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Generic and subject-specific professional learning communities in Natural Science

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Generic and subject-specific professional learning communities in Natural Science

MEd

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A dissertation submitted to the Wits School of Education, Faculty of Humanities, University of the Witwatersrand, Johannesburg, South Africa, in fulfilment of the requirements for the degree of Master of Education by Dissertation.

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Abstract

This study explored the extent to which the learning from generic professional learning communities (GPLCs) and subject specific learning communities (SSPLCs) worked together or in isolation from one another to offer professional learning opportunities to teachers in the form of developing pedagogic content knowledge (PCK) that might support instructional change in science classrooms.

The study was informed by Lave and Wenger's theory of situated learning and Dewey's notion of teacher reflection. The research positions teacher learning as being influenced and developed from the relationships that exist between an individual's own actions in relation to those of others within a context. The data was collected over a period of seven months and was in the form of interviews from three Grade 4 teachers, lesson observations and observations of these teachers participating in SSPLCs and GPLCs in one school in Johannesburg. The findings indicate that these two professional learning communities (PLCs) offer the opportunity for teachers to develop generic knowledge (GK) in the GPLC and PCK in the SSPLC. Working together, these two PLCs offer a context for teachers to develop their PCK. The findings further indicate that the PLCs expose the participants to different artefacts and tools which they use to reflect on their practices and promote learning. By engaging with artefacts, the GPLC provides its participants with knowledge of the language of learning to promote discussions in the SSPLC, were discussions around best practices support teacher reflection.

Key words: Generic professional learning communities, Subject specific learning communities, Professional development, Pedagogical content knowledge, Generic knowledge.

Declaration

I, Dhevan Marimandi (0206180P), hereby declare that this research study is my own work. It has not been submitted before for any other degree or examination to any other university. All the work taken directly from other works have been cited accordingly, and the full list of references have been provided. I fully understand that the University of the Witwatersrand will take disciplinary action against me if evidence suggests that this is not my own unaided work or that I failed to acknowledge the sources of the ideas or words in my own writing.



……..

University of the Witwatersrand, February 2022

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To my wife Nitasha and daughter Alisha, I thank you for helping me accomplish my dream. You have been patient and accommodating and have given me the space and time that I needed. Your support provided me with the endurance to complete this journey.

Dedication

I dedicate this Masters Dissertation to my wife, Nitasha, and daughter, Alisha.

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Abbreviations

CFG - Critical Friends Groups

DBE – Department of Basic Education

DHET - Department of Higher Education and Training

DIPIP - Data Informed Practice Improvement Project

FLC - Faculty Learning Communities

GK - Generic Knowledge

GPLC – Generic Professional Learning Community

HOD – Head of Department

ISPFTED - Integrated Strategic Planning Framework for Teacher Education and Development in South Africa

PCK – Pedagogical Content Knowledge

PD – Professional Development

SMK - Subject Matter Knowledge

SSPLC – Subject Specific Professional Learning Community

STLC - Science Teaching Learning Communities

TATT - Thinking about Thinking and Teaching

TD – Teacher Development

TDP – Teacher Development Programme

Chapter 1: Introduction

1.1. The need for instructional reform

Primary school science teaching needs to prepare learners who can work with scientific knowledge in a range of environments. Teachers should create learning environments that are stimulating for learners, allow opportunities for learners to construct meaning and acquire scientific knowledge. Beyond this, education should work towards building social cohesion among diverse and sometimes divided social groups. For countries to remain competitive in the 21st century, education needs to produce learners who feel confident with working in collaborative environments, have a passion for learning and are proficient at facing changes (Chan & Fai Pang, 2006; Williams, Brein & LeBlanc, 2012). Consequently, instructional reforms are increasingly placing emphasis on developing learners who are capable of problem-solving, teamwork, and becoming life-long learners in a complex and interdependent world (Cheng, Chow & Tsui, 2001; Townsend & Cheng, 2000; Williams, Brein & LeBlanc, 2012).

Bantwini (2010) argues that reforms "aim to bring about changes in the education system and in the classroom teaching and learning process" (p. 84). Ono & Ferreira (2010) point out that many schools in South Africa are faced with the challenge of poor-quality teaching, where teachers rely on textbooks, notes or the chalk and talk method as their primary form of instruction which can contribute towards lower learner performance. While this may be the case, one should note that the use of textbooks constitutes crucial parts of the teachers' toolkit that can be used effectively in teaching and learning.

