discussions, it is evident that the success of post-lesson reflection depends on effective lesson observations. In other words, the ability of mathematics teachers to engage in meaningful post-lesson reflection after lesson observations

would offer them more opportunities for PD and improved learning. Therefore, teachers begin to think critically about the lesson they have prepared. At the same time, they observe it in action when presented in class, then they continue to reflect critically based on the learners' responses. This further testifies that there must be meaningful alignment between these two stages, the lesson observation stage as an enabler for the post-lesson reflection stage.

2.8 CONCLUSION

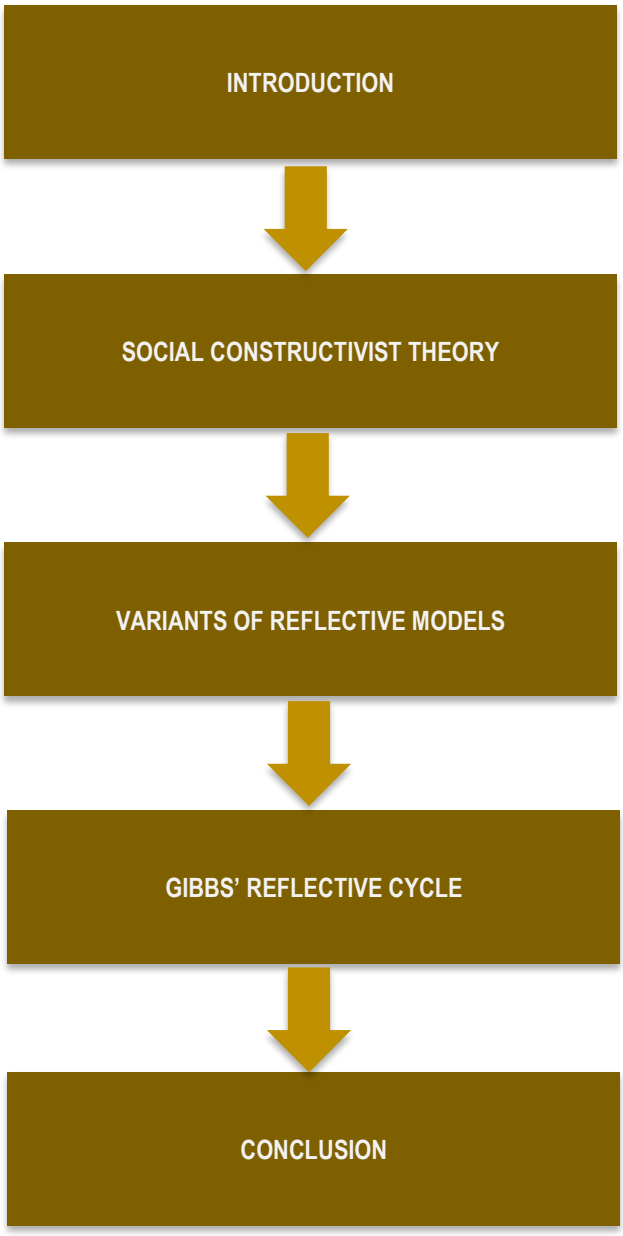
This chapter described how I divided my literature review into sub-sections to reveal the study's focus. These included contemporary PD approaches in which I listed and explained different models in line with LS's prescripts, such as collaborative learning and reflective practice. I explained LS as a progressive TD mode for contemporary mathematics classrooms. I explained what LS is, described models of LS from different countries, described LS in the South African setting and described the benefits and pitfalls of LS. It was important for me to focus more on reflective practice as an inherent feature of LS, in which I explained reflection in general, reflective practice in the mathematics education context and reflection as a platform to challenge the status quo through critical reflection in LS. Since my study focuses on how teachers learn through reflections, I had to show how post-lesson reflection can improve teaching practice. I completed my literature review by showing how lesson observations are a prerequisite for conducting post-lesson reflection within the content of LS.

CHAPTER 3: THEORETICAL FRAMEWORK

I have presented an overview or flow of the current chapter in Figure 3.1 below for ease of reference.

Figure 3.1

The structure of Chapter 3 - Theoretical Framework



3.1. INTRODUCTION

The theoretical framework provides the lenses I used to view my research study as a researcher (Luft et al., 2022). It is based on theories that have assisted me in understanding and planning my research. This chapter discusses the theoretical frameworks that assisted my study: Vygotsky's SCT and Gibbs' Reflective Cycle (Sekarwinahyu et al., 2019; Adam, 2017; Bishop & Blake, 2007). My study was guided by two theoretical frameworks which served different but complementary purposes. The two theoretical lenses I chose were Vygotsky's SCT (Vygotsky & Cole, 1978) and Gibbs' Reflective Cycle (Sekarwinahyu et al., 2019).

While one theoretical framework may suffice for many, I have chosen these two theoretical frameworks in which I viewed my study for the following reasons: firstly, LS provides a context for collaborative learning and development among teachers, as Dudley (2014) explained. Collaborative work aligns with the SCT's theoretical basis propounded by Vygotsky (Vygotsky & Cole, 1978). Secondly, according to the SCT, knowledge is socially created in a collaborative environment among individuals or teachers who can offer each other PD, and this is linked to the iterative process of Gibbs' Reflective Cycle.

Thirdly, the SCT gave me a theoretical basis/grounding for LS because of teacher collaboration from Stage 1 to Stage 5 of the LS cycle in SA. However, Gibbs' Reflective Cycle provided a theoretical basis/grounding on how reflection should be conducted in Stage 4 of LS in SA. LS does not provide explicit guidelines regarding how teachers should conduct post-lesson reflection. Gutierez (2015) deepens the concept of reflection into *critical reflection*, which challenges teachers to change the way they have always taught certain content to learn new teaching methods with the assistance

of other teachers. Hence, that justifies using the two frameworks within which my study falls, as both frameworks have concepts that are similar in application and fit the stages of the LS cycle, especially regarding aspects of reflection.

3.2. SOCIAL CONSTRUCTIVIST THEORY

Lev Vygotsky's SCT is based on and evolved from Piaget's Constructivist Theory. Originally, Piaget's Constructivist Theory posited that learning is directed by a learner as he or she constructs his or her understanding of information (Devi, 2019). Therefore, the emphasis is on individual personal experiences. Vygotsky, a Russian psychologist, extended Piaget's Constructivist Theory, focusing more on the social environment and interaction as important factors that assist learning rather than on the learner alone (Adam, 2017). Adam (2017, p. 2) revealed that "Vygotsky is considered as the father of social constructivist theory" and that "his work was based on Jean Piaget's idea of the child as an active learner."

Vygotsky's educational background of attending private tuition in which he was taught methods of critical inquiry and philosophical conversations led him to develop the Social Constructivist Theory, which attributed a learner's cognitive development to his/her social environment (Barnett, 2019). As Adam (2017) asserted, Vygotsky believed that the human mind is developed through interactions with the environment and that there was a significant connection between people's understanding of the environment and themselves (Peer & McClendon, 2002).

One of the application areas of Vygotsky's SCT (Adam, 2017) is peer collaboration, which reflects the notion of collaborative engagements. When referring to collaborative work among teachers, Adam (2017, p. 3) stated that "this method is mainly used in learning mathematics, science, and language arts, which attests to the recognised

impact of the social environment during learning." This is because knowledge is easier shared and verified in a social setting than when an individual works alone. The Social Constructivist Theory places more significance on the social environment as an enabler for PD and learning (Barnett, 2019 & Tolentino, 2012). Vygotsky and Cole (1978) stated that a child depends on other people during the early stages of its growth as the sociocultural environment constantly presents the child with various activities happening in his/her surroundings.

Key points in Vygotsky's SCT include viewing social interactions as critical, knowledge being co-constructed between two or more individuals, and self-regulation being developed through internalisation (developing an internal representation) of actions and mental operations that occurred in social engagements (Klimkowski, 2019). Vygotsky's SCT advocates for learning "not through interaction, but in interaction" (Adam, 2017, p. 3).

The Zone of Proximal Development (ZPD), as part of Vygotsky's SCT, can also be clarified as the difference between the actual level of development as determined by independent problem-solving and the higher level of potential development as guided by problem-solving under guidance or in collaboration with more capable peers (Vygotsky, 1978). The term proximal, which means nearby, alludes to the fact that the assistance provided by peers goes slightly beyond the learners' current competence but supports and builds on their current abilities (Shabani et al., 2010).

Vygotsky argued that education should prepare learners for unknown future challenges rather than dragging them along in sociological development. That meant differentiating between actual and potential development. The actual level can be realised by activities a person can handle by themselves, whereas the potential level

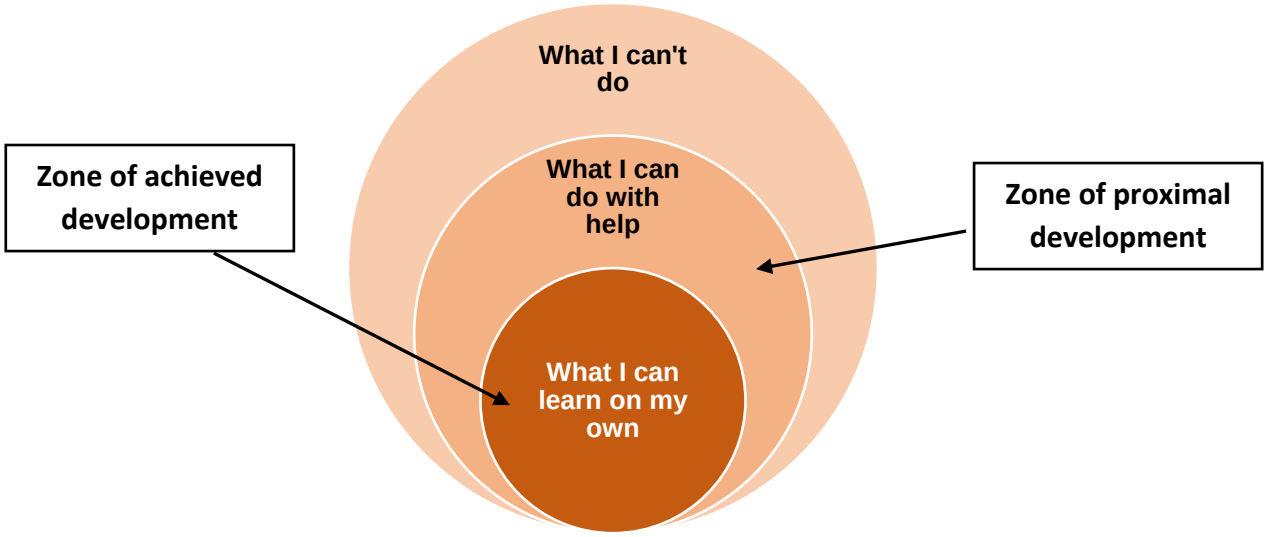
is where assistance for understanding one's life is needed. Vygotsky revealed that the gap between doing something individually and doing it with the assistance of others signifies different stages of development, which differ from one person to the next. In this way, Vygotsky regarded teachers' PCK as not just a tool to access information to be assimilated but as a stepping stone whereby learners' thinking abilities, with their structural characteristics, can progress from one level to the next.

Vygotsky and Cole (1978) defined the ZPD (see Figure 3.2) as the difference between what people can do on their own and what they can do with assistance from others. Then, post-lesson reflection after the lesson observations would lead to realisation and rethinking of how best the mathematics lesson could have been presented based on learner responses to achieve maximum understanding by the learners. The ZPD provides a platform for individual teachers to learn, in a social setting, from the views of other teachers, which they need to improve their teaching (Smagorinsky, 2018).

The notion of the ZPD, according to Adam (2017), stresses that people develop higher thinking levels when the gaps in their thinking and problem-solving are assisted by adults, peers, or more capable others. This support, according to Smagorinsky (2018), is called scaffolding. The social environment supports development because what can be done collaboratively can be accomplished later. Therefore, it is important for teachers to actively participate in the learning process for this development to happen. Teachers will not engage in LS every time they have to teach a new or difficult topic; they have to implement what they have learnt in a social setting near their peers and then implement it in their classrooms. That would be proof that, indeed, PD had taken place.

Figure 3.2

Zone of Proximal Development (Adam, 2017)



Vygotsky's SCT emphasises the importance of what the learner arrives at within any learning encounter to derive valuable meaning from it and contribute to possible solutions. His theory encompassed the dynamic nature of connections between teachers, learners and tasks and gave a view of learning emerging from engagement with other individuals. This meant that Vygotsky's theory assumed that learning occurred not through interaction but in interaction. Learners must first succeed in performing a new task with the assistance of their teachers and then internalise how the problem was solved so they can apply the solution independently without outside assistance. In this way, social interaction is an enabler for constructive learning. Hence, the theory further reveals that interactions that successfully facilitate learning are ones in which learners can simplify and solve new tasks.

(a) Scaffolding - the Connection-Making Process

Smagorinsky (2018) stressed that scaffolding is critical to learners' cognitive development and learning. It happens by creating supported situations in which learners are challenged to develop their present skills and knowledge. Learners connect the old and the new knowledge using scaffolding processes in a social, active environment. Xi and Lantolf (2021) stated that if scaffolding can be used skilfully, it can stimulate learners' interests, simplify their tasks so they are achievable and motivate them to pursue higher goals. In the constructivist model, peers and instructors provide the scaffolding based on which new content is internalised. Assimilating concepts and principles to real-life contexts assists one with acquiring new knowledge. Schunk and DiBenedetto (2016) asserted that participating in structured social activities that emphasise elaboration, analysis, and inferencing assists learners in making connections to real-life situations.

Through post-lesson reflection in LS, teachers engage in debates and discussions that stimulate their thinking abilities and creativity in teaching a concept, resulting in them learning new ideas about their pedagogy (Waring & Evans, 2014). Teachers had to first succeed in planning and teaching a mathematics topic using collective ideas, that is, with the assistance of other teachers in a social setting, and then learn how to teach that topic on their own, just as in ZPD. For example, during the lesson observation and lesson presentation stages of LS, the presenting teacher presented the lesson being observed by other teachers. The same teacher was then required to reflect on the lesson in a social setting, and all of them reflected on the lessons learnt during the post-lesson reflection sessions based on their lesson observations. After the post-lesson reflection sessions, teachers were empowered to reteach the same lesson differently, incorporating the reflection notes contributed by their colleagues. In the LS

context, social interaction among teachers is the main driver that facilitates teacher learning. Vygotsky and Cole (1978) believed that cognitive development, including higher-order learning, originates in social interactions. Hence, applying Vygotsky's SCT to my study, I see that the connections among teachers, learners, and activities present a perspective of learning that occurs when interacting in a group. Because of this social setting in LS, I have chosen to use this theory as the lens through which I viewed my study when I was looking into the reflective practices among teachers that were taking place. Specifically, I have focused on the *post-lesson reflection* stage of LS.

Vygotsky and Cole (1978) emphasised the social setting as an enabler of PD and learning. Patang and Machmoed (2020), who engaged English teachers in LS, acknowledged the affordances of Vygotsky's SCT in developing teachers. In my study, during the post-lesson reflection stage of LS, there will be social interactions among teachers who would have observed the lesson, including the presenting teacher. This is the social environment under which PD will be taking place. Specifically, teachers will reflect on the current topic they may have taught in the past and will bring their relevant past experiences as resources for the post-lesson reflection. Therefore, new learnings will propel teachers to want to improve their PCK. In relation to the ZPD, Vygotsky also stressed that instruction should be directed towards higher levels of the ZPD than the lower levels (Smagorinsky, 2018). In other words, learning experiences should make the teachers stretch their knowledge to meet high expectations, and this could be evidenced as teachers develop strategies to teach the observed lesson with confidence.

During the SCT, teachers construct knowledge in interaction, which could affect their self-confidence and self-efficacy, as Schunk and DiBenedetto (2016) discussed. Schunk and DiBenedetto (2016) revealed that self-efficacy refers to a person's understanding of their abilities to perform a given task efficiently. Self-efficacy provides further insight into learners' cognitive development, even in social settings (Artino, 2012). Self-efficacy can affect an individual in most aspects of existence, including educational experiences. Beliefs about an individual's competence to complete a task can influence motivation, interest, and achievement. Schunk and DiBenedetto (2016) deduced that the higher the perceived efficacy, the higher the possibility of achieving set goal aspirations people adopt and the stronger their commitment to achieve those goals. Thus, educational activities like teaching and learning should encourage self-efficacy in social interaction. Hence, the learning environment is structured to discourage competition and focus on self-comparison progress to build a sense of self-efficacy and promote academic success. Peer and McClendon (2002) discovered that individuals contribute to their life pathways by selecting, influencing, and constructing their own experiences based on perceived self-efficacy and self-regulatory capacity. Learners and teachers should choose tasks based on their self-efficacy beliefs (Maddux, 2016). Strong self-efficacy by learners and strong teacher efficacy would result in learners being able to manage their learning abilities, persist in achieving a task, and increase their goal attainment by choosing relevant tasks that challenge their current knowledge. Also, teacher efficacy is as important as learner efficacy in developing and implementing learning activities and tasks (Maddux, 2016).

In teaching mathematics, learners get motivated when they achieve simpler tasks, and therefore, they can aspire to do more challenging tasks, thereby developing a strong efficacy (Schunk & DiBenedetto, 2016). The opposite is true regarding their non-

achievement of given tasks, which will reduce their belief in being successful in mathematics. The implication for LS is that while teachers may have struggled to teach certain topics in mathematics, for example, how to teach the concept of the exterior angle of a triangle, they will be assisted on how to do so even better through post-lesson reflection. After being able to teach this geometric topic, they will be inspired to teach more difficult mathematics topics. Therefore, from an educational perspective, applying constructivist strategies in LS can help teachers relate their old teaching knowledge to new teaching strategies while developing a strong sense of self-efficacy. In general, the teacher's confidence in teaching tougher mathematics topics is not that high due to the lower levels of learner performance, as explained earlier; however, through reflective practice in LS, teacher morale could be boosted (Malinauskas, 2017). My study showed that teachers re-taught challenging lessons confidently and achieved better learning outcomes.

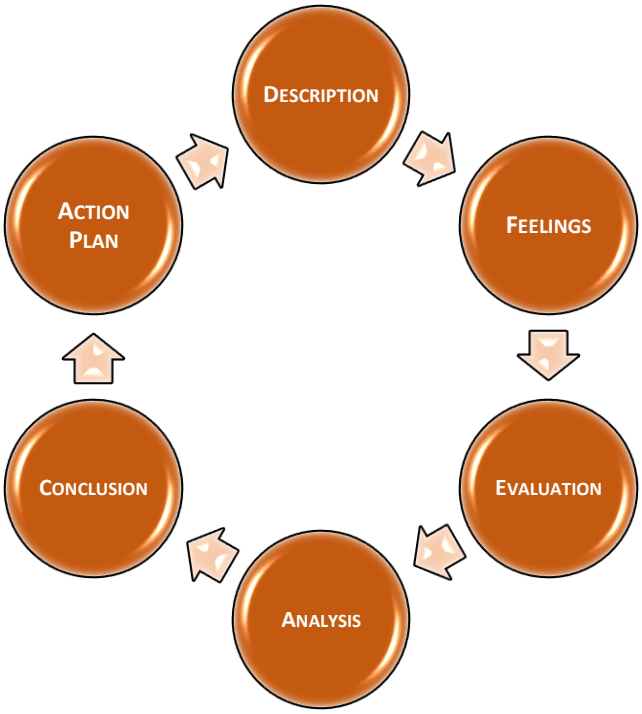
3.3. GIBBS' REFLECTIVE CYCLE

Graham Gibbs was an American psychologist and sociologist known for significantly influencing teaching, learning methods, and assessment (Gibbs, 2010). He developed a guide for teaching and learning methods that involves directly asking questions and providing explanations with concrete examples (Cooper & Wieckowski, 2017). Graham Gibbs is the proponent of Gibbs' Reflective Cycle, which evolved from Kolb's reflective model or learning cycle, and had four stages: concrete experience, reflective observation, abstract conceptualisation, and active experimentation (Dennison, 2009). Gibbs' Reflective Cycle has been widely used in the medical field for student nurses as a theoretical framework which requires reflective writing of medical reports on patients (Sekarwinahyu et al., 2019). Sekarwinahyu et al. (2019) stated that Gibbs' Reflective Cycle was also used in problem-based learning on plant development, an

online tutorial program to monitor whether the new program could improve the reflective thinking skills of students. What was encouraging from the programme was that it was discovered that Gibbs' reflective thinking could also be used in other courses to improve students' reflective thinking abilities. I have chosen Gibbs' Reflective Cycle (Sekarwinahyu et al., 2019). Figure 3.3 below offers guidelines for how reflection in the LS will occur during post-lesson reflection.

Figure 3.3

Gibbs' Reflective Cycle (Sekarwinahyu et al., 2019)



In the following paragraphs, I have explained each stage in greater detail.

(a) Description

Bishop and Blake (2007) explained that in the first stage of Gibbs' Reflective Cycle, called description, one would describe in detail the event being reflected upon. In this stage of reflection during my study, I was listening to and capturing teachers' comments about what was observed as captured in their observation tools during lesson observations, that is, retelling what happened. Moreover, the descriptions will offer new perspectives or experiences for describing particular instances. During the lesson observation stage, Sekao (2023) suggested that according to LS prescripts, the facilitator of the reflection session ought to allow the lesson presenter to describe the lesson presentation session. The initial conversations should be used to set a more relaxed environment where everyone can openly express their views without fear. One of Dewey's criteria for reflection is that it is strengthened when shared with others (Hébert, 2015). Dewey (1933) revealed earlier that sharing one's thoughts in a social setting can reinforce reflective practice. Doing so allows the other group members to comment on what has been mentioned. Therefore, after listening to the reflections of others, the individual teacher would feel accountable to the group and influence how they would teach that particular topic reflected in the lesson. Thus, the lesson presenter will reflect on their lesson, describe the lesson events and share how those events made them feel. At this point of reflection, the presenter would not be aware that they are following Gibbs' Reflective Cycle. Thus, the LS setting afforded by Vygotsky's SCT will provide an enabling environment for constructing new knowledge through reflection.

The following questions for the facilitator, as suggested by Sekao (2023, p. 100), could form guidelines to start the session; among them are:

- Why did the group engage in the LS activity?
- What was the lesson's goal, and how was it identified?
- What was the process for developing the lesson?

The facilitator should also identify the observers and knowledgeable others and explain to all participants how to conduct reflection. To guide the lesson presenter, the facilitator can also suggest the following aspects for reflection: how prepared they were, how learners behaved, whether the resources were user-friendly, and whether there was enough time to teach the lesson.

(b) Feelings

As explained by Bishop and Blake (2007), the second stage of Gibbs' Reflective Cycle is called the feelings stage, in which a person tries to recall and explore the things that were going on in their mind, i.e. why did this event stick to their mind, including thoughts of how did they feel when the event started; what were they thinking about at the time; how did it make them feel. In the context of LS, it may include how the teacher who taught the lesson in the presence of other teachers feels or how he or she felt about the outcome of the lesson. Furthermore, emotions may be experienced that lead to self-development, empowerment, and knowledge. Incorporating this stage into my study during post-lesson reflection, the lesson presenter continued to express their positive or negative feelings about certain aspects that took place while she was presenting. Sekao (2023) explained that these might also include feelings of anxiety being observed by other teachers, cases where learners seemed not to be understanding the lesson, certain discomfort or dealing with unexpected questions from the learners. Furthermore, the observing members may also share their feelings based on what they noted during the lesson presentation, which they wrote on their

observation tools. The reflections on feelings will be recorded to assist all participants in managing those incidences in the event they also encounter similar situations and, therefore, will be able to deal with them accordingly.