Teachers are restricted by various factors that influence their teaching and learning. These factors include: "the resources made available by their schools and departments; the organizational and institutional constraints in their school situations; and systematic issues such as standardized testing and curriculum developments" (Brodie & Shalem, 2011, p. 2). Even in schools where there is strong knowledge and meaning making, there are increased levels of academic expectations. These expectations come from parents and school management for learners to perform. Instructional changes in such schools are still needed to enable teachers to explore their strengths and weaknesses, to reconsider and redesign their teaching and learning environments so as to benefit all learners as there are still many learners who are not reaching their full learning potential. Many learners see science as a difficult subject. Learners who struggle to understand scientific concepts tend to fall further behind to a point where

"remediation is almost impossible" (Spaull, 2013, p. 6). Good teachers remain current in their expertise on teaching and learning and develop ways to create meaning for an increasingly diverse group of learners. They also create multiple learning opportunities for learners to grow their understanding and knowledge.

Instructional improvement efforts should aim at addressing these issues by focussing on teaching methods that have engaging pedagogy and support learner efforts (Niederhauser, Salem & Fields, 1999). Pedagogy can support learners to be actively involved and engaged in the learning process and support them in integrating "new information with existing knowledge to construct meaning through experience" (Niederhauser, Salem & Fields, 1999, p. 154). To become successful in these learning environments learners should be given equal opportunities and the necessary guidance and support to acquire and master the skills that are taught. Teachers are expected to engage in more ambitious pedagogy and approach their practice in new ways that support learners' curiosity, creativity, and growing confidence. Whitford and Wood (2010) suggest that "quality teachers know how to craft engaging and effective learning experiences" (p. 281) despite having learners with different needs.

Teachers interpret and implement any changes to instruction and pedagogy in their classrooms and therefore have an integral part to play in developing a culture of learning that occurs in the school, as their understandings are contributing factors towards the implementation of alternative practices (Cohen & Levinthal, 1990; Olsen & Kirtman, 2002; Pretorius, 2012). Having better-qualified teachers is not enough. South Africa needs teachers who are adaptable in their pedagogy and "can transform classrooms into more engaging and supportive learning environments" (Tadesse & Gillies, 2015, p. 2). Teachers need support in changing and refining their pedagogy by offering them opportunities to engage in more integrated, ongoing, and subject-specific forms of professional development. Archibald, Coggshall, Croft & Goe (2011) argue that "to influence student achievement, the teacher practice designated for change must clearly relate to student learning" (p. 3). Traditional professional development opportunities "fail to address teachers' subject matter knowledge and their instructional practices" (Mkhwanazi, 2014, p. 425).

1.2. Teacher professional development

Teacher development in South Africa faces many challenges. According to the Department of Basic Education (DBE), these challenges include "a lack of access to quality teacher education and development opportunities for prospective and practising teachers; a mismatch between the provision of and demand for teachers of particular types; the failure of the system to achieve dramatic improvement in the quality of teaching and learning in schools; a fragmented and uncoordinated approach to teacher education and development; the tenuous involvement of teachers, their organisations and other role-players in teacher education and development planning and inefficient and poorly monitored funding mechanisms" (DBE, 2011, p. 1).

The learning needs proposed by instructional reform efforts present challenges for teacher development, in that teachers must develop the necessary teaching skills and knowledge, be well educated in instructional practice, be adaptable to changes in their learning spaces, flexible in their pedagogy and creative in their planning. Furthermore, teachers are encouraged to promote collaboration among learners, create inquiry-based learning environments and build capacity for change, and new pedagogical content knowledge (PCK) which will hopefully support them in teaching science in creative and innovative ways. Instructional changes require teachers to work, learn, and plan more collaboratively and this process can be challenging without encouragement and assistance (Borko, 2004). In response to these challenges experienced by teachers, the DBE and the Department of Higher Education and Training (DHET) developed the Integrated Strategic Planning Framework for Teacher Education and Development in South Africa, 2011-2025 (ISPFTED). The main aim of the ISPFTED is to "improve the quality of teacher education and development in order to improve the quality of teachers and teaching" (DBE, 2015, p. 1). The ISPFTED makes provision for the establishment of professional learning communities (PLCs) as a form of professional development (PD) and highlights the teacher as being central in its efforts to improve teacher development. These provisions aim to strengthen and encourage "teacher professionalism to promote collective participation in professional activities for professional development" (DBE, 2015, p. 3).

PLCs have been highlighted as being productive environments for teacher professional development (Brodie & Borko, 2016; Owen, 2015). PLCs can be defined as groups of teachers coming together in communities and collectively learning from one another through discussions, reflections on practices and using learners' work to improve teaching practices and learning. The research of Jones, Stall, Yarbrough (2013) and Bullough (2007) suggest that

educational reformers have interpreted PLCs in different ways and as a result, implemented them differently. Owen (2015), in her research, focused on student learning outcomes and the links to teacher learning. Bryk, Camburn and Louis (1999) focused on the impact of the human and social factors that promote learning. Feldman and Fataar (2016) focused on the dialogical engagement of PLCs. Kempen and Steyn (2016) highlighted self-reflection as an activity in a professional learning community which helps develop teachers' "confidence and feelings of competence" (p. 36). Studies on PLCs suggest that the nature of PLC activities play a significant role in the success of PLCs to achieve their intended outcomes of building teacher capacity. This has a direct impact on teacher practice which in turn influences learner achievement (Jones, Stall & Yarbrough, 2013; Harris & Jones, 2010; Brodie & Chimhande, 2020).