(c) Evaluation stage

In my experience, positive or negative feelings have the potential to lead people to investigate the situations in which they find themselves. Hence, Bishop and Blake (2007) explained that in the third stage of Gibbs' Reflective Cycle, the evaluation stage, one would evaluate or judge what happened. They would consider what was good or bad about the teaching experience. In the context of my study, the evaluation stage (Sekarwinahyu et al., 2019), the observing teachers will discuss what worked or did not work during the lesson without attaching reasons. Sekao (2023) gives further guidelines in the context of LS that discussions should not focus on the presenting teacher to criticise him or her but on learners' thinking, as observed and recorded during lesson observations. This stage of reflection will allow observing teachers to contribute to their PCK (Adler & Alshwaikh, 2019) of the lesson being taught as part of their learning and thus note relevant issues. This stage resonates more with Vygotsky's Social Constructivist Theory, in which teachers construct knowledge as they learn from each other using learners' responses and the presenter's methodologies.

(d) Analysis stage

The fourth stage of Gibbs' Reflective Cycle is called the analysis stage, in which one must break the event down into its parts so that those events can be explored separately (Bishop & Blake, 2007). For example, what went well, what was done well, what did others do well, what went wrong or did not turn out the way it was planned,

and in what way did the presenting teacher or learners contribute to the event? During the analysis stage, alternative solutions, such as analytical reflection, would be suggested to improve the lesson, according to Gutierez (2015). It is further expected that teacher learning will continue because what teachers thought was always right to do when teaching the same lesson will be questioned for the first time to challenge the status quo, as in critical reflection (Gutierez, 2015). In critical reflection, the status quo of how certain concepts have always been taught is challenged based on the outcomes of learner thinking. Misconceptions observed in learners may also point out misconceptions that teachers' unawareness of their teaching may have caused. The reasons given as to why certain aspects of the lesson may or may not have worked well or may have been caused by the presenter deviating from the actual lesson plan due to contextual factors will be listed in reflection-in-action (Gutierez, 2015). Gutierez (2015) explained that reflection-in-action is when one makes a new decision during an action or lesson to avoid a certain outcome or lead learners to a desired outcome. Such reasons for deviation will be critical for learning by observing teachers.

Hence, the panel members' knowledge and the contributions of the knowledgeable others may assist in finding the best amicable way of dealing with such situations. The possible solutions could be backed up by research or other findings made in similar situations by panel members. Once again, Vygotsky's Social Constructivist Theory, as in the ZPD, will assist participants in moving from what they did not know to what they will learn from others.

(e) Conclusion stage

In the fifth stage of Gibbs' Reflective Cycle (Bishop & Blake, 2007), called the conclusion stage, teachers involved should ask themselves what they could have done

differently, as in critical reflection (Gutierez, 2015). According to Dewey (1933), upon reflecting on the treatment recommendations, the surgeon should realise his/her preferences for the treatment and prescribe alternative treatments in the future that may be more effective for particular patients. In this study, during post-reflections, panel members will be offered various solutions or conclusions, and they may select what is best for their learners in their different contexts. In Gibbs' Reflective Cycle, the conclusion stage will consist of summarising the main comments and key findings made by the panel members and the knowledgeable others based on what was learnt. These discussions will align with Vygotsky's Social Constructivist Theory, which states that knowledge is constructed in a social setting. The ZPD will close the gap between what teachers did not know and what they would have learnt.

A conclusive report will be written and kept for further referencing by the teachers (Sekao, 2023). Dewey (1933) noted that humans are both emotional and intellectual beings, and these aspects influence their decision-making processes. For example, while determining patient care, a surgeon serious about performing a certain procedure may be more likely to prescribe a normal treatment without considering the benefits of other methods. According to Dewey (1933), upon reflecting on this recommended treatment, the surgeon should realise his/her preference for the treatment and prescribe alternative treatments in the future that will be efficient for other patients.

(f) Action plan stage

Bishop and Blake (2007) explained that the sixth stage of Gibbs' Reflective Cycle is called the action stage, in which those involved look forward to reencountering the event and plan well to ensure improvement. The action plan is the final stage of Gibbs'

reflection cycle, which is based on the report, the key findings, and decisions that will be made on how to improve the lesson in case it needs to be re-taught (Sekao, 2023).

Fry and Kolb (1979) emphasised the continuous nature of learning, suggesting that there is always room for improvement and growth as teachers progress through the reflective cycle of reflection and learning processes. Fry and Kolb provided valuable insights into the nature of learning, demonstrating that there is no end to learning but only another cycle turn.

3.4. THE BASIS FOR SYNERGISTIC USE OF THE TWO THEORETICAL LENSES

My study focused on the fourth stage of the LS cycle used in SA, which is post-lesson reflection, during which teachers should reflect on a lesson collectively. Therefore, I have situated the process of reflecting within the social setting, emphasising the value of collective learning and shared experiences. This social setting makes the Social Constructivist Theory more significant, and the social environment is a mode of development and learning (Barnett, 2019).

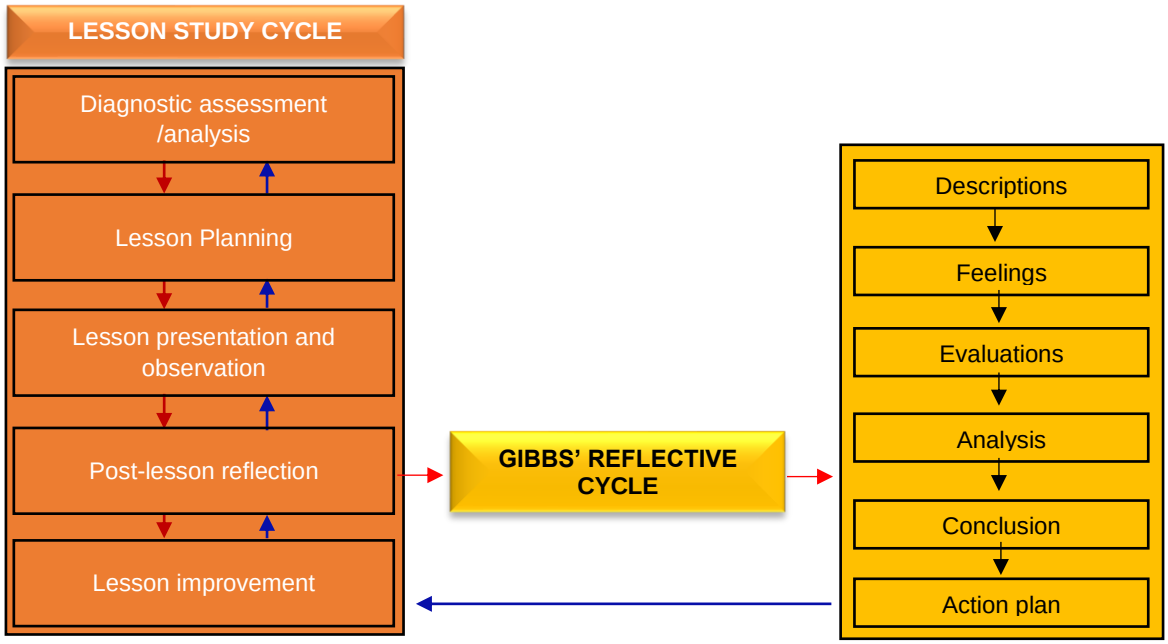
Vygotsky's SCT and its primary purpose in my study is to situate LS as a model for TD. However, Gibbs' Reflective Cycle becomes more appropriate for gaining more insight into the process of reflection. Coupled with this social setting proposed by Vygotsky's Social Constructivist Theory, Gibbs' Reflective Cycle will provide a structured method of reflecting during the post-lesson reflection stage of LS (see Figure 3.4).

The stage of post-lesson reflection resonates more with Vygotsky's Social Constructivist Theory, in which teachers will construct knowledge as they discuss and reflect on how their collective ideas were actualised when one of their colleagues

taught their collaboratively planned lesson. In my study, teachers have to first succeed in teaching a mathematics topic using collective ideas, that is, with the assistance of other teachers in a social setting, and then learn how to teach that topic on their own after reflecting on the best teaching strategies as in ZPD. For example, during the lesson observation and lesson presentation stages of LS, the presenting teacher will present being observed by other teachers. During the post-lesson reflection stage of LS, all the teachers will reflect on the lesson in a social setting to improve it. Suppose I was only to situate my study on Vygotsky's SCT. In that case, I will lack the guidance on conducting proper reflection through which knowledge will be constructed. Also, focusing on Gibbs' Reflective Cycle alone will limit my understanding of the necessity of PD through the construction of knowledge in the context of LS. Moreover, due to the post-lesson reflection, the metacognition skills afforded by the LS context within which my study is located will not be developed among teachers.

Figure 3.4

The link between the Lesson Study and Gibb's reflective cycle



3.5. CONCLUSION

In this chapter, I have clarified that two theoretical frameworks guided my study: Vygotsky's SCT (Vygotsky & Cole, 1978) and Gibbs' Reflective Cycle (Sekarwinahyu et al., 2019). LS will provide a context for teacher collaborative learning and development (Dudley, 2014). I have situated LS in Vygotsky's SCT (Vygotsky & Cole, 1978) while focusing on the LS cycle stage four, post-lesson reflection.

Variants of reflective models were cited, such as John Dewey's reflective model, as described by Hébert (2015) and Schön's model, as described by Paterson and Chapman (2013). I have given evidence that in Vygotsky's SCT, knowledge is generated in a social setting among individuals who offer assistance for their development.

At the same time, this is also linked to the iterative process of Gibbs' Reflective Cycle. Comparatively, I have revealed that in the SCT by Vygotsky (Vygotsky & Cole, 1978), the ZPD is related to Gibbs' Reflective Cycle wherein teachers engage in critical reflection during post-lesson reflection (Gutierez, 2015). It was also important for me to state that during critical reflection, teachers are challenged to change how they have always taught certain content and incorporate new methods learnt from other teachers. Information regarding all the stages of Gibbs' Reflective Cycle was discussed.

CHAPTER 4: RESEARCH METHODOLOGY

For ease of reference, I have summarised the structure of the current chapter in Figure 4.1 to illustrate its flow.

Figure 4.1

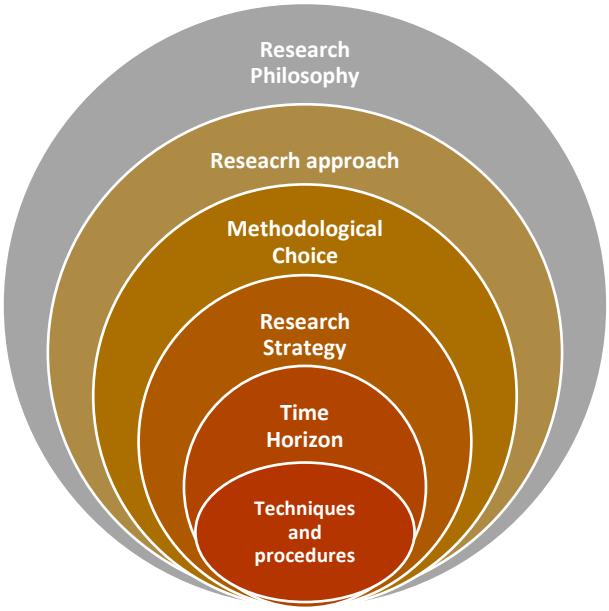
The structure of Chapter 4 - the Research Methodology

4.1 INTRODUCTION

Research methodology is a well-thought-out plan that constitutes a credible research philosophy, a research approach which underpins a methodological choice, a research strategy, data collection techniques and analysis procedures (Saunders et al., 2015). Pandey and Pandey (2021) further clarified that a research *methodology* is a systematic and theoretical analysis of research *methods* applied to a field of study. It is a way to solve a research problem systematically and may be understood as the science of studying how *research* is done scientifically. Snyder (2019) stated that a research methodology aims to explore facts and truths; it contributes to and builds developing knowledge, collects evidence for theories and advises actions to understand reality. In addition, Abutabenjeh and Jaradat (2018) asserted that research methodology assists researchers with understanding a phenomenon or behaviour, or it can be used to test a theory. In conceptualising the structure of the current chapter, i.e., Research methodology, I was guided by the research onion proposed by Saunders et al. (2015), as seen in Figure 4.2 below. According to Saunders et al. (2015), the research onion consists of the following layers: Research philosophy, Research approach, Methodological choice, Research strategy, Time horizon, Techniques and Procedures.

Figure 4.2

The Structure of The Research Onion (Saunders et al., 2015)



4.2 RESEARCH PHILOSOPHY

Mbanaso et al. (2023) emphasise that a research philosophy is a guiding belief about collecting, analysing, and using data in a specific research context. This philosophy, closely intertwined with the research approach, forms a comprehensive plan and procedure for detailed data collection, analysis, and interpretation (Creswell & Creswell, 2017). The interpretivist philosophy I adopted for my study plays a pivotal role in shaping all the research choices, from formulating research questions to selecting methodologies and making recommendations.

In my study, I adopted an interpretivist philosophy, as explained by Saunders et al. (2015). The interpretivists assert that reality is viewed from multiple perspectives in a subjective stance to effect change in teaching and learning (Putnam & Banghart,

2017). Interpretivist philosophy focuses on two distinctive features: meanings and interpretations. Putnam and Banghart (2017) stated that interpretation refers to making meanings or forming inferences about a phenomenon. Interpretivist philosophy is, therefore, based on the belief that reality is socially constructed or made meaningful through the participants' understandings and interpretations of events (Creswell, 2014). Putnam and Banghart (2017) stated that meanings refer to how actors make sense of their experiences or reach an understanding of their everyday lives. Interpretivist Philosophy focuses on synergising meanings and interpretations to understand a particular phenomenon within its social and cultural context.

Interpretivist philosophy can be viewed from ontological, epistemological, and methodological assumptions (Creswell, 2014). Creswell (2014) explained that the researcher's approach is influenced by his or her worldview, which comprises beliefs and philosophical assumptions about the world or situation and how it can be understood. Kivunja and Kuyini (2017) stated that these ways of thinking about the world are known as research paradigms and inform the design and conduct of research projects. Creswell (2014) stated that philosophical assumptions constitute a stance taken towards the nature of reality (ontology), how researchers know and what they know (epistemology), the role of values in the research study, the language of the research, and the methods used in the process. I approached it from ontological, epistemological, and methodological assumptions to provide a sufficient and meaningful understanding of interpretivism's attributes.

4.2.1 The Ontological Assumptions of Interpretivist Philosophy

The ontological assumptions of interpretivist philosophy state that the nature of reality is constructed by individuals who attach meanings to phenomena using interactions

(Putnam & Banghart, 2017). This aligns with Vygotsky's SCT, which I have used in my theoretical framework as the lens through which I viewed LS. Ontological assumption deals with, among other things, assumptions about reality typically cast in dualistic ways, for example, subjective versus objective, as confirmed by Pigeon et al. (2019). For Pigeon et al. (2019), a subjectivist stance, one of the attributes of interpretivist philosophy, is often depicted as allowing multiple views to solve or interpret a situation. On the other hand, an objective stance asserts that reality can only be viewed from a particular tested perspective, thus neglecting all other reasonable views or opinions.

From an interpretive perspective, all knowledge is grounded in an individual's experiences; it is subjective and bound to the natural contexts in which individuals enact their lives (Hiller, 2016). This means that what we know is always situated within cultures, social settings, and relationships with other people. From this perspective, validity or truth cannot be based on objective reality. Hiller (2016) stated that the ontological assumptions of interpretivism assume that reality, as we know it, is constructed subjectively through interpretations developed socially and experientially. Interpretivism and Social Constructionism aim to gain insight into how individuals derive meaning, thus bringing a different emphasis on the true understanding of social contexts. This ontological outlook of interpretivist philosophy diametrically opposes the positivist philosophy, which advocates for brief, clear, concise singular and absolute truth and does not use a descriptive form to describe human feelings or subjective interpretation (Hasan, 2016). Positivism is a philosophical school of thought that holds that all genuine knowledge is either true by definition or is positive (Eidlin, 2015). Eidlin revealed that positivism is a paradigm that depends on measurement and reason, that knowledge is portrayed from neutral and measurable things, meaning

quantifiable consideration of activities and actions or reactions. Positivism reveals that anything that is not measurable cannot be known as a certainty.

Unlike positivist philosophy, which advocates singular universal truth, the interpretivist philosophy embraces multiple context-based truths to explain one phenomenon. The above is because one interpretation of an event cannot be conclusive since knowledge can be interpreted from different perspectives; that is, the subjectivity element (Pigeon et al., 2019).

Moreover, I could analyse data from multiple perspectives since I used multiple data collection strategies such as document analysis, observations and interviews. During post-lesson reflection, I witnessed (without delving too much into the findings covered explicitly in Chapter 5) how realities or observations were viewed from the subjective stance of multiple perspectives by a group of teachers (Otoo, 2020). As teachers engaged in post-lesson reflection, different views and suggestions emerged on how certain methods could have been used to teach mathematics topics or concepts. At the core of post-lesson reflection is learning new and multiple methods that have not been used to teach before. In other words, how each teacher had always taught a particular topic in mathematics was challenged, as shown by other teachers who expressed their views on how the lesson could be improved.

4.2.2 The Epistemological Assumptions of Interpretivist Philosophy

Epistemological assumptions are about what can be known. They cater to a philosophical grounding that selects the knowledge that can be accessed and attempts to ensure that it is sufficient and legitimate (Kamal, 2019). From the interpretivist point of view, the epistemological assumption was that researchers should get as close as possible to the participants involved in the research – i.e.,

immerse themselves in the natural environment in which a particular phenomenon unfolded (Creswell, 2014). This implied that subjective evidence was gathered based on an individual's views. Hence, knowledge is known and based on an individual's subjective experiences. Therefore, I had to immerse myself and become part of the teachers in the environment where I was collecting data. I was in the classroom, observing lessons and conducting interviews with the teachers as part of data collection. This meant that my relationship with the collected data was direct and close because I verified that it was a true reflection of the events (lessons) from where it was obtained.

4.2.3 The Methodological Assumptions of Interpretivist Philosophy

There are different methodological approaches that researchers can adopt. They may be qualitative, quantitative or mixed methods (Malhotra, 2017). Since the interpretivist philosophy is about multiple realities and immersing myself into a classroom environment to understand how teachers learn through post-lesson reflection, the appropriate methodological perspective I adopted was a qualitative approach. Qualitative research is about collecting data in narrative or written form to gain in-depth insights into a problem (Onwuegbuzie et al., 2012). Since interpretivist philosophy mainly concerns how reality can be known, I needed to collect data clarifying how teachers learn from each other through post-lesson reflection. The qualitative approach assisted me in this regard. More information regarding the methodological choice is addressed in Section 4.4.

4.2.4 Relevance of Interpretivist Philosophy for My Study

I wanted to explore how mathematics teachers acquire learning through post-lesson reflection in LS due to the uniqueness of teachers and their teaching methods. The

interpretivist philosophy views teachers as active rather than passive subjects. I collected valid data as interpretivism focuses on personal meanings and motivations. Teachers were expected to plan lessons in a social setting, observe one of their colleagues presenting a lesson, write down their observations, and finally reflect on their observations during post-lesson reflection. Interpretivist philosophy is relevant to my study because as teachers engaged in post-lesson reflection, the fourth stage of LS, they could learn new methods of teaching mathematics concepts.

During post-lesson reflection, guided by Gibbs's reflective cycle (Sekarwinahyu et al., 2019), teachers interpreted the lesson proceedings from different realities and viewpoints to derive meaning and further understanding from the interaction. This is particularly true since teachers have always taught lessons using their existing methodology, and thus, they have achieved certain outcomes. Hence, it was worth noting how their realities were affected and changed by hearing about the different approaches used by other teachers. Furthermore, different views, meanings, interpretations and teaching methods emerged due to teachers' social and collegial efforts, meaning that they viewed the reality of the lesson presentation from different perspectives. This interaction among teachers during post-lesson reflection set up an environment that revealed how mathematics teachers acquire learning. Creswell (2014) gave insight into the fact that in organisational communication, as in teachers engaging in LS, interpretive scholars focus on the complexities of meaning as revealed in symbols, language use, and social interactions. This implies that for the interpretivists, an organisation's livelihood emanates from actions, social interactions, and interpretations formed while members communicate (Driskill, 2018), as witnessed during post-lesson reflection. This was also in line with Social Vygotsky’s

Constructivist Theory, which is part of the theoretical framework through which I viewed the post-lesson reflection.

4.3 RESEARCH APPROACH

Although some studies refer to the concept of a research approach as either qualitative, quantitative, or mixed methods (Tuffour, 2017; Taherdoost, 2022; Pluye et al., 2018), Saunders et al. (2015) referred to it as being an inductive, deductive or abductive approach. The interpretivist paradigm is typically associated with inductive approaches (Saunders, 2015). Furthermore, Creswell (2014) stated that qualitative studies are linked with an inductive approach. I aligned myself with Saunders's view of the research approach in my study. The study was guided by an inductive approach. However, since I was influenced by the research questions, theoretical framework and interpretivist philosophy, a deductive approach supplemented the study, so the study is viewed as an inductive-deductive approach (Rahmah, 2017). Rahmah clarified that the main difference between inductive and deductive approaches to research is that while a deductive approach is aimed at testing a theory, an inductive approach is concerned with generating a new theory as it emerges from the data.

A deductive approach requires the researcher to start from a general statement or assumption and apply it to various scenarios or situations to prove whether or not the phenomenon (general statement) is valid, i.e., yielded the expected results. Conversely, an inductive approach requires a researcher to start by exploring different situations or scenarios to form a theory. My study is mainly inductive because I was not testing a theory. Instead, I immersed myself in the environment where the data was collected, that is, in the classroom, to gain insights into the activities that then

needed to be reflected upon (Hiller, 2016). In line with the interpretivism philosophy, I looked at numerous cases or realities during post-lesson reflection, which I used to draw certain conclusions (Distefano & Leonardi, 2018; Khuntia et al., 2016). Although I knew certain aspects of Lesson Study and used Gibbs' Reflective Cycle (Sekarwinahyu et al., 2019), aligning my study with a deductive approach, I discovered numerous strategies teachers used and perceived as effective to improve their practices. In other words, practically, I could ascertain how teachers reflected on the activities executed during the classroom observations and other stages of the LS cycle. Hence, the deductive component was necessitated by using the established LS model as a context for my study. Gibbs Reflective Cycle was the framework I used to explore post-lesson reflection. I was, therefore, au fait with what I was looking for, at least from a theoretical point of view, during the data collection. Therefore, my research approach was inductive because of the numerous cases or realities that needed to be reflected upon, but also deductive because I viewed the data collected through the lenses of Gibbs' Reflective Cycle reflection (Sekarwinahyu et al., 2019).

4.4 THE METHODOLOGICAL CHOICE

Saunders et al. (2015) use the term methodological choice, while other researchers prefer the term research approach (Tuffour, 2017; Al-Ababneh, 2020; Harrison et al., 2017). I aligned myself with Saunders et al.'s (2015) concept of methodological choice, which I opted to use in my study. There are three distinct methodological choices, namely qualitative, quantitative, and mixed methods. Quantitative research involves numerical data and thus is rooted in the positivist tradition (Malhotra, 2017). It can help find patterns and averages or even predict the future and make generalisations (therefore deductive) about the findings to a larger population. The mixed method, rooted in the pragmatic/post-positivist tradition, is a research approach wherein a

researcher collects and analyses quantitative and qualitative data (therefore abductive) in the same study (McKim, 2017). Since my study is within the interpretivist tradition but also gravitated towards the inductive approach, quantitative and mixed methods are unsuitable for my methodological choice. Therefore, I have opted for the qualitative method because my research focuses on post-lesson reflection and discussions of the lessons where data was collected in words (spoken to written). Qualitative research can be used to gather in-depth insights into a problem or generate new ideas for research. Onwuegbuzie et al. (2012) maintained that qualitative research can produce vast amounts of data, including verbatim notes or transcribed recordings of interviews or focus groups. The data collection instruments I used included interviews (Annexure C), observations (Annexure A and B), and document analysis, which were in line with qualitative research.

4.5 RESEARCH STRATEGY

Malhotra (2017) stated that a research design is a strategy for answering a research question using empirical data. Other scholars refer to a research strategy as a research design (Dasgupta, 2015; Du Toit, 2014). Saunders et al. (2015) refer to it as a research strategy. Dasgupta (2015) refers to a research design as a plan that guides the researcher in their specific area of research. Du Toit (2014) admits that sometimes a research design is also referred to as a research strategy, which involves a particular way of engaging empirical reality that will assist in generating solutions for research questions as clearly as possible. Saunders et al. (2015) referred to examples of research strategies such as survey experiments, archival research, ethnography, action research and case studies. Case studies are appropriate for answering how or why research questions, which is my study's situation. Therefore, I decided to use a

case study because it aligns with the interpretivist philosophy. I gained an in-depth understanding of how teachers conduct post-lesson reflection and how they learn from such reflections.

Yin (1994, p. 13) defined a case study as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not evident … [and] relies on multiple sources of evidence”. Further explanation by Yin showed that case studies aim to understand complex social phenomena and real-life events, such as organisational or managerial processes. Yin (2012) asserts that a case study is an ideal methodology for a holistic, in-depth investigation. Therefore, the general purpose of a case study is to describe an individual situation, e.g., a person, a business, an organisation, or an institution, in detail and to rely on multiple sources of evidence in which the data obtained can be triangulated. Hence, in the context of my case study, I identified critical issues regarding post-lesson reflection and analysed post-lesson reflection using the relevant Gibbs’ reflection cycle (Sekarwinahyu et al., 2019) to reveal what teachers learn during post-lesson reflection.

Tetnowski (2015) posited that a case study refers to an empirical inquiry that explains a contemporary phenomenon in a real-world context. Furthermore, Graue (2015) added that in a case study, the researcher ensures that not only the statements and perspectives of the direct participants in the observed situation were looked at, but the researcher also incorporated himself into the environment of the participants and the interactions between participants to immerse him/herself as deeply as possible in the context of the investigated phenomenon. As a researcher, I have been in the

classroom collecting data from teachers in their environment, thus ensuring that I am close to the data and the participants.

However, according to Harrison et al. (2017), a case study is a rigorous analysis of an individual or community focusing on developmental factors about the environment to generalise the results. A case study is a qualitative research approach where multiple data collection instruments are used to perform a detailed examination of a single case (Heale & Twycross, 2018). I used observations, document analysis, and interviews to capture data for my research. Harrison et al. (2017) stated that the benefits of using a case study include, among other aspects, the ability to see a relationship between phenomena, context, and people; the flexibility to collect data through various means, with the ability to capture the context and lived reality of participants; with the flexibility to be used at various points in a research project including pilot research. In my research, I have immersed myself with teachers in the same classroom environment, exploring learning from post-lesson reflection as a phenomenon.

4.6 TIME HORIZONS

As Saunders et al. (2015) explained, a time horizon refers to the period over which the study is conducted and data is collected. Khuntia et al. (2016) explained that depending on the time horizon, there are two types of research: longitudinal and cross-sectional. In longitudinal studies, after the researcher has collected data at a particular time interval, he/she returns to the same sample to establish how the situation has changed and thus makes certain recommendations (Caruana et al., 2015). On the other hand, cross-sectional research is research in which a researcher wants to study samples during a particular period. Hence, data collection resembles a once-off snapshot at a particular time only (Saunders et al., 2015). In cross-sectional research,

the researcher will not return to the same sample to collect data. In contrast, longitudinal research involves studying samples over time, and the period can range from short-term to long-term, while in cross-sectional research, data is collected only once. I chose a cross-sectional study because I collected data as a single once-off event over five days. I must complete my study this year according to the timeframes set and will not have time to return to the school to collect data again.

4.7 TECHNIQUES AND PROCEDURES

4.7.1 Sampling

As stated in the methodological assumptions of interpretivist philosophy, my study was guided by a qualitative approach. Therefore, according to McKim (2017), the appropriate sampling method should reflect the character of qualitative studies. Purposive and convenient sampling methods lend themselves well to interpretivist qualitative research (McKim, 2017). Rai and Thapa (2015) defined purposive sampling as a process used in research in which a predetermined number of observations will be taken from a larger population. Etikan et al. (2016) and Campbell et al. (2020) stated that purposive sampling is used when a clear criterion for selecting respondents has been set. Only the participants meeting the criteria can be part of the research study. I needed to identify a school whose mathematics teachers practise LS; therefore, I had to exclude all schools that did not meet this criterion. I chose Grade 9 because it is an exit grade from the GET band to the FET band, and hence, it would give me the benefits of what learners have learnt from all the grades in primary school.

On the other hand, Mweshi and Sakyi (2020) stated that convenience sampling is a qualitative research sampling strategy where participants are selected based on how accessible and available they are to the researcher. Mweshi and Sakyi further

explained that convenience sampling is used when respondents are selected based on convenient factors for the researcher. In this context, convenience sampling is relevant because I am mindful that other provinces are implementing LS in SA. However, for data collection for my study, I needed a school near my work, and the teachers are familiar with LS there.

4.7.2 Data Collection

I collected data that aligned with qualitative data-collecting methods. Thus, I collected data using observations, document analysis and interviews (Morgan, 2022). According to the ontological assumptions of interpretivism, the reality is subjective. Therefore, I collected data through documents, observations, and interviews in a real classroom set-up to ensure the data's authenticity (Putnam & Banghart, 2017). This is also in line with the epistemological assumptions of interpretivism, which refers to how we know what we know (Hiller, 2016) because I was present in the environment where I collected data. Hence, I immersed myself in the classroom where data was collected. Regarding the methodological assumptions of interpretivism, justification for using observations, document analysis and interviews were given in the research philosophy section in 4.2 (Cudziło et al., 2018). Also, appropriate interpretations of data from different data sources assisted me in identifying common trends and triangulating the data (Morgan, 2022).

My study focused on how teachers acquire learning through post-lesson reflection, which can occur in any mathematics topic. Hence, I was not focusing on a particular topic in mathematical content but instead on the process of doing post-lesson reflection and on the development of teachers, which happens during post-lesson reflection. In addition, it should be noted that although my main interest was on post-

lesson reflection, this could not be achieved without the gaining insights into the other stages of the LS cycle such as lesson planning, lesson presentation and lesson improvement. In the following paragraphs, I explain how data was collected through observations. I used an observation tool, document analysis, to analyse data from documents such as teacher observation tools and lesson plans, and interviews, whereby I analysed teachers' responses to interview questions and observations.

4.7.2.1 Observations

Couper (2017) explained that observations are done when an observer notes the actions taken and the words spoken during an observation session. Couper explained the following types of observations: structured, covert, participant, overt, and unstructured. Zhang (2019) also explained that while the unstructured observations could offer the researcher more room to capture extensive data, the structured observations could focus more on specific criteria or aspects of the collected data. Therefore, since I had specific research questions to answer and specific attributes outlined in Gibbs' Reflective Cycle, I had to use a structured observation protocol, as attested to by Brown and Crippe (2016), as in Annexure A, to collect data during the LS stage of lesson presentation and observation. I immersed myself in the same environment or classroom where the lesson was taught and made observations, thus aligning with the interpretivist philosophy. The observations were made on Annexure A for all lessons, including the field notes, and were analysed to derive common themes and emerging trends (Smith & Firth, 2011). Furthermore, during the stage of post-lesson reflection, I used a different observation protocol, as in Annexure B, observing how the teachers reflected on the lesson. I analysed the data regarding common themes and trends as I was guided by the research questions.

The fact that I was present in the classroom in which I made observations and was part of the lesson proceedings made it easier to comply with the ontological and the epistemological assumptions of my research to gain insight into SRQ1 (secondary research question 1), which is about how teachers perform lesson observations in LS. Both the lesson presentation and post-reflection stages were video recorded and transcribed. This was done to ensure that what I captured through observations corresponded to the transcripts.

4.7.2.2 Document analysis

Couper (2017) defined document analysis as a data collection technique in qualitative research that adopts a systematic procedure to analyse evidence from documents to answer specific research questions. This method analyses various documents, including books, newspaper articles, academic journal articles, and institutional reports. Therefore, text documents are potential sources for qualitative analysis (Patton, 2014). My research included teachers' lesson plans and their observation tools (Annexure E).

Pre-existing data, such as documents, are often used with other types of data for triangulation, a strategy designed to increase a study's trustworthiness. According to Morgan (2022), triangulation helps determine whether a study's findings are consistent and derives a deeper conceptualisation of the topic under review. In addition to analysing pre-existing documents, I also had to collect data using interviews and observations. Using different methods to collect data assisted me with confirming my findings across data sets, thereby minimising the chances of biases. According to interpretivist methodological assumptions, my interpretation of the findings from document analysis would be appropriate since the tools had clear guidance on what

to look for when teachers were observing the lessons (Putnam & Banghart, 2017). Their observation tools assisted me with capturing findings from the lesson presentations and observations, as they observed one teacher at a time who presented a lesson.

4.7.2.3 Interviews

George (2022) distinguished three types of interviews: structured, semi-structured and unstructured. Firstly, according to George, structured interviews use questions that have been predetermined in terms of both topic and order. Secondly, semi-structured interviews emanate from the structured interview questions to probe further based on the responses given and are used to confirm clarity. Thirdly, the unstructured interviews comprised questions that were not planned. I chose to use semi-structured interviews because they are rich in data. I was also authorised to ask my participants further clarity-seeking questions, as Chauhan (2022) explained. However, although I was authorised to ask some guiding questions, I also needed to have an opportunity to probe the participants' responses further.

This was important because of the ontological and epistemological assumptions of the interpretivist paradigm, which required me to gain deep insights into how teachers knew what they were doing and how they justified those insights when asked about them later during the interview. The interview sessions were held after the post-lesson reflection, as shown in Table 4.1.

Table 4.1

Frequency of interviews

DATE OF INTERVIEW	NUMBER OF TEACHERS	LESSON NUMBER	TOPIC
28 August 2023	6	1	Numeric Patterns
30 August 2023	5	2	Numeric Patterns
04 September 2023	4	3	Exterior angle of a triangle
06 September 2023	5	4	Exterior angle of a triangle
18 September 2023	4	5	Similar Triangles

Semi-structured interviews allowed me to investigate deeply how teachers use their knowledge of PLR to improve their teaching (SRQ4) and about hindrances to post-lesson reflection (SRQ5). Annexure C comprises interview questions, and the research questions can be found in Annexure D. During the interview sessions, I corroborated the observed data collected during LS's lesson observation/presentation stage. Since LS emphasises collaborative practice among a small group (mathematics teachers in this case), the interviews took the form of whole group interviews while ensuring that opportunities to answer questions were given to all the teachers. The interview sessions were video recorded so I could transcribe the verbatim data into written texts afterwards. Moreover, using a video recorder afforded me a favourable environment whereby the participants and I could concentrate on the questions without any confusion regarding note-taking by the interviewer.

4.7.3 Data Analysis

In this section, I explain how data collected for the study were analysed. Data analysis was guided by the research questions (which formed the main themes for my study) and the stages of the Gibbs Reflective Cycle (Sekarwinahyu et al., 2019). The stages of Gibbs's reflection cycle included descriptions and feelings about what happened during the lesson, which would be discussed later during post-lesson reflection (see

Annexure B). The interview questions were expected to corroborate the data captured during the stages of the Gibbs Reflective Cycle, namely, evaluations and analysis. The descriptive accounts (excerpts) taken from all my data-capturing instruments were then labelled according to the research questions, which were the main themes. Sub-themes emerged from the main themes (secondary research questions - SRQ). They were closely related to the main themes, the LS cycle, Gibbs' Reflective Cycle and Vygotsky's Constructivist Theory, as aspects the teachers would reflect on.

The sub-themes elicited a pattern of similar excerpts from the five lessons observed. For example, the sub-theme of "Descriptions and feelings" (from SRQ1) emanated from one of the stages of the Gibbs Reflective Cycle. In the sub-theme of "Teaching methods," I focused on the skill or strategy used by the teacher during classroom instruction, such as the narrative method, the question-and-answer method, and the investigative method.

The presenting teachers frequently observed answers that formed part of the post-lesson reflection after the lessons. In the data analysis process, I derived the main themes from the SRQ. Under each main theme, sub-themes began to emerge. For instance, SQR2 stated: "What learning experiences do mathematics teachers gain from post-lesson reflection?" The main theme was "Learning experiences gained from post-lesson reflection." The following sub-themes emerged from the main theme: teaching methods, mathematical connections, and teachers' learning about learner thinking. More information/findings will be presented in Table 5.1 in Chapter 5.

4.7.3.1 Analysis of data collected through observations

Chauhan (2022) proposed approaches for analysing data collected through observations, which included thematic or content analysis, discourse analysis,

narrative analysis, semiotic analysis, etc. I analysed data using thematic analysis (Chauhan, 2022). I was guided by Braun and Clarke's (2006) process of thematic data analysis, whereby I identified, analysed, and reported the patterns emanating from the data. Braun and Clarke (2006) identified six phases of data analysis: Phase 1 involved getting familiar with the data; Phase 2 meant generating codes; Phase 3 involved searching for themes; Phase 4 required reviewing themes; Phase 5 involved defining and naming themes; and Phase 6 meant producing a report.

Phase 1: Getting familiar with the data.

I completed this phase by watching the lesson videos, the post-lesson reflection, and the interviews. I then had to transcribe the videos into Word documents. I then started reading the teacher observation notes, the lesson transcripts from the videos, and those from interviews. As I read, I recognised similar phrases to identify emerging themes.

Phase 2: The generation of codes.

I grouped and coloured common excerpts containing similar ideas or phrases. For instance, comments regarding teachers' feelings, such as "I felt confident," "it was sad," or "I was disturbed," formed part of the theme of descriptions and feelings.

Phase 3: Searching for themes.

The main themes emerged from SRQ, e.g., In SRQ1, the sub-theme that emerged was "description and feelings", which aligned with the inductive approach of the interpretivist assumption because I used numerous sub-themes to interpret my findings.

Phase 4: Reviewing of themes.

From the original themes, I had to verify whether the phrases belonged to a particular theme. I then decided to rename certain themes and remove certain excerpts from them to other more appropriate themes.

Phase 5: Defining and naming themes.

I had given certain names or labelled (colour-coded) exceptions with a name, e.g., “methodology.” However, I discovered that I had to be specific by renaming the theme “teaching methods,” as this name was more relevant to the context of my study.

Phase 6: Producing a report.

This was accomplished when, after identifying similar excerpts, I needed to explain the interpretations I had drawn from the transcribed conversations (excerpts) made by teachers.

The data I collected through my observation tools during the lesson observation stage (Annexure A) and the post-lesson reflection stage of the LS cycle (Annexure B) were also analysed according to thematic analysis, as explained in the previous paragraphs (Braun & Clarke, 2006). The teachers’ lesson observation instruments (Annexure E) were analysed to explore teachers’ reflective practices during LS to gain insights regarding SRQ2 (What learning experiences do mathematics teachers gain from post-lesson reflection in LS?) and SRQ3 (How do the information mathematics teachers collect during lesson observations inform their post-lesson reflection?). Based on each teacher's responses, common trends or patterns were identified and colour-coded to identify emerging themes (Wach & Ward, 2013). As I observed the lessons, I identified what teachers had learnt during post-lesson reflection and how the information

collected during lesson observations was used during post-lesson reflection (Annexures A and B) concerning SRQ2 and SRQ3.

Each lesson presented was video recorded and transcribed into a document. The lesson transcripts were analysed, and remarks about developing trends were included. That included re-reading the lesson transcripts to identify similar events or patterns in line with the established main themes (SRQ) and the emerging themes, which were colour-coded.

4.7.3.2 Analysis of data collected through documents

Document analysis is a method of data collection which means analysing content from written documents to draw certain conclusions, as guided by the research questions (Chauhan, 2022). The documents I analysed were the teachers' observation tools, i.e., the documents that teachers used to record what they had observed as per the prescripts of LS (Annexure E). As I was reading the documents, I could identify common patterns or trends from one teacher's observation tools to gather data related to the main themes (research questions) (Lester et al., 2020). When conducting thematic analysis (according to research questions), it is necessary to carefully consider the data set to identify similar extracts and relationships (Lester et al., 2020).

The teacher observation tools analysis (Annexure E) provided insight into teachers' learning during lesson observation, leading to post-lesson reflection (SRQ4). This analysis guided me on the connections between these two stages of LS, as the post-lesson reflection stage depended on the lesson observation stage. Verifying the originality and commonality of how teachers responded to each criterion in their observation tools was beneficial. That guided me on what I would have to discuss further during the interview sessions.

4.7.3.3. Analysis of data collected through semi-structured interviews

George (2022) asserted that interview analysis is a narrative analysis done to make sense of respondents' stories. The analysis of interviews included recording remarks to develop trends from the transcripts. This meant re-reading the transcripts of interview sessions to identify similar phrases, relationships, patterns, themes, distinct differences, and common sequences related to the main themes (Braun & Clarke, 2006).

Finally, I had to cover the consistencies discerned in the data. The common patterns or trends from the various views of teachers were added to the established or emerging themes (Thomas, 2003).

4.8 QUALITY CRITERIA FOR DRAWING INFERENCES FROM THE DATA BY MAKING A SET OF GENERALISATIONS AND QUALITATIVE STUDIES

Korstjens and Moser (2018) stated that four criteria are widely used to appraise qualitative research's trustworthiness: credibility, dependability, confirmability, and transferability. I will discuss these in greater detail and justify how I ensured they were conducted in my research study.

4.8.1 Credibility

Credibility is confidence in the truth of the research findings (Anney, 2014). It verifies whether the research findings represent correct information captured by the participants (Korstjens & Moser, 2018). To ensure credibility, I captured data over the five days in about three weeks, and video recordings were used as a backup. I also used multiple data collection instruments for triangulation. Triangulation was observed from the data collected regarding teachers' learning during post-lesson reflection and

the data collected during interviews. Hence, credibility was ensured when the information collected by these two data-collecting strategies confirmed one another. This meant that during the interview session I held with teachers, the responses to my questions did not contradict their discussions during the post-lesson reflection.

4.8.2 Transferability

Anney (2014) and Tuval-Mashiach (2021) explained that transferability refers to the degree to which the results of qualitative research can be transferred to other contexts or settings with other respondents. The precise explanations of activities observed during lesson presentations and post-lesson reflection sessions assisted me in ensuring transferability in case the same study was to be conducted in similar conditions.

In this case, the conditions for the study had been done in the SP at a secondary school practising LS for PD. This was because I used purposeful sampling to identify a specific phase, grades, and school. Transferability is ensured when a study is conducted in similar conditions (Suri, 2011). This sample implies that the findings from this study would apply to any school with similar conditions in which teachers engaged in LS.

4.8.3 Dependability

According to Anney (2014), dependability looks at the stability of the findings over a certain period. Furthermore, Anney (2014) explained that dependability involves participants' evaluation of the findings and how the findings can be interpreted. In ensuring the dependability of the findings such that the findings would remain useful for a certain period, my research questions represented themes, so if similar questions

were asked, similar responses would be received (Hagen, 2018). Participants were also able to verify the findings made and how such findings were interpreted. This meant that over a certain period of years, the body of research and the teachers would be assisted by the findings to improve their teaching practice using post-lesson reflection.

For example, one of the themes or research questions looked at how teachers' reflective practices could be enhanced to improve classroom practice. This meant developing a strategy of conducting post-lesson reflection. Thus, whoever was interested in investigating the strategy would be interested in the responses to this question.

4.8.4 Confirmability

Haven and Grootel (2019) mentioned that confirmability is the degree to which other researchers can confirm or corroborate the results of an inquiry. Anney (2014) had earlier asserted that confirmability is a safeguard that, indeed, the findings from a research study were correct.

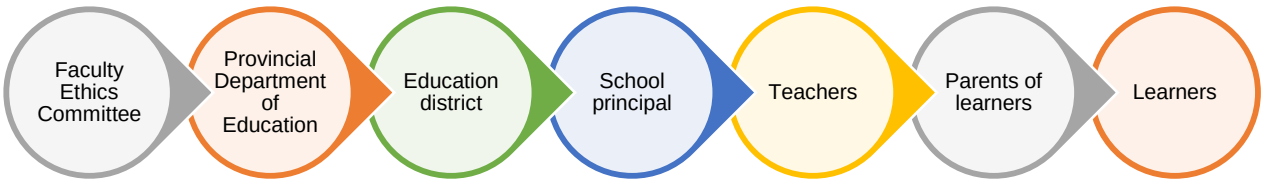
My findings were based on the data collected to ensure that other researchers doing a similar study could validate my research. I used multiple data-collecting instruments to corroborate or triangulate the data collected during lesson presentations, post-lesson reflection, interviews, and according to data from teachers' observation instruments. Hence, other researchers doing a similar study could also use one of these data-collecting instruments, confirming my findings. Since my study is based on teacher learning through post-lesson reflection, any other study on lesson reflections could follow the route of lesson observations, leading to reflections on what was observed and arriving at similar findings to those in my study.

4.9 ETHICAL CONSIDERATIONS

Ethical considerations comprised the research principles I followed to ensure my research study was truthful, fair, and honest (Ketefian, 2015). The process I followed in seeking approvals, permissions, consent, and assent is presented in Figure 4.3 below.

Figure 4.3

Process of Ethics Consideration



- I applied for and obtained ethics approval from the Ethics Committee at the Faculty of Education, University of Pretoria (UP). This approval was a prerequisite for me to start engaging with the other institutions for further approvals and with the participants for their consent to participate in the study.
- According to the South African Schools Act (Act No. 84 of 1996), although the national Department of Basic Education is the custodian of basic education, schools fall under provincial departments. I therefore sought permission from the Gauteng Department of Education (GDE) to collect data in one of its secondary schools.

- Upon obtaining permission from the GDE, I sought further permission from one of the Education Districts within its jurisdiction. The district chosen was the leading district in implementing LS.
- After the district director signed the application letter, I forwarded it to the Principal of Kenneth Masekela Secondary School, requesting permission to collect data from the school's teachers and learners.
- After his approval, I gave the consent letters to the relevant mathematics teachers in Grade 9 because that was the grade from which I had chosen to collect data.
- The teachers assisted me in sending consent letters to the parents, asking them to give consent on their children's behalf so that they could participate in my study.
- I then requested the learners to sign their assent forms agreeing to participate in my research study. I ensured that all the consent forms I received were signed before collecting data.

In terms of all the participants, I observed the following ethical practices:

Voluntary participation: I did not force or coerce any participants to participate in my study and informed them that they could withdraw at any time.

Confidentiality: I made the participants aware, through the consent letters that I had given and discussed with them, that I would not disclose their particulars to anyone.

Anonymity: To conceal their identities, I used pseudonyms instead of the participants' real names, naming them Teacher 1 (T1), Teacher 2 (T2), and so forth.

Informed consent: I explained my research study to the teachers and the benefits of participating in educational research, which would develop their reflective abilities in their teaching.

Safety: I informed teachers that I would not expose them to dangerous conditions during my data collection. My research would take place in their natural environment, the classroom, and the lessons were observed during that period, as reflected in the school timetable.

After adhering to the ethical process depicted in Figure 4.3 to collect data, I applied for an ethics clearance certificate from the university's Ethics committee in the faculty of education.

4.10 CONCLUSION

In this chapter, I have clarified that a research methodology is a systematic and theoretical analysis of research *methods* applied to a field of study (Pandey & Pandey, 2021). It is a way to solve a research problem systematically and may be understood as a science of studying how *research* should be done scientifically. Pandey and Pandey (2021) further explained that research methodology is a belief about how data relating to a phenomenon should be gathered. This includes the ontological, epistemological and methodological assumptions made, and I have discussed the relevance of the interpretivist philosophy. Snyder (2019) had described the purpose of a research methodology as way to explore facts and truths.

Methodology is used as a tool to contribute to and build developing knowledge, collect evidence for theories, and advise actions as a means of understanding reality. I have detailed the research approach underpinning the methodological choice, the research

strategy, the data collection techniques, and the analysis procedures (Saunders et al., 2015).

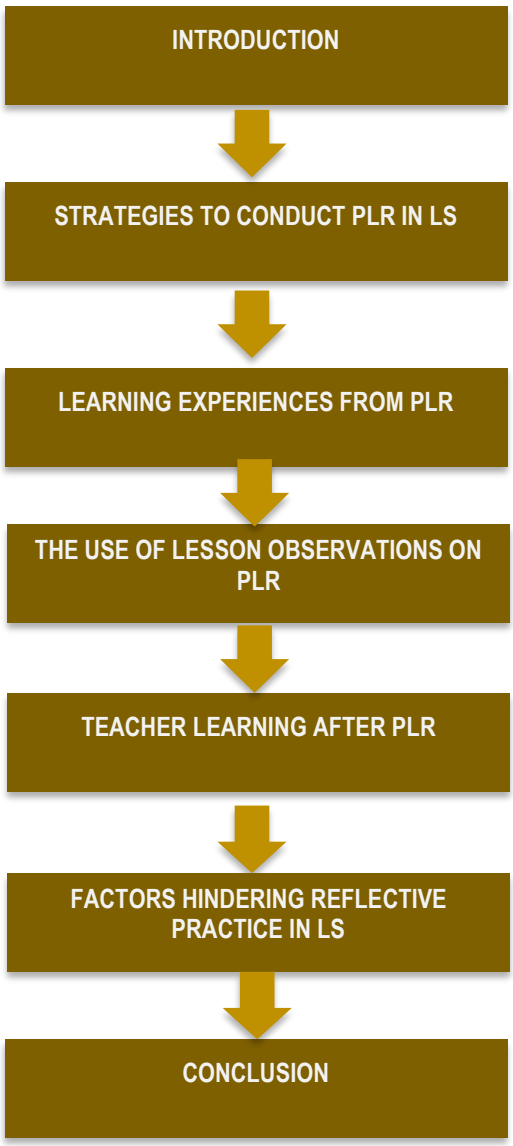
In addition, Abutabenjeh and Jaradat (2018) asserted that a research methodology assists a researcher in understanding a phenomenon or behaviour or can be used to test a theory. I was guided by the research onion proposed by Saunders et al. (2015), which comprised the following layers: Research philosophy, Research approach, Methodological choice, Research strategy, Time horizon, Techniques and Procedures.

CHAPTER 5: PRESENTATION OF THE FINDINGS

For ease of reference, I have presented an overview of the current chapter in Figure 5.1.

Figure 5.1

The structure of Chapter 5 - Presentation of the findings



5.1 INTRODUCTION

This chapter discusses the findings regarding how teachers learn and develop through post-lesson reflection, the fourth stage of the LS cycle. My data collection spanned five days, spread over three weeks. I collected data through observations of lessons and post-lesson reflection, document analysis and interviews. Since I immersed myself in the classroom to collect data, my findings have been supported by the evidence from my data-collecting instruments. This aligns with the epistemological assumptions of the interpretivist paradigm (Hiller, 2016).

5.2 CONTEXTUALISING THE FINDINGS

In the beginning, I started with six teachers, but one of them requested to be excused after lesson 2. I did not ask for their reasons since I had to adhere to the ethical principles I had set out before I collected data. As mentioned in Chapter 4, I selected two classes in Grade 9 where I observed five lessons in which lessons 1 and 3 were re-taught in a different class to ascertain lesson improvement, as seen in Table 5.1. Lesson 2 was based on numeric patterns and was the improved version of lesson 1, taught in another class. At the same time, lesson 4 was the improved version of lesson 3 on the exterior angle of a triangle, which was also taught in another class. Lesson 5 was taught only once (see Table 5.1).

Table 5.1

Lessons foci

LESSON 1	LESSON 2	LESSON 3	LESSON 4	LESSON 5
Numeric Patterns	**Numeric Patterns**	**Exterior angle of a triangle**	**Exterior angle of a triangle**	**Similar Triangles**
First Presentation	Second presentation after lesson improvement	First Presentation	Second presentation after lesson improvement	Presented once only
Date: 29/08/2023	**Date: 30/08/2023**	**Date: 06/09/2023**	**Date: 14/09/2023**	**Date: 18/09/2023**

To ascertain improvement, the improved lesson was taught to another class. After reflecting on the first lesson, another teacher presented the same lesson in a different class, incorporating new ideas. My interest was not in a particular topic in the mathematical content; therefore, teachers were at liberty to decide on the topic in accordance with the prescripts of LS. Since teachers were working according to the ATP (Annual Teaching Plan), they presented their lessons accordingly. The last lesson was presented as a stand-alone lesson, in which further training from post-lesson reflection was to be made. The data collected was transcribed from the videos and analysed regarding the research questions, which formed the main themes (Braun & Clarke, 2006). Some sub-themes emerged from the main themes. These emerged from conversations (transcripts) conveying the same ideas and were captured during lesson observations, interviews, post-lesson reflection, and using teachers' observation tools (Table 5.2). In line with Braun and Clarke (2006), after transcribing the lesson videos to familiarise myself with the data, I then labelled similar conversations or scenarios from which I derived the sub-themes. After identifying the sub-themes, I could name them accordingly; for example, the sub-theme named

"Teaching methods" was named after identifying numerous scenarios in which teachers mentioned various teaching methods.

Table 5.2

Main themes, sub-themes and their descriptions

MAIN THEME	SUB-THEMES	DESCRIPTION
Learning experiences gained from PLR in LS	Benefits of reflection	What teachers found valuable for implementation in their practice
	Teaching methods	A strategy used by the teacher for classroom instruction.
	Mathematical connections	How mathematics concepts are links between mathematical concepts and how they build on each other to produce a coherent whole, to recognise and apply mathematics in context.
	Teachers learning about learner thinking.	Learners can explore their perceptions of mathematical facts by creating new knowledge to generate ideas and make connections.
The information from LO used on PLR	Teaching methods	Strategies used by the teacher for classroom instruction.
Teachers' use of post-lesson reflection to improve their teaching practice	Teachers' learning experiences during post-lesson reflection	These were the PD advantages that teachers discovered by engaging in post-lesson reflection.
	Lesson improvement	Based on the PLR and key findings, decisions will be made on improving lessons in case they need to be re-taught.
Factors hindering teachers' reflective practice in LS and teachers' proposed solutions.	Hindrances to reflections	This implies the lack of time and support that can derail one's ability to reflect on a task that has been completed.
	Possible solutions to hindrances	Strategies implemented to overcome hindrances to reflections.

These sub-themes cut across the main themes (Lester et al., 2020). In my data analysis, I have included quotations from the data-capturing instruments, as listed previously, to prove the findings. These were verbatim quotations, which I have called excerpts, extracted from the transcripts. I did not edit what was said during

the transcription of data. This was done to identify sub-themes and to validate the findings. In all the lessons, as soon as the lesson presentations were completed and the learners had moved out of the classroom, the teachers came together to reflect on their lesson observations by conducting a post-lesson reflection session led by the Department Head and the chairperson. All the teachers had lesson observation tools, which they used to make notes per the criteria they had set out. The post-lesson reflection occurred in a social setting where all teachers were to reflect on how they observed the lesson. I viewed the post-lesson reflection sessions through the lens of Gibbs' Reflective Cycle (Sekarwinahyu et al., 2019). Table 5.3 below presents the labelling of excerpts from lesson transcripts, post-lesson reflections, interviews, and observations.

Table 5.3

Labels and their descriptions

LABEL	DESCRIPTION
L1, L2, L3, L4, L5	Lesson 1, Lesson 2, Lesson 3, Lesson 4 and Lesson 5
L1: PLR: p.1(2-8)	Excerpt drawn from Lesson 1 transcript of the post-lesson reflection found on page 1 and in lines 2 to 8
L1: Interviews: p.2(4-7)	Lesson 1 interview transcript on page 2 and in lines 4 to 7
T1, T2, T3, T4, T5	Teacher 1, Teacher 2, etc
L1: TOT row 5	Lesson 1 teacher observation tool in row 5
SRQ 1, SRQ 2, etc	Secondary Research question 1, Secondary Research question 2, etc.
Min	Minutes, at which point the video for the excerpt can be traced to.
Sec	Seconds, at which point the video for the excerpt can be traced to.

In cases where excerpts had words spoken in other languages, I translated them into English and put them in brackets.

5.3 STRATEGIES USED TO CONDUCT POST-LESSON REFLECTION IN LESSON STUDY

The SRQ addressed this theme: How do teachers conduct post-lesson reflection in mathematics? I have organised the findings according to the following sub-themes: Descriptions and feelings as one and evaluation and analysis as another.

5.3.1 Descriptions and Feelings

According to Gibbs' Reflective Cycle, the first and the second stages are description and feelings, respectively (Sekarwinahyu et al., 2019). However, I merged the two stages into one sub-theme in the current chapter. Gibbs ' Reflective cycle guided the process of identifying strategies for conducting post-lesson reflection, where teachers should describe what they did or observed during the description stage. In the feelings stage, the teachers expressed their positive or negative feelings about certain events during the lesson (Sekao, 2023). These may include achievement issues or anxiety because of being observed by other teachers or when learners seem not to understand the lesson. In addition, the other teachers shared their feelings based on what they observed during the lesson presentation. The first two stages of Gibbs' Reflective Cycle were combined to form one sub-theme because when teachers described what happened during the lesson, they simultaneously expressed how they felt.

The findings regarding the introductory statements by the chairperson of the post-lesson reflection session revealed that she had stipulated the key issues to be

addressed by the teacher who taught the lesson. For instance, as depicted in Excerpt 1, the chairperson explicitly directed the teacher to focus on the lesson's introduction and objectives. The chairperson's approach was the same during the post-lesson reflection of Lesson 1 to Lesson 5. The chairperson's introductory statements are presented in Excerpt 1, based on the post-lesson reflection of Lesson 1 taught by Teacher 4, where the topic of numeric patterns was taught:

Excerpt 1(L1: PLR: p.1(2-8))

> Chairperson (00min21s): Colleagues, we are going to start with our lesson reflection; I think we are going to start with [Teacher 4], the person who presented the lesson. [Teacher 4], I think you will start with the introduction, the objectives, the introduction, then go to the presentation. Yeah, and then you get to your conclusion.

The chairperson's comment is typical of Gibbs' model of reflection, which starts with the lesson presenter's description and feelings. However, the chairperson did not allow the presenter to state their feelings in this excerpt.

Excerpt 2 is the response from T4 as directed by the chairperson, explaining how she introduced the lesson by stating lesson objectives:

Excerpt 2 (L1: PLR: p.1(9-11))

> Teacher 4 (00min48s): Afternoon. Uh, in terms of the introduction, the lesson was introduced very well. I introduced the lesson by stating the objectives, which is the most important part for learners to know what they must know for the lesson.

Excerpt 2 is the response from T4 as directed by the chairperson, explaining how she introduced the lesson by stating lesson objectives:

Excerpt 2 (L1: PLR: p.1(9-11))

> Teacher 4 (00min48s): Afternoon. Uh, in terms of the introduction, the lesson was introduced very well. I introduced the lesson by stating the objectives, which is the very most important part for learners to know what they must know for the lesson.

In Excerpt 2, T4 shallowly addressed the issues as directed by being channelled to delve directly into the specific aspects of the lesson. She could not, therefore, express her personal and general feelings about, for instance, how she felt when presenting a lesson while being observed by her colleagues. Given that the presenter mentioned aspects of the lesson that went well, the chairperson also redirected her to highlight the lesson's negative aspects since only the general comments were mentioned. Excerpt 3 is an illustration of what the teacher mentioned as things that did not go well:

Excerpt 3 (L1: PLR: p.1(20 – 23))

> Chairperson (DH): Thank you. So, um, those were your “ups.” Have you got any “downs?”
>
> Teacher 4: Yeah, the downs were for me the pace, the pace, was one of them. It's the only thing you wish you could, you wish you could do better. It's just the pace.

The presenter stated that she wished she could have done better regarding the pace of the lesson, probably because she was too slow. The lesson took longer because the learners struggled to understand the content. A similar trend was observed in lesson 2, where the chairperson asked the presenter to share her feelings. Lesson 2 was presented by T1 (a different teacher) as an improved lesson on numeric patterns to incorporate the suggestions made during the post-lesson reflection of lesson 1.

Excerpt 4 shows how the nature of the description by the presenter lacked the mathematical content that affected her positively or negatively:

Excerpt 4 (L2: PLR: p.1(2 – 13))

> Teacher 1 (00min38s): Um, with today's lesson, it was tough. I will start with the negatives. Um, time management. Um, the lesson was way too long. Um, as a teacher, I didn't manage my time well. Um, the lesson was more than an hour. Um, and, explaining to the kids, um, what made it to be long. Um, the introduction was okay. Um, we did manage to finish the first two questions within two minutes. And did the corrections. Did the mental maths. Then we went on to extending the pattern.

Though she also failed to manage time in this lesson, it is unclear what “was okay” regarding the introduction, the completed questions, and the mental maths. The limitations of not being able to reflect mathematically have the potential to rob teachers of PD of the benefits of post-lesson reflection.

During the interview session of lesson 2, other teachers expressed feelings of pride, accomplishment and collective achievement because the presenter taught the lesson according to their expectations. They also responded without mathematical content:

Excerpt 5 (L2: Interview: p.1(8 – 19))

> Teacher 2: I was feeling, proud as this was our lesson, it was not mam “Presenter’s” lesson but our lesson, so I was feeling proud. I was also learning, uh, in saying that…
>
> Teacher 3: Well, uh, as soon as we, as much as we had, uh, specific, uh, objectives that we needed to follow, what was important was that learners were supposed to know that…
>
> Teacher 4: I think I felt positive about the main key for the second one; there was……

The teachers' feelings were still generic even in lesson 2 since there was no specific mathematical content or method they were proud of or positive about. Excerpt 6

depicts how reflections were conducted in lesson 3 in which, as in the previous excerpt, the chairperson allowed the presenter to reflect first:

Excerpt 6 (L3: PLR: p.1(2 – 12)

> Chairperson (DH): (00:00s) Good afternoon, colleagues. Teacher 4… Thanks for raising your hand to say, okay, I will start. Thank you very much. It was a wonderful lesson. However, I think I want you to just first reflect on your lesson and on our lesson that you have presented. And tell us ukuthi (that)…what were your strengths where do you that here I needed to improve … What do you see that you needed to improve?
>
> Teacher 4: {01min12s} Well, eish the presentation, I feel like I have delivered the content, but my examples were too little or not sufficient enough for the learners. And also, um, my voice, I think my voice is a big problem. Because at times I feel like I'm fluctuating. The other time I'm here, the other time I'm here.

It is worth noting that the chairperson stated that the presenter "raised" her hand to present this lesson, implying that the presenter volunteered to the teacher and was not forced, which is one of the principles of presenting a lesson in LS. Unfortunately, the presenter's comments lacked mathematical clarity and were generic.

5.3.2 Evaluations and Analysis

This sub-theme of evaluations and analysis ties up with Gibbs' Reflective Cycle, as Sekarwinahyu et al. (2019) explained. However, these two processes happen interchangeably, meaning that one will analyse first and then evaluate, while sometimes, after evaluating, one will give an analysis. During the evaluation stage, the panel members should discuss what worked or did not work during the lesson without attaching reasons. During the analysis stage of reflection, panel members, after verifying what worked or did not work during the lesson, continue to find reasons for

such (Sekao, 2023). After the teachers evaluated an event in the lesson, they also analysed it and vice versa; therefore, I decided to combine the two stages into one sub-theme.

In this part of my findings, I focus on the reflections by all the LS team members who observed the lesson as they grappled with what worked or did not work, and then examined them to arrive at the possible reasons thereof, i.e., what worked or did not work. Naturally, the whole group reflection ensued after the teacher who taught the lesson had given his/her views about the lesson; however, this does not preclude him/her from making further contributions during the reflection sessions; after all, he/she is still part of the LS team.

In Excerpt 7, Teacher 1 was the first to be allowed to reflect on the lesson, where comments about the lesson objectives, mental mathematics and lesson presentation were made:

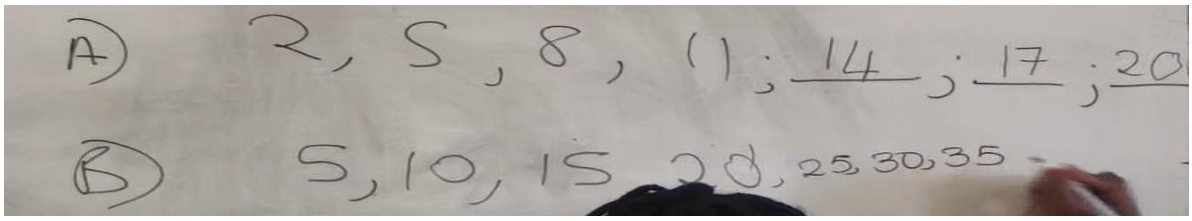
Excerpt 7 (L1: PLR: p.1(25-31))

> Teacher1: {02min50s} Um, for me, uh, the lesson was okay. Um, the teacher was able to... to state the lesson objectives, the topic, um... Um, about the lesson presentation. Um, it was good for the teacher to start with…. Was it mental maths? To remind the learners, um, their prior knowledge. Um, and also what I like is the fact that, um, the teacher asks the learners to justify their answers on the board.

The teacher evaluated the presenter and said it was good for the presenter to state the lesson objectives and then do mental mathematics before leading to the lesson presentation. This implies that these aspects of the lesson assisted learners in understanding the lesson. Figure 5.2 also shows how learners came to the board to complete the numeric pattern to justify their answers.

Figure 5.2

Learners' solution on the board



Hence, the teachers evaluated that this aspect of the lesson worked well as it promoted learners' participation, leading to their understanding of the concept.

In Excerpt 8, Teacher 1 I analysed her lesson:

Excerpt 8 (L2: PLR: p.1(26 – 29))

> Teacher 1: {2min56s} I think most learners were a bit confused. And as a maths teacher, we know that you can't move to a classwork or move to your homework, um, while learners are not understanding. So, we needed to explain and explain, and explain for, for learners, for them to understand. Um, that is number one, which is, um, time management.

Teacher 1 evaluated her lesson presentation section and felt that learners were confused. This evaluation made her decide to take more time to explain further so that learners could understand better. I can infer that her lesson analysis depended on the learners' understanding.

In Excerpt 9, during the post-lesson reflection of lesson 4, the presenter evaluated the lesson planning by indicating the angles she used to teach the concept of the exterior angle of a triangle:

Excerpt 9 (L4: PLR: p.1(23 – 28))

> Teacher 1: {02min57s} And also, while they were presenting group 1 and group 4, they were able to come up with their conclusions, the angles… Yes, um, the other challenge was the … While we were planning, we never thought we should cut out, um, 70^0. We only did um, 60^0 and 50^0. But during the lesson, I felt that there is a need to cut, um, 70^0, um, why, why cut out um, 70^0, uh, to avoid learners making misconceptions to say, um, what if I add that 70^0 and 50^0 to give me that exterior angle. So, it was important for them to see that it is only if you take 50^0 and 60^0 to get that exterior angle.

The evaluation was that they did not cut out a 70^0 angle for learners to paste onto the triangle that was on the chart. She then had to measure the angle and cut it out to allow the learner to fit it into the triangle. Hence, in her analysis, pasting the angle onto the tringle assisted learners with understanding the concept of the exterior of a triangle. The picture depicts the charts pasted on the board for learners to insert the angles.

In Excerpt 10 from lesson 4, the chairperson analysed the lesson by stating that not enough exercises were given to learners to complete.

Excerpt 10 (L4: PLR: p.1(36 – 41), p2(1 – 2))

> Chairperson: Would you complain that learners, even if you don't give them exercises to do because it ended on the explanation part, would you complain that learners, even if you didn't give them exercises to do?
>
> Presenter: Um, yes. Why? Because already we have investigated that the exterior angle is equal to the sum of the interior opposite. So, with them having, maybe those angles have been replaced by $2x$, x, by different variables, they would still be able to do it why

because it was evident that from that prior knowledge, that one of calculating the value of x, triangle and a straight line, they were able to do it.

However, the presenter stated that based on prior knowledge, the activity was good enough to lay a strong foundation for learners to understand the work. The summary of the findings of this secondary research question is as follows:

1) Teachers follow a structural method for reflection; the chairperson leads the session, the presenter reflects first, followed by other teachers, and post-lesson reflection happens in the classroom where the lesson was taught. The chairperson was specific about the issues to be reflected upon. The chairperson would thank the presenter since the presenter “raised” her hand, volunteering to teach the research lesson.
2) The presenter and teachers shared general feelings—not mathematical, e.g., less was okay, the challenge was the pace of the lesson, and the lesson was introduced well.
3) Evaluation and Analysis - The importance of objectives to guide the lesson that was evaluated and analysed, as being done correctly to guide learners as to what they were supposed to know on the day.

   Prior knowledge – the teacher analysed the introduction using prior knowledge to assist learners in understanding the lesson.
4) The lesson presentation was evaluated and analysed since the teacher took more time to explain to the learners than planned.

5.4 LEARNING EXPERIENCES GAINED FROM POST-LESSON REFLECTION

The secondary research question in this theme was: What learning experiences (benefits) do teachers gain during post-lesson reflection? After thorough analysis of

data regarding learning experiences gained by teachers, I identified and organised the findings into three sub-themes: Teaching methods, Mathematical connection in lesson development and presentation and teacher's learning about learner thinking.

5.4.1 Benefits of reflecting

In an interview with teachers, we asked them whether there were any benefits for reflecting on their lessons for both learners and teachers. Generally, teachers felt that as they reflected on their lessons, they would consider other teaching methods they could have used, and that when teaching the same lesson in another class they would change their initial teaching method. For instance, two teachers responded in the following manner:

> Teacher 2: Well, it... Helps the teacher to actually rethink on what strategies do they need to use in their teaching, while teaching mathematics. So, you need to have different ways in a lesson, or maybe conduct your lesson in a way so that you, cannot teach some of the things the same way. So, in geometry, can I please shift a bit? So, in geometry you need to use... um, diagrams and all that to show what is it that is actually being dealt with.
>
> So, using different strategies for different topics as well, um, allows the teacher to actually see, okay, this one works for this and this one doesn't.
>
> Teacher 3: (03min38s) I think another benefit would be that writing reflections give you a way to actually find out how different learners are susceptible to different topics.

What we found most interesting was that teachers were thinking deeply about better teaching strategies which they would not normally do had it not for them reflecting. It was evident that after reflecting about what happened in one class would affect the manner in which the same lesson would be taught in another class.

In another instant we asked teachers how they could have taught the observed lesson using a different method.

> Teacher 1: (15min15s) As I was teaching them, I was wondering if, how if the learners investigated and came up with different ways of finding the general rule. As I was teaching them. Maybe, it was going to be... More fruitful, more methods for learners, finding the general rule, just not, not just one method of us telling them maybe they should have investigated…

Teacher 1 realised the benefits of reflecting on different teaching methods, that is, pertaining to how the lesson could have been improved to develop learners' investigative skill. Hence, we can infer that reflecting critically on this lesson would assist in improving their teaching methods.

Another benefit of reflecting was regarding collaborating with each other to improve their teaching. There was professional development through their critical viewpoints as well as address their misconceptions in teaching certain concepts. The next extract is a quotation from one of the teachers:

> Teacher 3: {06:34} ...as a teacher then now I can develop, I can gain…, because sometimes you think that you are right only to find that you are wrong. There are a lot of misconceptions as a person or individual that you might give to learners. But when we reflect, we show you that. And then you yourself and yourself, you, you become developed as a teacher…

It was interesting to note that teachers' reflective practices were driven by their abilities to self-introspect as seen in the next response:

> Teacher 2: Well, to add on what you said to determine areas of thought. Also makes you to do a self-introspection on how are you going to deliver the next lesson. What are the mistakes you have done that you need to prevent from happening in the next lesson? So, it basically allows…. Don't lose just one part of your attention, but also reflect on your strategy when focusing on a topic in which you are going to teach.

Hence, benefits of reflecting on their teaching methods and better strategies to assist learners understand content better, while also teachers admitted that reflecting can assist in removing their own misconceptions that they make when teaching which can result in further misconceptions among their learners.

5.4.2 Teaching Methods

A teaching method is a teacher's skill or strategy for classroom instruction. Examples of teaching methods include storytelling, the question-and-answer method, investigation, and project-based teaching (Carpenter, 2006). In Excerpt 11 from lesson 1, the chairperson felt that the presenter should have used an investigative teaching

method, which was agreed upon during lesson planning, which the presenter did not use:

Excerpt 11 (L1: PLR., p.2(11 – 23))

> Chairperson: Okay. I think it's me now...I would have loved to see you (presenter), um, doing sort of an investigation because you gave them Term 1 is equal to four in going to the, to the, to the whole itself. I would have loved to see her giving them term number one, term number two, so that they actually see what is happening.

One would have expected the chairperson to ask the teacher why she deviated from the teaching method they agreed on during lesson planning. Nevertheless, teachers must use relevant teaching methods.

In Excerpt 12, the information was taken from the observation tools used by the teachers who observed the lesson, confirming what happened:

Excerpt 12 (L1: TOT, p.1 row 5)

> T2: (Teacher) asked questions.
>
> T3: Through questions and answers and writing on the board.
>
> T4: Active participation of learners was visible.
>
> T6: It was good for the teacher that the teacher (presenter) took different learners, making them more involved.

Evidence gathered from teachers' observation tools (used by the observers during the lesson teaching) showed that the presenter consistently used the question-and-answer method to help learners understand the concept of numeric patterns. The presenter also allowed learners to display their solutions on the board to encourage participation.

In Excerpt 13 from lesson 2, teachers noted the learner involvement during the lesson:

Excerpt 13 (L2: TOT, p.1 row 12)

> T4- lesson objectives clearly stated.
>
> Learners were actively engaged with the content.
>
> The teacher accommodated every learning style.
>
> T5 – The teacher was able to stimulate learners' interests.

It can be inferred that the teacher used the question-and-answer method to get learners involved in the lesson, and this was reflected by the other teachers in their observation instruments. T4 and T5 stated that learners were actively engaged, accommodated through various learning styles, and stimulated their interests.

5.4.3 Mathematical Connection in Lesson Development and Presentation

Mathematical connections are how concepts in mathematics interconnect and develop from each other to produce a coherent whole and identify and implement mathematics in various contexts not related to mathematics (Mosimege, 2012). In Excerpt 14 from lesson 3, teachers noted the mathematical connections that the teacher used:

Excerpt 14 (L3 TOT, p.2 row 12)

> T2 – the teacher started the lesson by mentioning the lesson topic and the objectives.
>
> Revision exercise was too long where the teacher asked about triangle's types.
>
> T3 – the voice projection at the beginning of the lesson was a challenge. Learners were not corrected on the issue of transposing (instead of additive inverse). Good example when introducing the lesson on the "exit" linking it to real-life. Encourage learners to give a reason for every statement.

Teachers observed that the presenter did revision exercises during the prior knowledge section to link the content regarding types of triangles to the concept of the exterior angle of a triangle that the lesson was addressing. Teacher 3 mentioned the real-life context of the words “entrance” and “exit” so that the learners understood the concept of the exterior angle of a triangle:

Similarly, in Excerpt 15, mathematical connections were evident:

Excerpt 15 (L3: PLR: p.2(18 – 28))

> Teacher 2: (06min05s) OK, I would like to say thank you, mam, for the lesson. Eh…for introduction, the teacher introduced the lesson very well by stating the lesson objectives and the topic. Then today’s objectives were that the learners should be able to investigate the angles of a triangle, focusing on the relationship between the exterior angle of a triangle and its interior angles; of which learners were doing during presentation. So, during the presentation, the teacher used prior knowledge to link what the learners were taught in Grades 7 and 8 to what she was going to teach in class today.

During the post-lesson reflection of lesson 3, Teacher 2 reflected on the introduction, using prior knowledge from previous Grades (7 and 8) to assist learners in understanding the concept of the exterior angle of a triangle. This was important to help learners understand the current concept that was presented.

In Excerpt 16, the learning experiences through post-lesson reflection were that doing reflections was empowering because they realised the value of linking prior knowledge to the current lesson:

Excerpt 16 (L4: Interview: p.4(12 – 20))

Presenter: Uhm, I feel empowered; firstly, I will talk about the introduction part. Um, as my colleagues have said, um, it was good because, uh, we're able to link the prior knowledge with uhm, um, today's lesson. Um, it shows that the next time we're planning a lesson, we need to make sure that learners' prior knowledge is brought up...number two, uh, learner's participation in class. Um, always when teaching, we need to make sure that learners are involved in the lesson. And the type of, um, exercise to give to learners, um, should relate to the objectives of the day.

The lesson activities were sequenced from lesson objectives to prior knowledge and relevant classwork exercises to encourage learner participation.

5.4.4 Teachers' Learning About Learner Thinking

Learner thinking is when learners create new knowledge to build ideas and make connections; it enables their exploration of perceptions of mathematical facts (Idris, 2005).

In Excerpt 17 from lesson 5, teachers' learning through learners, teachers mentioned participation:

Excerpt 17 (L5: TOT, p.1 row 5)

T1: They (learners) were able to measure angles.

T2: At the board, the teacher asks them questions.

T3: From the intro, learners were given a worksheet with prior knowledge and explained solutions on the board, solving at the worksheet and board.

The lesson was learner-centred because learners worked in groups to measure angles and then displayed their answers on the board. Teachers reflected on this learner's involvement in their observation tools. They learnt the importance of

encouraging learners' thinking through learner participation in the lesson to assist them in understanding the content.

The summary of the findings of this secondary research question is as follows:

1) Teaching methods as learning experiences—it was observed that the investigative method of teaching numeric patterns for learners to derive the rule, coupled with the question-and-answer method of soliciting answers from learners, led to the achievement of the lesson objectives.
2) Mathematical connections—The content from the topic was connected to learners' prior knowledge, i.e., the types of triangles and the sum of angles of a triangle to teach the exterior angle of a triangle. Real-life scenarios and words such as entrance and exit were used to relate to the concept that the exterior angle equals the sum of interior angles.
3) Teachers learnt about learner thinking as learners participated in the lesson, using the worksheets to complete mental mathematics and continuing to explain their solutions on the board to the entire class.

5.5 THE USE OF INFORMATION FROM LESSON OBSERVATION ON POST-LESSON REFLECTION

This theme addressed the secondary research question: How does the information collected during lesson observations inform post-lesson reflection?

During lesson observation sessions, all observers use an instrument with specific focus areas (Chauhan, 2022). Observers record their observed episodes, which are intended to inform the post-lesson reflection. In other words, the post-lesson reflection process is an organised and systematic process entirely contingent on observing the presented research lesson.

The findings I present under the current theme are meant to share insights into SRQ3 on how the information collected during lesson observations informs post-lesson reflection. From the analysis of the observation instruments of the teachers who observed the lesson, I came up with three sub-themes: Lesson objectives and introduction, lesson presentation and development, and learner involvement and participation.

5.5.1 Lesson Objectives and Introduction

In Excerpt 18 from Lesson 1, lesson objectives were stated during the introduction of L1. Stating the lesson objectives was necessary because it was later reflected upon in Excerpt 19, as to whether the objectives were achieved, as well as demonstrating how the presenter dealt with them:

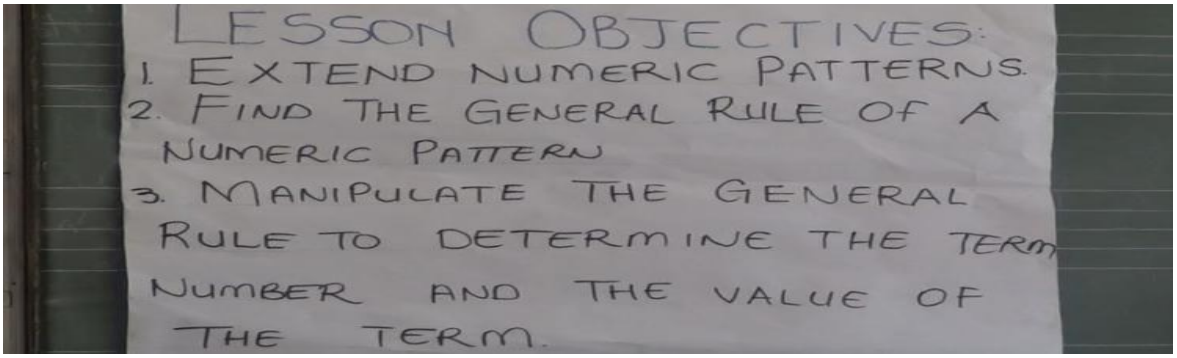
Excerpt 18 (L1: p.1(6-9))

> Teacher: (00min58s) So, today's lesson objectives are these ones, ne? At the end of this lesson, you should be able to extend numeric patterns. You should be able to find the general rule of a numeric pattern. You should be able to manipulate the general rule to determine the term number and the value of the term."

Figure 5.3 serves as evidence that lesson objectives were discussed with learners so that they can reflect on their achievement:

Figure 5.3

Lesson objectives



The achievement of lesson objectives was essential to gauge the lesson's success.

The chairperson in Excerpt 19, during post-lesson reflection, asked about the achievement of the lesson objectives, and it was also mentioned so that the teachers paid attention to the objectives of the lesson:

Excerpt 19 (L1: PLR: p.1(35-36), p.2(1 – 9))

> Chairperson: (03min22s) According to you, was the lesson objectives, uh, achieved?
>
> Teacher 1: Um, for me, yes. Um, learners were able to do the activities in groups and individually.
>
> Chairperson: Okay, Madam Teacher 2
>
> Teacher 2: Good afternoon. Now, for me, the lesson was well presented. Because the introduction was okay. The kids were given enough time for them to understand the objectives. And the introduction of the integers…
>
> Chairperson: Objectives reached?
>
> Teacher 2: Yes, objectives reached.

The achievement of lesson objectives was reflected upon superficially. Teachers did not delve into the actual mathematical aspects of the lesson that were done to achieve the objectives.

During the interview, teachers needed to reflect on the importance of the introduction in lesson 4 as a springboard to make connections between prior knowledge and the new content that was to be taught:

Excerpt 20 (L4: Interview: p.1(24-34))

> Teacher 2: (02min30s) What was important on the introduction? It was when madam used the sum of angles of a triangle, and the angles of a straight line, for me that was important. And it stood out because after, she immediately came back and explained it when they were doing the exterior of a triangle and related it to the angles of a straight line. I think that one stood out for me because learners were able to identify them quickly. And on the introduction, it is where she was stressing the, the, the, the statement and the reasons. Issues that you know, you cannot just say yes without a reason. In mathematics, or the statement in Geometry is always a reason. I think that one stood for me the thinking of that rule….

Teacher 2 responded that the prior knowledge used was regarding types of triangles, angles in a straight line, and the sum of angles in a triangle. Hence, the interview session reflected on the prior knowledge that was part of the criteria for teachers to observe in their observation tools.

5.5.2 Lesson Presentation and Development

Excerpt 21 and Excerpt 22 (where Excerpt 21 depicts an incident that happened in class, and Excerpt 22 shows how it was reflected upon by teachers from their tool or

during post-lesson reflection and interviews) In Excerpt 21, the presenter pasted a triangle on the board and then presented to the learners how to measure angles on the board using a protractor, assuming that learners can do the same. After measuring all the angles, the presenter then showed learners that the angles added up to 180°:

Excerpt 21 (L5: p.2(15-22))

> Presenter (13min10s): So now, I've got this one activity for you. This one that's the activity ne? I've given you this and this ne (right)? I'm going to show you on the board on how to measure. On how to measure. So, I want you to measure. Okay? Please take note ne. This is how we measure using a protractor. You put your protractor on zero ne? Can you see, this is 50^0, ne? then you come this side, and put your protractor this way...we've got 60 ne? Then you come and put it on top, you got 70^0. Ne? Any sets….
>
> So, we've got 50^0, plus 60^0, plus 50^0, and they all add up to... 180^0, ne? Okay, so... Can you please use this activity to measure.

In the teacher observation tools of L5, teachers indicated that learners were investigating angles by measuring with a protractor on a given worksheet. Thereafter, learners had to present their solutions on the board and justify their answers by giving reasons:

Excerpt 22 (L5: TOT: p.1 row 5)

> T1: They were able to measure angles.
>
> T3: From the intro, learners were given a worksheet with prior knowledge and explained solutions on the board.

Excerpt 23 and Excerpt 24 (where Excerpt 23 depicts an incident that happened in class, and Excerpt 24 shows how it was reflected upon) In Excerpt 23, the teacher engaged learners in a practical demonstration in which the learners had to come to the board and paste cut-out angles inside the triangle. Through trial and improvement, learners had to figure out which angle fits to which vertex. All learners saw that, indeed, angles inside the triangle added up to 180^0:

Excerpt 23 (L4: p.10(17-37))

> Teacher: (49min27s) Yes. Um, because of time, we are approaching the end of our period. To conclude this lesson, we're going back to our example. So, from our example, we have measured angle A to be 60^0 angle B to be 70^0, and angle C to be 50^0. Which means we are having those three angles. So, I need the first candidate to paste angle 50^0, angle 50^0. Yes. Let us be quick. 50 degrees. Another one come and paste 70^0... So, angle 50^0...70^0. Yes…
>
> Learners: (learners come forward to the board to paste the required angles)
>
> Teacher: (51min01s) Paste 70^0… Yes.
>
> Teacher: Our angle A. What else angle A?
>
> Learner: 60^0.
>
> Teacher: 60^0. So, it means here we need to have 60^0. Anyone to paste 60^0? Yes, baby girl, … (learners came forward o paste) That is our angle 60. What happened to our angle 70^0 now? Uhm anyone to paste angle 70^0 real quick? No one? Anyone? Uhm angle 70, anyone? There is angle 70^0 baby girl. Angle 70^0 is coming now…. Yes, here is angle 70^0…
>
> Learner: pastes angle 70^0 on the triangle on the board

Teacher: So, do we see that angle 60^0, 50^0 and angle 70^0 they fit inside that triangle?

Learners: Yes.

Excerpt 24 is the evidence that during post-lesson reflection, the presenter reflected on pasting angles on a triangle to convince learners that the interior angles of a triangle add up to 180^0 :

Excerpt 24 (L4: PLR: p.1(23 – 32))

Teacher 1: (02:57) And also, while they were presenting group 1 and group 4, they were able to come up with their conclusions, the angles… Yes, um, the other challenge was the … While we were planning, we never thought we should cut out, um, 70^0. We only did 60^0 and 50^0. But during the lesson I felt that there is a need to cut 70^0, um, why, why cut out 70^0, uh, to avoid learners making misconceptions to say, um, what if I add that $70^0$and 50^0 to give me that exterior angle. So, it was important for them to see that it is only if you take 50^0 and60^0 to get that exterior angle. That one was a challenge because I was busy doing it slowly and when the learners were trying to finish … ag, causing problems but at the end, we managed to do it. Um, and also the issue of activity, um, I feel that I should have given them that activity to calculate but because of time uhm, some other time …

The summary of the findings related to how teachers use the information collected during lesson observations to inform their post-lesson reflection is as follows:

1. Teachers reflected on lesson objectives and lesson introduction during the reflection session – whether objectives were achieved or not to gauge the success of the lesson – whether the teacher did activities in line with achieving the objectives (never diverted) – that the introduction was important as a basis for learners to understand the topic of that day (exterior of a triangle)

2. Teachers reflected on the lesson presentation and development, including how the presenter demonstrated how to measure angles using a protractor, how learners were given opportunities to present their solutions, and the practical exercise of pasting cut-out angles onto the triangle on the board.

5.6 TEACHERS' USE OF POST-LESSON REFLECTION TO IMPROVE THEIR TEACHING PRACTICE

The secondary research question addressed by this theme was: How do teachers use their learning experiences to improve their teaching practice after conducting post-lesson reflection? Learning experiences in this research refer to the PD of teachers by engaging in post-lesson reflection so that their teaching will improve the next time they teach the same lesson. During the evaluation stage by Sekarwinahyu et al. (2019), teachers investigate what worked and what did not during the lesson presentation stage of LS. This research question was addressed using three sub-themes: benefits of reflection, lesson improvement, and action plan.

5.6.1 Teachers' learning experiences during post-lesson reflection

During lesson 1 interviews, I asked the teachers about beneficial experiences for them and their learners for engaging in reflective practice.

In Excerpt 25, teachers learnt the importance of having different ways of teaching a lesson, such as the use of diagrams in Geometry:

Excerpt 25 (L1: Interviews: p.1(23-37), p.2(1-8))

> Teacher 2: (02m36s) Well, it... Helps the teacher to actually rethink on what strategies do they need to use in their teaching, while teaching mathematics. So, you need to have different ways in a lesson, or maybe conduct your lesson in a way so that you,

cannot teach some of the things the same way. So, in Geometry, can I please shift a bit? So, in Geometry you need to use... um, diagrams and all that to show what is it that is actually being dealt with.

So, using different strategies for different topics as well, um, allows the teacher to actually see, okay, this one works for this, and this one doesn't.

Teacher 3: (03min38s) I think another benefit would be that writing reflections give you a way to actually find out how different learners are susceptible to different topics.

The importance of reflecting on how learners responded to different teaching methods was noted. It was evident that reflecting on what happened in one class would affect how the same lesson would be taught in another due to what they experienced. This meant the new class would experience an improved lesson delivery than the former class or period. To challenge the teachers about their teaching in Excerpt 26, I asked the educators how they would teach the same lesson differently. The presenter admitted that she was also pondering various teaching methods to assist learners:

Excerpt 26 (L1: Interviews: p.5(24-29))

Teacher 1: (15min15s) As I was teaching them, I was wondering if, how if the learners investigated and came up with different ways of finding the general rule. As I was teaching them. Maybe, it was going to be... More fruitful, more methods of learners, finding the general rule, just not, not just one method of us telling them maybe they should have investigated rather than us. I'm not sure if I'm using the right word, and I see telling them probably. Probably. Yeah. Okay. I think that's what I, I thought maybe we should have done.

Teacher 1 realised the benefits of reflecting on different teaching methods, specifically how the lesson could have been improved to develop learners' investigative skills. It

was clear, therefore, that the experiences of reflecting critically on this lesson would assist in improving their teaching methods.

In Excerpt 27 from lesson 3 reflections, the chairperson gave critical reflections on how things could have been done differently:

Excerpt 27 (L3: PLR: p.1(20-30))

> Chairperson: Uhm, the other thing ngibonile siwa drawile ama (I saw we drew the) triangles and everything like, especially… I prefer us to always that we need to try angle A, angle B angle C. I think the first sketches they were not adequate… that one for me… uhm. The other one I want to talk about is that we need to always tell learners that there is a statement and a reason… so that they know that when they start, there is a statement and a reason. I liked these two ones, the last two… they wrote the reasons, but I think there is a learner that wrote I think they did not put them. $30^0 + 80^0 + x$, did not write any reason, just the values, I think we need to be very careful because you emphasise that until they get it right. The last one, that was the issue of the additive inverse. Because they said we group the like terms. This one will go that side… they should ukuthi (that) OK here it was $x + 110^0 = 180^0$, then we apply the additive inverse it will be $x + 110^0 - 110^0 = 180^0 - 110^0$, that is why that side is 110. Otherwise, it was a good lesson. It was a good lesson.

The chairperson's reflections added more strategies to teach Geometry. These included making further sketches to explain the geometric concept, writing the statement and a reason, and the additive inverse. Of greater importance was that teachers needed to emphasise these strategies in basic Geometry topics for later application.

In Excerpt 28, during the interview session, I asked teachers: “Why was it important to reflect after the lesson was taught?”:

Excerpt 28 (L3: Interviews: p.2(8-18))

> Teacher 3: {04min41s} It makes you a better teacher. Because you first reflect yourself, this is what I did, this is what I did not do, this is where I want to improve next time. And your colleagues giving you their thoughts, what I may, maybe I would have done it this way. It develops you as a person. It develops you as a teacher. It makes you a better teacher in the classroom.
>
> Right now, we were investigating, I felt that the investigation was not investigative enough, then they will discuss it, then they or myself or somebody else on the next lesson, doing the same lesson will know that OK if I have to be investigating, I cannot just give them one. Then it will not be investigation per se. But if I give them one, two, three, then they are able to conclude. You need to improve as a teacher.

Teachers learnt that reflecting benefited them by allowing them to collaborate to improve their teaching. Their critical viewpoints about the new strategies or methods provided PD.

In Excerpt 29, I asked teachers during the interview how they could encourage the experience of post-lesson reflection.

Excerpt 29 (L3: Interviews: p.2 (29-37))

> Teacher 3: {06min34s} … But when we reflect, we show you that. And then you yourself and yourself, you, you become developed as a teacher. I think it is

important that they see that, because if you just tell them that, go and do it, they won't.

Teacher 3 acknowledged that one advantage of post-lesson reflection was that they could share teaching ideas that led to their PD. Unfortunately, they did not specify the ideas they had learnt.

5.6.2 Lesson Improvement and Action Plan

In Excerpt 30, I asked teachers how they could have taught the lesson differently. Teacher 2 and Teacher 3 responded that, for an investigative approach, it is important to use more than one example to convince learners.

Excerpt 30 (L3: Interviews p.5(5-9))

> Teacher 2: {12min:3s} I agree with what they have said. Also, to investigate on 2 diagrams and not only 1, to check of the exterior angle of triangle number 1, and that of triangle number 2, they reach the same conclusion.
>
> Teacher 3: {12min35s} I think another one I would change is when, when we give them the worksheets. I would say group 1 and 2 do number 1, 2, do number 2, like that. So that when this group presents, the other groups will be so interested. Yeah, because they did not do this. It will capture their attention. And then when the other group is presenting, remember they did not do it. Then they will be very much attentive. It also saves time.

Teachers learnt to manage activities differently, i.e., giving different groups different activities on the worksheet to complete and increasing learners' interests when one group presents their activity. Hence, the lesson was improved by catering to investigative activities and encouraging learner participation.

Once again, in Excerpt 31 from lesson 4, during the teacher's post-lesson reflection, teachers valued the learner involvement with practical investigations to foster understanding of mathematics concepts:

Excerpt 31 (L4 PLR: p.2(6-18))

> Teacher 1: (05:37) Afternoon, colleagues.
>
> Teachers: Afternoon.
>
> Teacher 1: I'd like to say thank you madam for presenting our lesson. Uh, Oh, first things first. Uh, Madam presenter was able to stimulate the learners' interests by her introduction. And then the lesson objective was that the learners would be able to interact and participate. They were also working in small groups. And the teacher then started the lesson nicely by cutting and pasting the angles … Then most of the learners had shown that they understood because they were able to stand up and present their answers on the board. Thank you, madam.
>
> Chairperson: I will ask you the same question again. Do you feel confident that the learners can apply this concept?
>
> Teacher 1: Yes. Mainly because they were able to stand up and present their answers. And if they saw that one of the values is an incorrect answer, they will be able to correct it... they will be able to apply it.

It was evident that teachers' learning during post-lesson reflection would be incorporated into their teaching based on what they observed from the presenting teacher. The lesson was practical, allowing learners to use concrete objects to understand the mathematical concept of the exterior angle of a triangle.

The summary of the findings for this secondary research question is as follows:

1. Benefits of lesson reflection: how learners respond to different teaching methods; different ways of teaching Geometry; collaboration in lesson planning; PD: new strategies or teaching methods.
2. Lesson improvement and action plan: Use worksheets, present an investigative lesson, and give different groups different practical activities.

5.7 FACTORS HINDERING TEACHERS' REFLECTIVE PRACTICE IN LS AND TEACHERS' PROPOSED SOLUTIONS

Hindrances to reflection imply the challenges teachers encounter that prevent them from reflecting on their lessons, such as the school's lack of time and support (Jaeger, 2013). The secondary research question addressed by this theme was: "What factors, if any, hinder mathematics teachers' reflective practice in LS?" I dealt with this theme using the following subheadings: hindrances to reflections and possible solutions to hindrances.

5.7.1 Hindrances to reflections

Excerpt 32 depicts a teacher's response to one of the questions. I asked if possible hindrances to engaging in developmental post-lesson reflection existed. Teacher 4 indicated how scared they would be when being observed teaching and their fear of being judged by other experts observing the lesson:

Excerpt 32 (L1: Interviews: p.1(9-20))

> Teacher 4: (04min57s) Um, I think maybe they're scared to be criticised based on their lesson. Um, they feel sort of scared to share with others how to teach maybe a certain topic. Because, um, yeah, it's tough to teach with all the maths experts in the

> field, and you feel like they don't judge you based on what you're teaching, how you use the mathematical language, how you ask the learners, how... How the lesson is going basically. So, yeah, they feel that they will be judged, that say, ah, this one can't teach.

In Excerpt 33 from the lesson 2 interview session, hindrances to reflection were stated in terms of being scared and being judged, based on the teaching methods being used:

Excerpt 33 (L2: Interviews: p.2(21-28))

> Teacher 6: It is difficult for teachers, uh, to sit and reflect on their lessons, especially like this, it's colleagues or peers because some of them is scared that they may be judged on how they teach on their teaching and their teaching methods because now we are moving to 4IR, so us as teachers mostly use gadgets, and the experience of Teacher 5 is not like us who use gadgets, so that can cause a conflict. So, most teachers don't like to sit like this among them.

In Excerpt 34 from lesson 4 interviews teachers, I challenged them to overcome hindrances to reflection, including the fact that they were not used to reflecting. There was also the issue of having an inferiority complex, as some teachers might not be willing to see how weak they are in their teaching:

Excerpt 34 (L3: Interviews: p.3(5-29))

> Question 4: Do you think that there are hindrances to reflection? Why teachers can't come together? What are the hindrances if you feel they are there?
>
> Teacher 3: (08min02s) We are not used to it.
>
> Interviewer: Oh, you are not used to it?

Teacher 3: No, I'm not used to something. It's a new, new method to us. So, when even everyone, anyone, can come to my class when I am teaching, I don't want to…

Teachers: (08min15s) (all laughed)

Interviewer: But why is that the case?

Chairperson (DH): Inferiority complex.

It was encouraging to note that teachers agreed to invite other teachers to reflection sessions like ours, although time was unavailable since they were always busy. Other hindrances mentioned were that doing reflections was a new concept for teachers, the inferiority complex, not being exposed to reflections, and the uneasiness of having someone observe while they teach.

Excerpt 35 revealed hindrances to reflections since some had an inferiority complex, misconceptions in teaching maths and were afraid of being criticised:

Excerpt 35 (L4: Interviews: p.4(28-37), p.5(1-2))

Teacher 2: (13min19sec) Criticism.

Interviewer: Criticism?

Teacher 2: inferiority complex You are not sure of the misconceptions, the things, and these people that are, are analysing you, the, sometimes you even forget, because you are scared that people are watching you. And I think, as I saw madam sitting here and was supposed to start with our reflection. She was like "wow, I wonder bazothini (what are they going to say), I wonder what am I going to say about…." Nginamanga (am I lying)? She even said it… That's being afraid of criticism, sometimes, in most cases with this, it's positive criticism. You're not criticising a person, but you're criticising us as a group, but you know it's nature and you're the presenter. You feel as if it's only you, yet it's us.

In Excerpt 36, teachers further explained that time was one of the major hindrances since reflection is not part of the school timetable (not institutionalised). Suggestions

were given earlier, such as that the department should organise something like LS reflection sessions for certain subjects for a week, etc.:

Excerpt 36 (L5: Interviews: p.5(20-26))

> Teacher 2: Or when you visit each other. They tried... What was it? I think... IQMS. Yeah, I tried IQMS, but it failed. It did not work. I feel like if we can have an example like that, then people will gain a lot. Will gain a lot. This exercise, nobody is criticising anybody here. We are just, it's our lesson. We observe it. We make inputs. We see ukuthi (that) OK, we've planned this lesson but maybe we should have done this and that there in the introduction. I think it is helpful. It is just time factor.

5.7.2 Possible solutions to hindrances

Excerpt 37 focused on overcoming hindrances to reflection, in which I asked them for other methods of reflecting on their teaching to improve.

Excerpt 37 (L3: Interviews: p.4(2-8))

> Teacher 1: {09min34s} You can reflect, uh, by giving learners assessments, uh by giving learners assessments maybe you can give them based on the topics. Then, you can see which topic they understood better. Then another way, you can tell whether you taught this topic in a good way or not. So, you can reflect by giving learners assessments.

One method mentioned included administering assessments to learners.

In Excerpt 38, Teacher 5 indicated that through learner activities and learner demonstrations on the board, they could use learners' responses to reflect on how effective their teaching was:

Excerpt 38 (L3: Interviews: p.2(9-17))

> Teacher 5: (10min9sec) Well, I would say the learner, learner activity. Like today, what we did was ask the learner to go to the board and then write their answers... you can tell whether they understood or not.
>
> Interviewer: …So, as they write on the board, are you saying that they are also reflecting at the same time? Or you, you as a teacher, you are reflecting?
>
> Teacher 5: Reflecting in action.

In Excerpt 39, teachers mentioned possible solutions to hindrances that can be done:

Excerpt 39 (L5: Interviews: p.3(26 – 29), p.4(1 – 5))

> Teacher 1: (07min15s) eh… sir for me as an individual reflection helps to see which topics I taught better. Which topics I didn't, which topics I can improve on. Then in terms of, reflecting on a regular basis. Uh, for me it may be difficult to do it every day. But, uh, in a week, we might do it three times in the form of class activities maybe an assessment.

Possible solutions included learner performances on class work and assessment activities that could be used to improve their teaching.

In Excerpt 40, teachers mentioned the benefits of doing post-lesson reflection:

Excerpt 40 (L5: Interviews: p.4(26 – 34), p.5(1 – 2))

> Teacher 2: (10min7s) Eish meneer (mister), reflection, it's a must that we do it for us to be better teachers because we need to improve. Times are changing. Uh, but... I think the three colleagues of mine spoke about reflection with learners' class

activities and going to the other class; you perform better because you did self-reflection.

Interviewer: Yes, self-reflection.

Teacher 2: Yeah, it is self-reflection. Even if, when you give them exercise, I think it is important that when we teach, we make sure that there's time for at least one or two activities that you can monitor because that tells you like, okay, this group is not doing it, that, that girl is not getting it, that boy there. I, I think that one is very important and sometimes we don't do it.

Teachers indicated that post-lesson reflection helped them improve their lesson delivery. One method was to reflect during the lesson through classwork activities so that they could intervene for specific learners who were not understanding the material. The summary of the findings for this secondary research question and the hindrances to reflection included the following:

1. The fear of being observed while teaching is due to a lack of confidence.
2. The fear of being judged.
3. The lack of time due to a heavy teaching workload – have LS sessions.
4. Inferiority complex in case they teach misconceptions due to incompetence in the subject.
5. Teachers are not used to reflecting on their lessons.
6. The uneasiness of having someone observing them while they are teaching.

Table 5.4

Overall summary of the findings

Research question	Key finding
Secondary Research Question 1 (par. 5.2)	• Teachers follow a structural method for reflection: the chairperson leads the session, the presenter reflects first, followed by other teachers, and post-lesson reflection happens in the classroom where the lesson was taught. The chairperson is specific about the issues to be reflected upon. The chairperson thanked the presenter since the presenter "raised" her hand, volunteering to teach the research lesson. • The presenter and the teachers shared general feelings—not mathematical, e.g., less was okay. The challenge was the pace of the lesson. The lesson was introduced well. • Analysis and Evaluation - The importance of objectives as a way to guide the lesson was analysed and evaluated as being done correctly to guide learners as to what they were supposed to know on the day. • Prior knowledge – the teacher analysed the introduction using prior knowledge to assist learners in understanding the lesson. • Lesson presentation was evaluated and analysed – since the teacher had taken more time than was planned to explain to the learners.
Secondary Research Question 2 (par. 5.3)	• Teaching methods as learning experiences – the investigative method to teach numeric patterns for learners to derive the rule – the question-and-answer method for encouraging learner participation. • Mathematical connections – content connected to prior knowledge, i.e., the types of triangles and the sum of angles of a triangle to teach the exterior angle of a triangle. In real-life scenarios, words such as entrance and exit relate the concept of exterior angle to the sum of interior angles. • Teachers learn about learner thinking as learners participate in the lesson. They use the worksheet to complete mental maths and explain their solutions on the board.
Secondary Research Question 3 (par. 5.4)	• Reflected on lesson objectives and lesson introduction – whether objectives were achieved or not; to gauge the success of the lesson – whether the teacher did activities in line with achieving the objectives (never diverted) – that the introduction was important as a basis for learners to understand the topic of that day (exterior of a triangle). • Lesson presentation and development – how the teacher demonstrated to learners how to measure angles using a protractor – how learners were given opportunities to present their solutions – the practical exercise of pasting cut-out angles onto the triangle on the board.
Secondary Research Question 4 (par. 5.5)	• Teachers' learning experiences during post-lesson reflection – how learners respond to different teaching methods – different ways of teaching Geometry – collaboration in lesson planning – PD: new teaching strategies or methods. • Lesson improvement and action plan – use of worksheets – how to do an investigative lesson – different groups should be given different practical activities.
Secondary Research Question 5 (par. 5.6)	• Fear of being observed while teaching. 2. Fear of being judged. 3. Lack of time due to heavy teaching workload – having LS sessions. 4. Inferiority complex in case they teach misconceptions. 5. Not being used to reflecting on their lessons. 6. Uneasiness of having someone observing while they teach.

5.8 CONCLUSION

In this chapter, I have detailed the findings regarding how teachers learn and develop through post-lesson reflection during the fourth stage of the LS cycle. Findings were presented from data collected through transcripts from lesson observations, post-lesson reflection, document analysis and interviews. This means that the findings presented in this chapter were authentic and valid according to epistemological assumptions of the interpretivist philosophy (Kamal, 2019). Since qualitative analysis was undertaken, data sets were presented as excerpts from the transcripts.

The research findings were presented concerning five themes with the sub-themes that emerged. The themes presented included the following: strategies used to conduct post-lesson reflection in LS; learning experiences gained from post-lesson reflection; the use of information from lesson observations on post-lesson reflection; learning experiences used by teachers to improve teaching after conducting post-lesson reflection and factors hindering teachers' reflective practice in LS. The sub-themes were relevant to my study because they clarified the main theme in various ways.

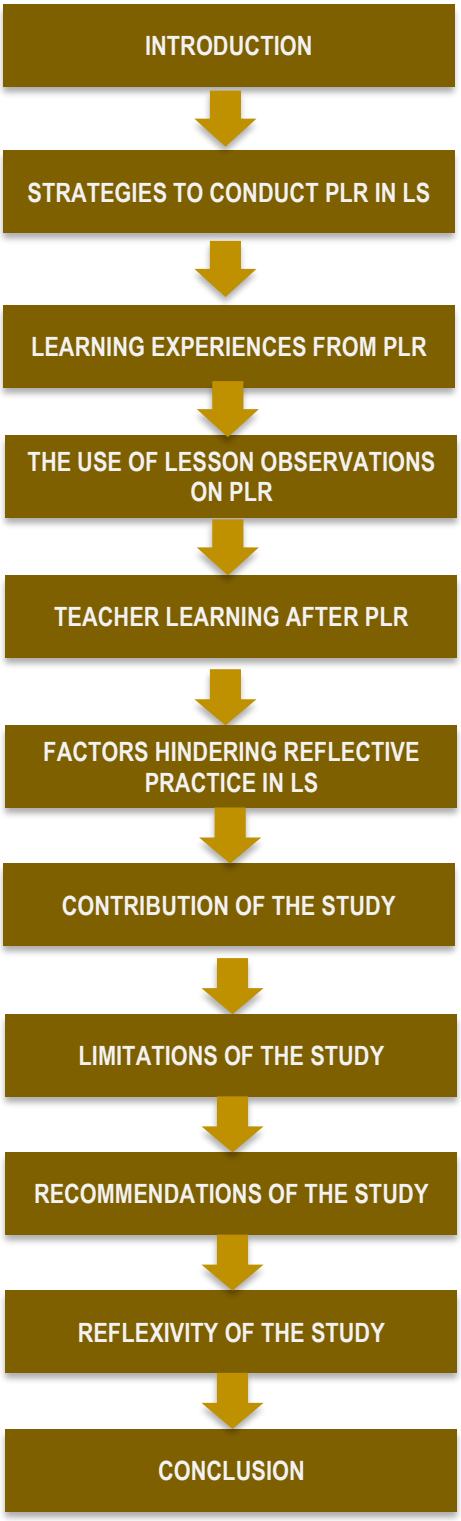
For example, sub-themes emerged under the theme referring to learning experiences gained from post-lesson reflections: *teaching methods and pedagogic content knowledge*. Since I needed to strengthen my analysis of the findings, numerous excerpts were given under each sub-theme as verbatim statements from the data, which were then interpreted. Data collected from lesson observations and document analysis was corroborated through post-lesson reflection and interviews to confirm or dispute cases or incidents made earlier. Each excerpt presentation was followed by a brief comment or interpretation to assist me during the discussion chapter.

CHAPTER 6: DISCUSSIONS AND RECOMMENDATIONS

For ease of reference, I have dealt with this chapter in the following manner:

Figure 6.4

The structure of Chapter 6 - Discussions and recommendations



6.1 INTRODUCTION

In this chapter, I discuss my research findings from the previous chapter. The discussions and the recommendations were organised according to the SRQ, which were the main themes. I have made valuable contributions and drawn critical conclusions regarding the findings.

This chapter has been divided into the following sections: the first secondary research question (SQR1) was aimed at finding out strategies on how mathematics teachers conduct post-lesson reflection in Lesson Study; the second secondary research question (SQR2) investigated learning experiences that mathematics teachers gained from post-lesson reflection in LS; the secondary research question (SQR3) revealed how the information mathematics teachers collected during lesson observations informed their post-lesson reflection.

The fourth secondary research question (SQR4) investigated how mathematics teachers used their learning experiences to improve their teaching practice after conducting post-lesson reflection in LS.

Lastly, in the fifth and final secondary research question (SQR5), I wanted to identify factors that hinder mathematics teachers' reflective practice in LS. The findings from the data collected were discussed in the relevant literature from my literature review; justifiable implications and recommendations accompanied the findings.

Further discussions took place regarding the framework's utility, the study's contributions, limitations, and reflexivity.

6.2 STRATEGIES USED TO CONDUCT POST-LESSON REFLECTION IN LESSON STUDY

In this section I discussed the findings related to SRQ1, which states: How do mathematics teachers conduct post-lesson reflection in LS?

In four of the five lessons observed, the post-lesson reflection sessions took place in the classroom where the lessons were presented, and the first person to reflect was the lesson presenter. Similarly, while conducting classroom observations, Farrell (2011) presented a classroom plan in which all classroom activities, e.g., learners' activities, were recorded for reflection after the lesson. Farrell (2011) did this to guide novice teachers on how to deal with learners' participation, based on which learners were more active than others. Teachers appointed a chairperson who managed post-lesson reflection sessions. The first person to reflect on the lesson was the teacher who presented the lesson. I used Gibbs' Reflective Cycle as part of the theoretical framework for my study (Sekarwinahyu et al., 2019).

In the initial lessons, the teachers' reflections were general remarks that lacked mathematical content and pedagogical rigour. Phrases such as "the lesson was introduced very well" and "the introduction was okay" did not give any insight into what aspect of the lesson went "very well" in mathematical terms. Other comments were "You could do better", "I feel I have delivered the content", and "With the lesson, I feel like it started well". These did not specify what was done better or what "delivered the content" or "started well" meant.

These comments imply that reflecting this way will deny teachers an opportunity to learn mathematics and develop professionally. This confirms the study by Sekao and Engelbrecht (2022) in SA, Eastern Province, where teachers' reflective comments

during post-lesson reflection were personal and did not focus on lesson improvement and learners' thinking. Hence, teachers must be guided on how to reflect mathematically rather than generally.

In one lesson, the teachers mentioned that: "the lesson was okay" because the lesson objectives and the topic were stated and that "it was good for the teacher to start with mental mathematics to remind learners of prior knowledge needed". Thus, I can infer that in her analysis of mental mathematics and prior knowledge, her evaluation was that it was appropriate for the lesson because this prior knowledge prepared learners for the lesson. This was a fair comment with mathematical content such as mental maths and prior knowledge. In another lesson, the chairperson stated that she "would have loved to see" the teacher doing an investigation to convince learners how to derive the general rule. According to Gibbs' Reflective Cycle (Sekarwinahyu et al., 2019), the chairperson analysed learners' performances and said that they were not convinced by the presenter's teaching method and that an investigative teaching method would have been appropriate. Her critical reflection provided an action plan on how the lesson could be taught differently, which could lead to PD. This reflection is in line with Vygotsky's SCT concerning the Zone of Proximal Development (ZPD), which is the difference between what people can do on their own and what they can do with the assistance of others (Adam, 2017). Hence, at this point, the evaluation allowed the presenter to develop through other teachers' reflections.

There were mathematical reflections that were mentioned in lesson 4 having the mathematical content, such as that learners were able to cut out and paste angles as a way of using concrete objects to prove that the internal angles of a triangle add up to 180^0. This investigative method also proved that the exterior of a triangle is equal

to the sum of the two opposite interior angles. Though earlier reflections from the teachers were generic and superficial, it seems teachers' reflective comments improved from lesson 1 to the latter. This proved that teachers participating in LS can reflect mathematically to improve their pedagogic content knowledge.

My study revealed the following suggestions when conducting post-lesson reflection:

- the first person to reflect should be the presenter of the lesson so that the presenter can express his/her feelings non-threatening (Sekao, 2023).
- post-lesson reflection should happen in the classroom where the lesson was taught so that the presenter and the observers can reflect on the exercises that should still be visible on the board "*bansho*" (Tan, 2021).
- a lesson observation tool that was used during the lesson presentation must be used or referred to focus on the reflections on what was recorded during the lesson observations to avoid comments from other observers, which could be based on what prior observers have mentioned rather than on what the observer witnessed in the classroom.
- it is recommended that all other teachers also reflect as if they were part of the lesson, focusing on lesson delivery and the learners' participation as they take ownership of their research lesson, which was planned collectively.
- reflections must not be generic or personal but instead should focus on real learning and the mathematics that happened or did not happen during LS's lesson presentation and observation stages.
- reflections must be developmental and provide new teaching strategies to maximise learners' participation, while critical reflection should be the guiding principle.

6.3 LEARNING EXPERIENCES GAINED FROM POST-LESSON REFLECTION

In this section, I discussed findings related to SRQ2, which stated: What learning experiences do mathematics teachers gain from post-lesson reflection in LS?

One of the benefits teachers encountered during the learning experiences was improved teaching methods. An investigative method was deemed appropriate in one lesson because the teacher used a narrative to derive a general rule. Hence, teachers learnt how to select teaching methods appropriately. In another lesson, the presenter consistently used the “question-and-answer” method to solicit responses from learners and encourage them to participate so they could understand numeric patterns.

What the teacher did regarding the “questions and answer method” reflected the characteristics of *neriage*. Natan Jr. and Ishii (2023) stated that how teachers facilitate a problem-solving session in mathematics classrooms with their learners is important for developing their thought processes. For most teachers, such discussions might derail their lessons for teachers engaging in LS, so they should carefully consider options when selecting problem-solving exercises. The implication for teachers is that they should ensure that relevant problem-solving exercises will ignite thoughtful discussions and deepen the learners’ understanding of mathematical concepts. Serious consideration is also needed when selecting appropriate teaching methods in which certain mathematics content, like numeric patterns, is brought up, where they then land themselves, which is investigative.

The data from teachers’ observation tools revealed the importance of mathematical connections. Teachers reflected that the presenter did exercises during the introduction using prior knowledge to link the content by relating types of triangles to the concept of the exterior angle of a triangle that would soon be taught. In another

instance, I observed that the presenter used a real-life context of the words “entrance” and “exit” in hospitals so that the learners could understand the concept of the exterior angle of a triangle. Another benefit teachers acquired in this study was how they organised their teaching activities on the board to depict a logical flow in conceptual ideas as the lesson progressed from the introduction to the main presentation. In Japanese, this organisation method is called *bansho* (Tan, 2021).

In the lesson dealing with deriving the rule for numeric patterns, the teacher revised the addition and subtraction of integers during the introduction. This was necessary since learners needed to learn to deal with negative numbers, which they struggled with, to extend the numeric pattern and derive the rule. This benefit was evident because learners were assisted with remembering what they needed to do and making connections because there was a logical flow of the lesson events on the board. The way the teacher derived the rule shows a logical flow from Term 1, Term 2, Term 3, and so forth until learners could generalise the rule.

The other advantage was that learners could see the connections between different parts of the lesson and the progression of the lesson. One lesson started by discussing the types of triangles and proceeded to the concept of the sum of angles in the triangle. Then, the exterior angle of a triangle was discussed, which was the lesson's topic. This was necessary as part of conceptual development for the learners. The implications for teachers are that, as far as possible, activities for prior knowledge should be planned carefully to assist learners with understanding tougher concepts and that making connections between mathematical concepts and contexts is necessary to assist learners with assimilating and accommodating a new concept (Piaget, 1976).

Teachers' learning about learners' thinking was evident as learners displayed and explained their solutions on the board. Teachers learnt that learners could present their solutions in various ways to learn from each other and make connections between concepts and their perceptions of mathematical facts (Idris, 2005). Moreover, learners' thought processes were challenged and developed through adopting the teacher's questions and methods.

In another lesson, the teacher asked learners to give the size of the last angles in two triangles by inspection, which learners were able to do easily since they knew that the sum of the angles of a triangle added up to 180^0. Shimizu and Kang (2022) highlighted the value of observing learners' thinking from their written exercises, thus offering teachers an opportunity to find ways to assist their learners. The implications for teachers would be to learn how to create an enabling environment for learners to be involved in a lesson through carefully choosing exercises and then allowing learners to present their solutions.

Teachers' learning experiences gained from post-lesson reflection were critical. Olteneanu (2017) explained that reflective teaching involves examining one's philosophy about teaching and learning and how this philosophy applies to actual classroom practice before, during, and after the lesson. In Australia, Widjaja et al. (2017) discovered that post-lesson reflection assisted teachers' PD by developing collaborative planning skills, paying attention to learners' thinking, and finding new ways to manage whole class discussions.

6.4 THE USE OF INFORMATION FROM LESSON OBSERVATION ON POST-LESSON REFLECTION

In this section I discussed findings related to RQ3, which states: How does the information mathematics teachers collect during lesson observations inform their post-lesson reflection?

In this part of the discussion, I revealed how the information from lesson observations helps inform post-lesson reflection. During the interview, teachers must reflect on the importance of lesson objectives and the introduction as a springboard to connect prior knowledge to new content. Iskandar and Suratno (2010) explained that the ability of mathematics teachers to engage in meaningful post-lesson reflection after lesson observations would offer more opportunities for PD among them and gain improved learning from their learners. Furthermore, Myers (2012) found that observations were worthwhile experiences to prepare teachers to recognise and identify key teacher and learner behaviours in the learning environment. In line with Widjaja et al. (2017) and Myers (2012), in my study, teachers ensured that lesson objectives as a guiding tool were relayed to the learners during the introduction. Teachers seemed to understand that achieving objectives would reveal the lesson's success and that learners needed to focus on the lessons' objectives. Moreover, stating the objectives was necessary since what the presenter did for learners to achieve them would be reflected upon during post-lesson objectives. Hence, lesson observations provided a platform to build upon and authenticate reflections based on observed evidence in preparation for post-lesson reflection. Teachers must focus on activities that will make the lesson successful by sticking to the objectives, using the introductory activities to guide the latter activities sequentially, and creating a logical flow.

Teachers reflected on the lesson presentation that learners were investigating angles by measuring with a protractor on a given worksheet; thereafter, learners had to present their solutions on the board and justify their answers by giving reasons. Also, the teacher engaged learners in a practical demonstration in which the learners had to come to the board and paste cut-out angles inside the triangle. Through trial and improvement, learners had to determine which angle fits onto which vertex. After engaging in this activity, all learners eventually realised that, indeed, angles inside the triangle added up to 180^0. Myers (2012) observed that lesson observations have the potential to be powerful tools for facilitating teacher growth.

This growth included increasing content knowledge and understanding of curriculum, methodology, and learning by learners and developing critical observations and post-lesson reflection habits. Posthuma (2012), in her research, focused on reflecting on the videos the teachers had taught. When the videos were played during the reflection session, the challenges experienced pertained to how teachers would not reflect on their lessons. Teachers were not aware that their teaching and managing of lesson events was counterproductive. The situation was when the learners could not solve a linear equation, and the teacher asked other learners to assist, only to confuse the entire class. When the teacher reviewed her actions, she realised she could have done better, and the process of post-lesson reflection empowered all the teachers in the study. The implication is that teachers should continuously reflect on their actions after presenting a lesson and regularly engage in post-lesson reflection so that if they create misconceptions, they can eradicate them with their learners. Moreover, reflecting on learners' reactions during the lesson could alleviate unintended outcomes of causing misconceptions.

6.5 TEACHERS' USE OF POST-LESSON REFLECTION TO IMPROVE THEIR TEACHING PRACTICE.

In this section I discussed findings related to SRQ4, which states: How do mathematics teachers use their learning experiences to improve their teaching practice after conducting post-lesson reflection in LS?

The benefits of reflecting on how learners respond to different teaching methods were indicated. Teachers recorded that reflecting on how the lesson was taught in one class would affect how the same lesson would be taught in another. Reflecting on different teaching methods about how the lesson could have been improved, such as developing learners' investigative skills, was one of the benefits of engaging in post-lesson reflection. It became evident that critical reflection was a skill that was needed among teachers to assist in improving their teaching methods. For example, teachers suggested strategies to teach Geometry, including making sketches to explain concepts. Furthermore, learners insisted that they write a geometric statement, that a reason was critical for making justifications, and that the proper use of the additive inverse rather than "transposing" was highlighted.

One of the seven characteristics of effective PD, as suggested by Darling-Hammond et al. (2017), is that it must be content-focused and should incorporate active learning supported by collaboration. In my research, teachers focused on the content of teaching Geometry, which is often problematic for both learners to learn and teachers to teach. In this post-lesson reflection session, teachers used their knowledge base and experiences to aid their learning. This means that adult learners are much better suited to direct their learning, as Darling-Hammond et al. (2017) revealed. Another important observation through this reflective practice by teachers was that their PD

was job-embedded. LS reflections happened among individual teachers within their school contexts so they could better implement the new teaching strategies they had discussed quickly.

In my study, teachers learnt that reflecting had benefited them in collaborating to improve their teaching. There was PD through their critical viewpoints about the new strategies or methods. Teachers acknowledged that one of the affordances of doing post-lesson reflection was that they could share teaching ideas that led to their PD.

Lim-Ratnam et al. (2019) asserted that LS is acknowledged extensively as an effective engagement for teachers as active learners for their PD. Furthermore, Sekao and Engelbrecht (2021) also discovered that during post-lesson reflection, teachers discussed improving their mistakes regarding lesson presentation. It was also evident that teachers realised the value of post-lesson reflection, especially in noticing how other teachers taught the lesson differently than they would and identifying where the lesson could have been improved.

The implication for teachers is that they could take responsibility for their own PD, which should occur within the school setting, especially through LS, rather than attend workshops outside their environment. Hence, strengthening systems to cultivate PD within schools, such as institutionalising LS as a TD model in education departments, is essential.

Regarding lesson improvement, teachers learnt to manage activities differently, i.e., by giving different groups of learners different activities on the worksheet to complete. The teacher thought doing so would increase learners' interests when one group presented a solution to an activity different from theirs.

One lesson was to be improved by catering to investigative activities that encourage learner thinking. It was evident that teachers' learning during post-lesson reflection would be incorporated into their teaching based on the ideas they had reflected upon.

For example, one of the lessons needed to be practical for learners and teachers should use concrete objects to assist their learners in understanding the mathematical concept of the exterior angle of a triangle. Shuilleabhain and Clivaz (2017) explained that one of the benefits of doing LS was that it allows teachers to engage in conversations, as in post-lesson reflection, as if they were the learners and begin to think about mathematics from the learners' perspective. The implication for teachers is to develop learner-centred, investigative, and practical lessons.

6.6 FACTORS HINDERING TEACHERS' REFLECTIVE PRACTICE IN LESSON STUDY AND TEACHERS' PROPOSED SOLUTIONS

In this section I discussed findings related to SRQ5, which states: What factors, if any, hinder mathematics teachers' reflective practice in LS?

Hindrances to reflections implies challenges that teachers encounter, which prevent them from reflecting on their lessons, such as the lack of time and support from school managers (Jaeger, 2013). The findings in my study confirmed that teachers were still not able to engage in meaningful reflection during post-lesson reflection; they were apprehensive and fearful of negative comments that their colleagues might reflect about, which could expose their inefficiencies in teaching (Ningsih & Lengkanawati, 2023).

In the study by Sekao and Engelbrecht (2022), teachers reflected on minor mistakes made by the presenter during the lesson and not on the teaching of

mathematics. Furthermore, it was discovered that some of the teachers' comments when engaging in reflective practice during post-lesson sessions in LS were personal and did not focus on the lesson improvement and learners' thinking. The hindrance of not reflecting effectively among teachers in my study was due to the lack of confidence since they feared what others might say about their teaching. Teachers were unsure about their teaching abilities when presenting their lessons to their colleagues because they lacked confidence.

Since LS is a TD model, low teacher confidence is increased due to collegial efforts when teachers assist one another to improve confidence in themselves (Kimberly, 2002). This means that teachers should take advantage of being in a social setting where they are assisted to develop their confidence and overcome the fear of being judged or looked down upon. The challenge of low teacher confidence was also noted in the study by Mon et al. (2016), where teachers' lack of confidence was due to insufficient content knowledge and teachers' discomfort when being observed while teaching. Mon et al. (2016) indicated that the lack of teacher confidence among teachers practising LS should be a compelling reason for them to participate in LS because, in LS, they will be supported through collaborating with other teachers at every stage of the LS cycle.

As seen in the previous paragraph, further hindrances regarding reflection included inferiority complex issues. Teachers stated they were unwilling to be seen as lacking mathematical concepts. Again, this assertion was due to their lack of confidence, which can also be attributed to their low self-efficacy. Schunk and DiBenedetto (2016) defined self-efficacy as the belief about an individual's competence to complete a given task successfully. Since self-efficacy can affect teachers' educational

experiences, the implication for teachers practising LS is that their participation is meant to develop their confidence and not the opposite.

In my study, teachers stated that they were not used to reflecting since it was not required. This hindrance was also experienced by Iskandar and Suratno (2010) in Indonesia, where teachers perceived LS as a new concept required for their PD and found it boring. The inference from this hindrance is that unlike in Japan, LS is not institutionalised in most countries (Lim-Ratnam et al., 2019). Ono and Ferreira (2010) also alluded to the fact that some of the challenges emerging from the implementation of LS in the province of Mpumalanga in SA were systemic because LS was not institutionalised in the education system of SA.

The lack of time was one of the hindrances to reflection since teachers were always busy after school and would be too tired to engage in extra activities. This hindrance of time was because post-lesson reflection in LS was not accommodated as part of the school's timetable. The lack of time as a hindrance to reflection was experienced in SA in the study by Adler and Alshwaikh (2019), where teachers often did not have time to engage in post-lesson reflection. Adler and Alshwaikh (2019) inferred that this happened because teachers were least interested in openly discussing their classroom practices and finding possible improvement solutions. A study conducted in Malaysia by Mon et al. (2016) also identified time constraints and teachers' workload in teaching many classes that affected their participation in LS.

The implication for school managers is to institutionalise PD through LS, which encourages post-lesson reflection. This will address the time issue because individual schools will allocate dedicated time for LS sessions, and teachers will not have to engage in post-lesson reflection during their time. Possible solutions teachers

mentioned to deal with the hindrances to post-lesson reflection included being open to positive criticism and needing to improve by allowing others to observe one's teaching and give constructive feedback. Other general methods of reflecting that teachers mentioned outside of LS were that teachers could use an assessment to gauge learners' understanding after having taught them, then through learner activities and learner demonstrations on the board in which the teacher can then intervene where learners are struggling, that is, *reflection-in-action* as explained by Gutierez (2015).

Though these reflection strategies were suggested, in my study, teachers preferred post-lesson reflection in a LS context, a social setting wherein other teachers can suggest development and lesson improvement. Hence, during my interview sessions, it was encouraging to note that teachers were willing to conduct post-lesson reflection, even if it could be once a month, offering sustainable PD within the school.

My study confirmed that although teachers could benefit from post-lesson reflection, hindrances to reflection still existed. Some hindrances were beyond the teachers' scope since reflecting in LS was not yet institutionalised as part of the school timetable or regular event (Lewis & Perry, 2014; Fujii, 2014). My study also revealed that even though teachers can be willing to engage in post-lesson reflection, they cannot organise these sessions because they have full teaching loads of teaching periods at school. Hence, by the end of the day, they are too exhausted to hold yet another meeting in which, after observing one of their colleagues teach a lesson, they can reflect on it. As a possible solution to this challenge, the involvement of higher authorities within the school, such as the SMT or even the district officials, could assist

in ensuring that an enabling environment is created at schools for teachers to reflect on their lessons as a collective and subsequently be responsible for their own PD.

6.7 UTILITY OF THE FRAMEWORK

My study focused on the post-lesson reflection stage of LS in which teachers reflected on the lessons as a collective, meaning that the process of reflecting was within the social setting. This social setting made the Social Constructivist Theory more appropriate because the social environment created a context for teachers to develop and learn. In my study, as teachers collaborated by reflecting on the lessons taught, they could give comments, analyse, and evaluate specific actions during the lessons to develop themselves.

Coupled with this social setting created by Vygotsky's Social Constructivist Theory, Gibbs' Reflective Cycle provided me with a structured method of viewing teachers' reflections during the post-lesson reflection stage of LS. The stage of post-lesson reflection resonated more with Vygotsky's Social Constructivist Theory, in which teachers constructed knowledge by learning from each other using learners' responses and the presenters' methodologies. The structured approach for doing reflection, as guided by Gibbs' Reflective Cycle, offered a reliable strategy of viewing teachers' reflections as descriptions, feelings, evaluations, analyses, conclusions, and action plans.

As I observed teachers, these stages were evident; however, in my research, combining the descriptions and feelings to form one stage was necessary because teachers' feelings were based on what they described. Similarly, the stages of *evaluation* and *analysis* could form one stage because teachers gave an analysis of what they had evaluated. Finally, the *conclusion* and *action plan* stages were

combined into one stage because as teachers concluded the reflections, they also suggested changes for future lesson presentations (see Figure 6.2).

6.8 CONTRIBUTIONS OF THE STUDY

I have stated from research by various researchers, in Chapter 1, that teachers do not reflect on their practice except in the context of LS in which provision is made to allow for reflection (Adler & Alshwaikh, 2019; Posthuma, 2012; Pretorius & Ford, 2016, and Widjaja et al., 2017). However, even within the context of LS, there is very little guidance for reflection during post-lesson reflection (Burleson & Chipidza, 2017; Posthuma, 2012; Sekao & Engelbrecht, 2022). My study has revealed learning experiences, how teachers improve teaching, and strategies for engaging in post-lesson reflection within LS. Through the findings from my study, teachers will be afforded an opportunity for PD in teaching mathematics through the collaborative efforts of LS. They will be shown how to engage in *critical reflection* as normal practice. To solve the challenges regarding teachers not engaging in reflective practice, I have consulted the reflective model by Terry Borton, which includes three stages: the what, so what, and now what (Grant et al., 2017). Terry Borton used these stages as a group facilitation technique and created the what, so what, and now what model of reflection in the 1970s before it was well-known as a reflective tool for clinical healthcare practitioners in the 1980s (Abadi et al., 2022; Grimmer, 2022; Hurst, 2020; Grant et al., 2017). It has become a simple and effective reflective learning and communication technique. Driscoll later incorporated it, who summarised his 7-step reflective model in line with Terry Borton's original model (Dharmasaroja, 2024). Driscoll (2007) lists the following 7 steps for reflection:

1. Action - a learning encounter to reflect on.

2. Reflection: ***What?*** A person or teacher explains the lesson.
3. Action - reflecting on relevant lesson events.
4. Reflection: ***So what?*** Gaining more understanding about why certain reactions happened during the lesson.
5. Action - recognising that learning happens through reflection.
6. Reflection: ***Now what?*** Based on the understanding, an individual will formulate actions for improvement.
7. Action – applying new ideas in the next lesson (during the next time the same concept is taught).

This model has subsequently become known as the Driscoll model of reflection. I am not suggesting that Driscoll's model of reflection be used in its 7 steps because it lacks the elements of Gibbs' Reflective Cycle, such as feelings, evaluation, or conclusion, though it has an action plan. In my study, I found it important for teachers reflecting in LS to state their feelings about their teaching experiences. Hence, due to the findings in my study, I also do not suggest that Gibbs's reflective model be used in its current form.

This is because as the teachers began the post-lesson reflection sessions, they also stated their feelings in the same breadth when they described the lesson. I must mention that I did not tell the teachers how to reflect on Gibbs' Reflective Cycle. I was the only one viewing their reflections regarding Gibbs' Reflective Cycle. They also analysed and evaluated the lesson events simultaneously. May I again stress that they were unaware that I was verifying their next part of the reflection regarding analysis and evaluation? Hence, I could infer that as they analysed a lesson event, they also evaluated it and were critical in determining what caused it and its possible

solution. The final remarks of the teachers were about lesson improvement, in which they listed actions for teaching the lesson in better ways. Hence, these six stages of Gibbs can be paired, as seen in the suggested model of reflection in Figure 6.2 and the explanation I have given.

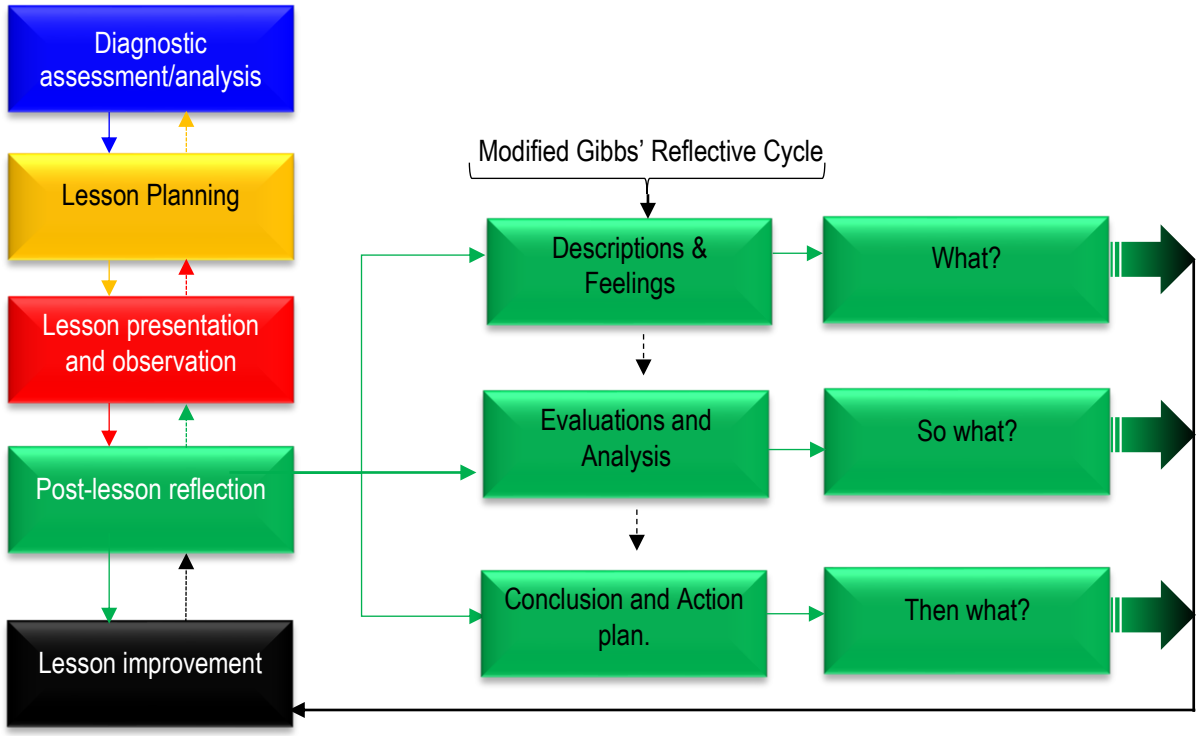
As suggested, Figure 6.2 presents a new model for reflection for teachers; I am proposing that from the stages of Gibbs's reflective cycle, the stages of *descriptions* and *feelings* be combined and renamed the "*what*" stage. Similarly, the *evaluation* and *analysi*s stages are combined as one and are called the "so what" stage with an element of critical reflection (Gutierez, 2015). This means that teachers will not just describe what happened but reflect on their observations, identify what was significant about it and then determine what they should do next. Finally, the stages of *conclusion* and *action plan* could be combined and be referred to as the "*then what*" stage of reflection. Though the words "now" and "then" convey a similar meaning, using the word "then" in the context of reflection would mean what should happen *after* an action has taken place, that is, the past tense of the word "now" (Peter, 2013). My proposed model for reflection can be subjected to further research to explore its effectiveness and practicability.

The reflection framework in the LS can be explained as follows:

(a) The "what" stage

This stage refers to the current observations of what happened in the classroom, where teachers identify challenges and lessons' successes. It is a simple description of events experienced by the teacher and their feelings.

Figure 6.2.5 *The proposed reflection framework in Lesson Study*



(b) The "so what" stage

This stage would include analysing what happened and judging or evaluating its effect during the lesson, whether positive or negative. Teachers will also be critical about how certain concepts could have been taught differently to achieve better outcomes.

(c) The "then what" stage

This would be a concluding stage of reflection, which incorporates an action plan in which teachers decide on a way forward regarding implementing the possible solutions or strategies for teaching or improving the lesson next time. These three steps consolidate Gibbs' Reflective Cycle, a simplified version of reflection that would encourage teachers to reflect effectively and improve their teaching practice in LS. As

teachers follow the South African model of LS, they will use this proposed model of reflection when they come to the post-lesson reflection stage after observing a lesson.

6.9 LIMITATIONS OF THE STUDY

This section contains limitations I encountered in my study. Firstly, this study was conducted in Grade 9 at a secondary school practising LS. Though the findings of my study can be used in most school settings, applying these findings might need a few adjustments. Thus, the context of my study might be limited to schools that do not practise LS. Secondly, during my data collection, I noticed that I could have used unstructured interviews so that I did not always have to ask questions from the list I had already made.

Thirdly, in my study, teachers reflected superficially during the initial lesson interviews. Hence, I could have taken them through guidelines on how to reflect mathematically with a critical perspective. Fourthly, I was collecting data mainly from the lesson observations and post-lesson reflection stages of LS; therefore, had I also focused on the diagnostic stage, I would have verified the real challenges that teachers had in teaching the topics that were presented and thereby come up with further suggestions on how to teach these topics successfully. However, my study focused on post-lesson reflection irrespective of the topic. Lastly, I should have used a questionnaire to ascertain further learning experiences from teachers after engaging in post-lesson reflection and investigate further hindrances to reflection.

6.10 RECOMMENDATIONS

It is recommended that irrespective of which stage of LS one focuses on, one must be part of the entire LS cycle. This will assist in understanding the challenges regarding

the topic used to plan a research lesson. Even though my study focused on the fourth stage of the LS cycle, which can be done on any topic, it will be necessary to generate findings on improving the teaching of those topics I was engaged in during post-lesson reflection. My study was cross-sectional and time-bound as I only collected data over a short period, i.e., five days. However, there is a need for a longitudinal study to assist teachers in being consistent with post-lesson reflection to improve their teaching.

It is highly recommended that policy relating to TD models in SA consider the LS prescripts regarding post-lesson reflection. Through this, teachers will engage in common lesson planning as they reflect on new methodologies to improve teaching and learning. Otherwise, the teachers will continue attending workshops in which the departments will have no certainty of their impact on the teaching of the learners, even as learners' mathematical performances remain low, especially in Grades 8 and 9.

6.11 REFLEXIVITY

I became interested in LS as a model that can be used for teachers' PD in a PLC setting at school and district levels. As an educational official, my work is to organise workshops for teachers. However, we often question the effectiveness and the implementation of these workshops at the school level if they can assist teachers' PD, especially in improving their methodologies in teaching mathematics. Hence, I was motivated to pursue my studies because I wanted to make a valuable contribution to teachers' PD that would be sustainable and cost-effective for the department.

I decided to select a school that was practising LS. Moreover, the schools could not have denied me access because I am an official of education in the province. Hence, I acknowledge my bias in selecting the school and the SP since I coordinate district officials in this phase. When I started my study, it was exciting to encounter research

literature relevant to my chosen topic. This motivated me to construct my problem statement immediately. However, as I was starting to engage myself further, there were many challenging aspects from time to time that almost made me give up as I could not see myself overcoming them. These aspects included the research proposal, the theoretical framework, and the research methods. While I need to get the qualification as a professional, the journey for my study was very educational and transformational in gaining more understanding of research issues and methods. I have also gained more knowledge regarding LS's prescripts, which I hope will land itself in many schools, teachers and classrooms in the province of Gauteng.

6.12 CONCLUSION

In this chapter, I have answered the primary research question by answering the SRQs that dealt with Mathematics Teachers' Reflective Practices and teachers' learnings. These included that teachers should reflect in the classroom in which the lesson was taught, that the first teacher to reflect should be the one who presented the lesson, and that reflections must be specific to the mathematics concepts taught. The learning experiences gained by teachers when conducting post-lesson reflection involved choosing appropriate teaching methods. Teachers should be aware that they can create misconceptions and should be conscious of the language and phrases they use when explaining concepts or procedures. I have observed that through the question-and-answer method, the teachers could solicit responses from learners and have learners clarify what they meant when answering questions to guide their thinking appropriately.

The link between the information collected during lesson observations and post-lesson reflection was critical for teachers to report and record lesson events in the manner

they witnessed so that they can critically reflect on them and state areas of improvement the next time the lesson is taught. Hence, the benefits of engaging in post-lesson reflection collaboratively were important for teachers as it allowed them to develop one another, do introspection, and check for mistakes to prevent them from occurring in the next lesson.

On the other hand, hindrances to post-lesson reflection were prevalent, and learners suggested that teachers might be afraid of being criticised or sharing their skills in front of other teachers, probably because they sometimes felt inadequate in teaching a subject or a particular mathematics topic. They also felt that being observed by other experts could be uncomfortable, as it felt as if learners were being judged. As stated by the teachers, one possible solution to these hindrances was to be open to positive criticism, which could allow them to improve through receiving constructive feedback.

I have summarised the overall responses to research questions thus: in relation to SQR1 (How do mathematics teachers conduct post-lesson reflection?) generally teachers follow a structural format of doing reflections, however superficially. In relation SQR2 (What learning experiences do mathematics teachers gain from post-lesson reflection in LS?) teachers reflect on pedagogical and content knowledge as part of their learning experiences. In relation SQR3 (How does the information mathematics teachers collect during lesson observations inform their post-lesson reflection?) it was discovered that teachers conduct post-lesson reflection based on the observation tool to gauge the achievement of the lesson objectives. In relation to SQR4 (How do mathematics teachers use their learning experiences to improve their teaching practice after conducting post-lesson reflection in LS?) teachers benefit in doing post-lesson reflection regarding especially how learners respond to different

teaching methods which leads to their understanding and lesson improvement. In relation to SQR5 (What factors, if any, hinder mathematics teachers' reflective practice in LS?) although teachers demonstrated a fair understanding of conducting reflection, there were hindrances regarding the quality of their reflections which lacked mathematical rigor.

The use of the two theoretical frameworks proved worthwhile. What was significant was my study's contribution to the body of research regarding the model of reflection that should be used in the fourth stage of the LS in SA so that teachers could reflect easily and effectively.

One limitation of my study was that I could have used the unstructured interview setup to ask different questions each time. A questionnaire could have assisted learners with getting further data from the teachers. I recommend that such studies be longitudinal so that LS, especially the post-lesson reflection sessions, could be sustainable at schools to offer progressive PD. Another recommendation is that TD in the SA should assume the LS stages so that teacher training can happen at the school level. Finally, my study's reflexivity revealed that I had learnt valuable information. However, a few biases were evident in the school selection when I captured data regarding the lessons' grades.

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ANNEXURES

ANNEXURE A: Classroom Observations Tool

CRITERIA
Collaborative lesson planning and reflection-in-practice took place. Changes were made to the lesson plan while teaching. SRQ 2
Different methods that teachers use to do lesson observations during lesson presentations. SRQ 3
Capturing of lesson observations and learner responses. SRQ 3
Observations were made on the lesson introduction, prior knowledge, and resources used to explain the current topic to learners. SRQ 2
Comments on classwork activities were given. Comment on classwork completion. SRQ 2
Lesson conclusion activities. SRQ 2
Verification by the presenting teacher is needed to ensure the lesson objectives are met. No changes were made to the lesson plan during the lesson presentation. SRQ 2, 4 &5
General comments

ANNEXURE B: Observation Sheet for Reflections

a) The strategies teachers use to conduct post-lesson reflection in mathematics. *Description*
b) Learning experiences gained by teachers during post-lesson reflection. *evaluation*
c) The link between the information collected during lesson observations and post-lesson reflection. *Evaluation and analysis*
d) The use of teachers' learning experiences after conducting post-lesson reflection to improve their teaching practice. *Conclusion and action plan*

ANNEXURE C: Semi-Structured Interview Protocol (SRQ 5)

1	Are mathematics teachers willing or unwilling to reflect on their lessons after delivering them in LS? Why?
2	Can you explain what benefits, if any, exist for both learners and teachers in engaging in reflective practice?
3	What challenges hinder mathematics educators from engaging in reflective practice within LS?
4	In your understanding of reflective practice and the benefits thereof, how can the above challenges be overcome?
5	How can teachers' reflective practices be enhanced to improve their classroom practice?
6	Can reflection be a teacher's normal daily practice in teaching mathematics? Explain.
7	Which types of reflective practices could be beneficial for teachers? Explain.

ANNEXURE D: Alignment of Key Aspects

	Research question	LS stage	Theoretical framework	Data collecting tool
1	How do teachers conduct post-lesson reflection in mathematics? (Are they reflecting by themselves while I observe?)	Post-lesson reflection	Vygotsky's S.C. - environment Gibbs' R.C. – description stage	Lesson observations (lesson transcript) Document analysis (teachers' LS observation tools) Annexure E Post-lesson reflection session (Transcript) Semi-structured interview
2	What learning experiences (benefits) do teachers gain during post-lesson reflection?	Post-lesson reflection	Vygotsky's S.C. – learning arises from interactions Gibbs R.C. – evaluations and analysis	Post-lesson reflection session (Transcript) Lesson observations (lesson transcript) Document analysis (teachers' LS observation tools) Annexure E Semi-structured interview
3	How does the information collected during lesson observations inform post-lesson reflection?	Lesson presentations and observations	Vygotsky's S.C. – interdependency, ZPD Gibbs R.C. – analysis and evaluation	Post-lesson reflection session (Transcript) Lesson observations (lesson transcript) Document analysis (teachers' LS observation tools) Semi-structured interview
4	How do teachers use their learning experiences to improve their teaching practice after conducting post-lesson reflection?	• Post-lesson reflection • Lesson improvement	Vygotsky's S.C. - ZPD Gibbs R.C. – analysis, evaluation and conclusion	Post-lesson reflection session (Transcript) Semi-structured Interview
5	What factors, if any, hinder mathematics teachers from engaging in reflective practice within LS?	Post-lesson reflection	Vygotsky's S.C. – learning arises from interactions. Gibbs R.C. – evaluations and analysis	Semi-structured Interview

ANNEXURE E: Teachers' Mathematics Lesson Observation Sheet for Lesson Study

(Teacher's tool/instrument)

OBSERVER'S NAME: _____

OBSERVER'S INSTITUTION:_____

DATE OF LESSON PRESENTATION/OBSERVATION: _____

Name of lesson presenter:	
Name of school Where the lesson is conducted	
Grade:	
Topic:	
Lesson objective/s	
Duration of the lesson	

		Yes	No	Comments/Motivation
Introduction	Learners' interest in the topic was stimulated. Motivate your observation.			
Objective	Was presented to learners			
	Were aligned to the curriculum			
	Was grade-appropriate			
Lesson Presentation	Learners were actively and meaningfully engaged in the lesson.			
	Sufficient time was given to learners to think, discuss and respond individually, in pairs or groups. (Give practical scenario)			

	Learners were asked to justify their answers where necessary. (Give practical and observed scenario)			
	Learners provided solutions to demonstrate their understanding (You may provide a snapshot)			
	When learners worked in small groups, pairs, or individuals, the teacher moved around to offer support and strategically identify responses to be placed on the board for discussion.			
Conclusion	The lesson was wrapped up by emphasising key issues related to the objective(s), e.g., Multiples, equivalence, etc.			
	Most learners achieved the lesson objectives. Motivate your observation, e.g. talk about the solution to the problems given.			
Field Notes				

ANNEXURE F: University of Pretoria Approval Letter

Make today matter

FACULTY OF EDUCATION
Ethics Committee

Amendment

23 June 2023

Dear Mr DS Maphanga

The application for ethical clearance for the research project described below served before this committee on 21 June 2023 :

Ethics Protocol No:	**UP 19/03/01 SEKAO23-03**
Principal investigator:	**Mr DS Maphanga**
Student/Staff No:	**22821831**
Degree:	**Doctoral**
Supervisor/Promoter:	**Dr RD Sekao**
Department:	**Science Mathematics and Technology Education**

The decision by the committee is reflected below:

Decision:	**Approved**
Comments:	
Period of approval:	**Three years**

The approval by the Ethics Committee is subject to the following conditions being met:

1. The research will be conducted as stipulated on the application form submitted to the Ethics Committee with the supporting documents.
2. Proof of how you adhered to the Department of Basic Education (DBE) policy for research must be submitted where relevant.
3. In the event that the research protocol changed for whatever reason the Ethics Committee must be notified thereof by submitting an amendment to the application, together with all the supporting documentation that will be used for data collection namely; questionnaires, interview schedules and observation schedules, for further approval before data can be collected. The changes may include the following but are not limited to:
    - Change of investigator,
    - Research methods any other aspect therefore and,
    - Participants.

The Ethics Committee of the Faculty of Education does not accept any liability for research misconduct, of whatsoever nature, committed by the researcher(s) in the implementation of the approved protocol.

Best wishes

Prof Funke Omidire
Chair: Ethics Committee
Faculty of Education

Room 3-63, Level 3, Aldrel Building
University of Pretoria, Private Bag X20
Hatfield 0028, South Africa
Tel +27 (0)12 420 5858
Email edu.ethicsadmin@up.ac.za
www.up.ac.za

Faculty of Education
Fakulteit Opvoedkunde
Lefapha la Thuto

ANNEXURE G: Gauteng Department of Education Research Request and approval Form

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	**15 August 2023**
Validity of Research Approval:	**08 February 2023– 30 September 2023** **2023/337**
Name of Researcher:	**Maphanga DS**
Address of Researcher:	**4 Flathner**
	Roodepoort /Witpoortjie
Telephone Number:	**079 340 6191**
Email address:	**Dumisani.maphanga@gauteng.gov.za**
Research Topic:	**Mathematics Teachers' reflective practices through lesson study**
Name of University:	**University of Pretoria**
Type of qualification	**PhD**
Number and type of schools:	**1 Secondary School**
District/s/HO	**Gauteng East**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

15/08/2023

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

1. *Letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. ***Because of the relaxation of COVID 19 regulations researchers can collect data online, telephonically, physically access schools or may make arrangements for Zoom with the school Principal. Requests for such arrangements should be submitted to the GDE Education Research and Knowledge Management directorate.***
4. ***The Researchers are advised to wear a mask at all times, Social distance at all times, Provide a vaccination certificate or negative COVID-19 test, not older than 72 hours, and Sanitise frequently.***
5. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*
6. *A letter / document that outline the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
7. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
8. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
9. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
10. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
11. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
12. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
13. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
14. *On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.*
15. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
16. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

.....

Dr. Gumani Mukaluni

Acting CES: Education Research and Knowledge Management

DATE: 15/08/2023

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

ANNEXURE H: Request for Permission to Conduct Research Study (District Director)

Faculty of Education

Enquiries: Dumisani Maphanga
Email: Dumisani.Maphanga@gauteng.gov.za

District Director
Gauteng East
Corner 7th St & 5th Avenue
Telkom Towers
SPRINGS
1560

Dear Ms E.S. Tshabalala

REQUEST FOR PERMISSION TO CONDUCT RESEARCH STUDY

I am a PhD student at the University of Pretoria, conducting a research study titled **Mathematics Teachers' Reflective Practices Through Lesson Study.** The study aims to explore mathematics teachers' reflective practice through LS. This exploration will be done through gaining insights into how teachers conduct post-lesson reflections in mathematics and teachers' learning experiences during post-lesson reflection. This letter requests your permission to conduct research at Kenneth Masekela Secondary, where GET Phase learners and mathematics teachers will be involved.

This study involves observing teachers while they teach mathematics lessons to learners. I will be a passive participant who will record audio/video and take field notes while the teacher and the learners are engaged in a lesson. I will observe a minimum of three lessons. The lessons will be observed as they appear in the school timetable to avoid any disruption. Teachers will also be audio/video recorded during the collaborative lesson planning, lesson presentation, and post-reflection stages of the Lesson Study cycle.

This research project will also involve semi-structured interviews with mathematics teachers after school hours. The information obtained will be treated with the strictest confidentiality and used solely for this research.

I would also like to request your permission to use the data provided, confidentially and anonymously, for further research purposes, as the data sets are the intellectual property of the University of Pretoria. Further research may include secondary data analysis, and researchers may use the data for teaching purposes. The confidentiality and privacy applicable to this study will be binding on future research studies.

You may contact me, Dumisani Maphanga, at 079 340 6191 or my supervisor, Dr R.D. Sekao, at 012 420 4640 or david.sekao@up.ac.za.

Yours Sincerely

_____

Maphanga D.S.

ANNEXURE I: Request for Permission to Conduct Research Study (Principal)

Faculty of Education

Enquiries: Dumisani Maphanga
Email: Dumisani.Maphanga@gauteng.gov.za

The Principal
Kenneth Masekela Secondary
Gauteng East District

Dear Principal

REQUEST FOR PERMISSION TO CONDUCT RESEARCH STUDY

I am a PhD student at the University of Pretoria, conducting a research study titled **Mathematics Teachers' Reflective Practices Through Lesson Study.** The study aims to explore mathematics teachers' reflective practice through LS. This exploration will be done through gaining insights into how teachers conduct post-lesson reflections in mathematics and teachers' learning experiences during post-lesson reflection. This letter requests your permission to conduct the research in your school, where GET Phase learners and mathematics teachers will be involved. The District Director has granted permission in this regard, and I have attached the permission letter.

If permission is granted, the GET Phase mathematics teachers will be invited to participate in this study by:

a) being observed and audio/video recorded during the lesson study cycle (collaborative planning, lesson presentation, post-reflection stages).
b) availing their collaboratively prepared lesson plan for analysis.
c) being part of an interview session that will be audio/video recorded.

After their parental consent is obtained, the learners will be invited to participate in this study by being observed during lesson presentations. In addition, note that *participation* of the teachers and learners is entirely *voluntary,* and if they agree to participate, I will ensure that the following ethical principles are adhered to:

- *Informed consent:* Teachers' and learners' consent to participate will be based on their understanding of the study's purpose and process, as I would have explained to them.
- *Safety in participation:* The teachers and learners will not be exposed to any risk or harm of any form because they will not be required to deviate from their day-to-day teaching and learning process.
- *Privacy*: The names and the data provided by teachers and learners will be kept confidential and anonymous.

- *Trust*: Teachers and learners will not be deceived or betrayed by the research process or its published findings.

I also request your permission to use the data provided, confidentially and anonymously, for further research purposes, as the data sets are the intellectual property of the University of Pretoria. Further research may include secondary data analysis and use the data for teaching purposes. The confidentiality and privacy applicable to this study will be binding on future research studies.

You may contact me, Dumisani Maphanga, at 079 340 6191 or my supervisor, Dr R.D. Sekao, at 012 420 4640 or david.sekao@up.ac.za.

Yours sincerely

_____ _____

Mr D.S. Maphanga (student) Dr R.D. Sekao (Supervisor)

ANNEXURE J: Request for Permission to Conduct Research Study (Teachers)

Faculty of Education

Enquiries: Dumisani Maphanga
Email: Dumisani.Maphanga@gauteng.gov.za

Dear Teacher

REQUEST FOR PERMISSION TO CONDUCT RESEARCH STUDY

I am a PhD student at the University of Pretoria, conducting a research study titled "Mathematics Teachers' Reflective Practices Through Lesson Study." The purpose of the study is to explore mathematics teachers' reflective practice through Lesson Study. This exploration will be done by gaining insights into how teachers conduct post-lesson reflections in mathematics and teachers' learning experiences during post-lesson reflection. I therefore request you to participate in the study above.

If you agree to participate in my study, you will be requested to:

a) be observed and audio/video recorded during the Lesson Study cycle (planning, lesson presentation, reflection stages).
b) avail the collaboratively prepared lesson plan and monitoring tools for analysis.
c) be part of an interview session that will be audio/video recorded.

The learners will be invited to participate in this study by being observed during the lesson presentation. In addition, note that *participation* of the teachers and learners is entirely *voluntary,* and if they agree to participate, I will ensure that the following ethical principles are adhered to:

- *Informed consent:* Your consent to participate will be based on your understanding of the study's purpose and process, as I would have explained to them.
- *Safety in participation: You will not be exposed to any risk or harm of any form because you will not be required to deviate from your day-to-day teaching process.*
- *Privacy: Your names and the data you provide will be kept confidential and anonymous.*
- *Trust*: You will not be subjected to deception or betrayal in the research process or published findings.

I also request your permission to use the data provided, confidentially and anonymously, for further research purposes, as the data sets are the intellectual property of the University of Pretoria. Further research may include secondary data analysis and use the data for teaching purposes. The confidentiality and privacy applicable to this study will be binding on future research studies.

You may contact me, Dumisani Maphanga, at 079 340 6191 or my supervisor, Dr R.D. Sekao, at 012 420 4640 or david.sekao@up.ac.za.

Yours sincerely

_____ _____

Mr D.S. Maphanga (student) Dr R.D. Sekao (Supervisor)

ANNEXURE K: Request for your Child's Participation in the Research Study (Parents)

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Education

Enquiries: Dumisani Maphanga
Email: Dumisani.Maphanga@gauteng.gov.za

Dear Parent

REQUEST FOR YOUR CHILD'S PARTICIPATION IN THE RESEARCH STUDY

I am a PhD student at the University of Pretoria, conducting a research study titled "Mathematics Teachers' Reflective Practices Through Lesson Study." The purpose of the study is to explore mathematics teachers' reflective practice through LS. This exploration will be done by gaining insights into how teachers conduct post-lesson reflections in mathematics and teachers' learning experiences during post-lesson reflection. I, therefore, request your permission to observe mathematics lessons in your child's class.

Note that you are not compelled to grant permission, and your child is also not compelled to be observed; however, if you give me permission, which I will greatly appreciate, I will ensure that the following ethical principles are adhered to:

- *Informed consent:* I will provide any additional information you may need so that you clearly understand the purpose and process of the study I have explained herein.
- *Safety in participation:* Your child will not be exposed to any risk or harm because they will not be required to do anything outside their daily classroom teaching and learning activities.
- *Privacy*: Your child's name and the information generated will be kept confidential and anonymous.
- *Trust*: Your child will not be subjected to deception or betrayal in the research process or its published findings.

I would also like to request your permission to use the data that your child will provide, confidentially and anonymously, for further research purposes, as the data sets are the intellectual property of the University of Pretoria. Further research may include secondary data analysis and use the data for teaching purposes. The confidentiality and privacy applicable to this study will be binding on future research studies.

You may contact me, Dumisani Maphanga, at 079 340 6191 or my supervisor, Dr R.D. Sekao, at 012 420 4640 or david.sekao@up.ac.za.

Yours sincerely

_____ _____

D.S. Maphanga (student) Dr R.D. Sekao (Supervisor)

Dear Mr D.S. Maphanga

LETTER OF CONSENT FOR MY CHILD TO PARTICIPATE IN THE RESEARCH STUDY

I, ……..……, parent of……..……..……, voluntarily and willingly permit my child to participate in the research study titled: **Mathematics Teachers' Reflective Practices Through Lesson Study.** I understand that my child's participation in the study above, to which I am granting permission, will involve being observed during the lessons taught by their teacher(s). I declare that I understand the purpose of the study and that you subscribe to the ethical research principles, including *informed consent, safety, privacy* and *trust.*

In addition, I grant the University of Pretoria permission to use the data provided for this study, confidentially and anonymously, for further research purposes, as the data sets are the intellectual property of the University of Pretoria. Further research may include secondary data analysis and use the data for teaching purposes. The confidentiality and privacy applicable to this study will be binding on future research studies.

Given the above information, I permit my child's participation in the study.

(**Name** and **surname**)	Signature	Date

ANNEXURE L: Invitation to Participate in the Research Study (Learners)

Faculty of Education

Enquiries: Dumisani Maphanga
Email: Dumisani.Maphanga@gauteng.gov.za

Dear learner

INVITATION TO PARTICIPATE IN THE RESEARCH STUDY

I am a PhD student at the University of Pretoria, conducting a research study titled **Mathematics Teachers' Reflective Practices Through Lesson Study.** The purpose of the study is to explore mathematics teachers' reflective practice through LS. This exploration will be done through gaining insights into how teachers conduct post-lesson reflections in mathematics and teachers' learning experiences during post-lesson reflection. I therefore request your permission to observe your mathematics lessons in mathematics.

Please note that you are not forced to grant permission to be observed; however, if you give me permission, which I will greatly appreciate, I will ensure that:

- You fully understand the purpose and process of the study, as I would have explained to them.
- you will not be exposed to any risk or harm of any form since I will observe the lessons during the time reflected on your timetable. Therefore, you will not be required to do anything outside of your day-to-day teaching and learning process.
- your names and the information you provide will be kept confidential and anonymous.
- you will not be subjected to any act of deception or betrayal in the research process or its published findings.
- you may withdraw from being observed at any time without any consequences.

I would also like to ask for your permission to use the data you will provide, confidentially and anonymously, for further research purposes, as the data sets are the intellectual property of the University of Pretoria. Further research may include secondary data analysis and use the data for teaching purposes. The confidentiality and privacy applicable to this study will be binding on future research studies.

You may contact me, Dumisani Maphanga, at 079 340 6191 or my supervisor, Dr R.D. Sekao, at 012 420 4640 or david.sekao@up.ac.za.

Yours sincerely

_____ _____

D.S. Maphanga (student) Dr R.D. Sekao (Supervisor)

Dear Mr D.S. Maphanga

LETTER OF ASSENT TO PARTICIPATE IN THE RESEARCH STUDY

I, ……..……, a GET Phase learner at Kenneth Masekela Secondary, voluntarily and willingly agree to participate in the study titled: **Mathematics Teachers' Reflective Practices Through Lesson Study.** I understand that I will be observed during the lessons as part of the study to which I consent.

I declare that I understand the purpose of the study and that you subscribe to the ethical research principles, including informed consent, safety, privacy (confidentiality and anonymity) and trust, as you explained to me.

In addition, I grant the University of Pretoria permission to use the data provided for this study, confidentially and anonymously, for further research purposes, as the data sets are the intellectual property of the University of Pretoria. Further research may include secondary data analysis and use the data for teaching purposes. The confidentiality and privacy applicable to this study will be binding on future research studies.

Given the above information, I agree to participate in the study voluntarily.

_____	_____	_____
(**Name** and **surname**)	Signature	Date