Two kinds of PLCs have been identified in the literature: generic and subject specific. Generic professional learning communities (GPLCs) serve to equip teachers with generic knowledge (GK) which includes a variety of learning theories and a common language. Shulman (1987) states that GK includes "broad principles and strategies of classroom management and organisation that appear to transcend subject matter" (p. 8). Grossman and Richert (1988) suggest that GK involves "knowledge of theories of learning and general principles of instruction, an understanding of the various philosophies of education, general knowledge about learners, and knowledge of the principles and techniques of classroom management" (p. 54). In order for teachers to collaborate successfully in developing the GK, Steyn (2013) argues that "schools need to guide teachers to participate in appropriate continuing professional development programmes" (p. 283) with the focus on growing teacher knowledge and improving learning.

Subject Specific Professional Learning Communities (SSPLCs) are an ongoing form of professional development that focus on grade-level collaborative teaching teams organized to discuss matters relating to curriculum, lesson planning, assessment strategies and learning that takes place in a subject. The focus on subject-related professional development activities can help teachers develop a more robust understanding of learners' needs, grow their PCK and guide teachers in their planning to ensure learner success. Brodie and Chimhande (2020) highlight the following activities as successful for teacher learning: teachers collaboratively developing lesson plans, observing learners' engagement in lessons, post-lesson analysis and refinement of follow up lessons. Teachers in a SSPLC also analyse and discuss video

recordings of lessons that have been taught, learner assessments and learner activities, all of which contribute towards teacher knowledge and developing their practice.

1.3. Teacher knowledge in instructional reform

It is the teacher and the school that influences and makes a difference in the learners' learning and development. In attempting to comprehend the influence of the teacher in the instructional reform process, Thomas and Brown (2011) suggest the teachers' individual and collective capacity are contributing factors towards reform progress. For effective instructional reforms in science education, teachers need appropriate SMK, GK, and in particular, PCK, Shulman (1986) has proposed that PCK is a unique kind of teacher knowledge as it enables teachers to use various instructional methods to teach content in a way that learners can understand. Mavhunga and Rollnick (2016) describe PCK as an "intellectual bridge between difficult content and student understanding" (p. 2). Having well-developed PCK can support teachers' instructional practice in the classroom and develop in them the confidence to explore more innovative instructional practices, which can lead to improved learner performance.

To achieve the goals of positive instructional change in science, professional development opportunities that help teachers acquire new instructional practices and enhance their PCK have been suggested (Borko, 2004). In building their capacity, teachers' pedagogical learning requires support and guidance. While there is consensus among reformers that teachers, schools, and learners benefit from activities and discussions that occur in a GPLC, the lack of PCK and SMK (subject matter knowledge) expertise within the GPLCs offers very little guidance in the form of content-specific help that will support teachers in improving instruction in their subject areas (Curry, 2008). Bausmith and Barry (2011) agree and argue that although PLC structures are an effective strategy for generic teacher development in that they contribute towards GK, they are inadequate for realizing the expectations of subject-specific reform, where PCK is important. Furthermore, very little is known about how the talk, reflections, and practices that occur in GPLCs may create the conditions necessary to carry over into actual and beneficial changes in classroom teaching (Curry, 2008). In research conducted by Curry, half of the teachers interviewed commented that their Critical Friends Groups (CFG)[1] "fell short of

[1] A particular type of generic professional learning community consisting of 4-12 educators who agree to gather regularly to engage in thoughtful discussions with the aim of improving their practice.

deepening their content and pedagogical content knowledge" (Curry, 2008, p. 761). Without PCK, professional learning communities are not likely to improve learner performance (Bausmith & Barry, 2011).

In response to the significant role that teachers have in the implementation of changes to practice, this research explores whether and how teachers' collaboration, discussion, and reflections that take place in a GPLC as well as in a SSPLC, support teachers in meeting the expectations of instructional changes and whether and how the learning in a SSPLC links with the activities that occur in a GPLC to support instructional changes in science classrooms. Putnam and Borko (2000) argue that "how a person learns a particular set of knowledge and skills, and the situation in which a person learns, become a fundamental part of what is learned" (p. 4).

1.4. The purpose of this study

Putnam and Borko (2000) suggest that "interactions with the people in one's environment are major determinants of both what is learned and how learning takes place" (p. 5). Curry (2008) highlights that while a Critical Friends Groups (CFG) enhances teachers' collegial relationships and their capacity to undertake instructional improvement, these professional communities only offer partial combinations of support for teacher professional development and exert minimal influence on teachers' PCK. The purpose of this study was to establish the extent to which the learning from GPLCs and that from SSPLCs work together or in isolation from one another, and the extent to which they both offer professional learning opportunities in the form of developing PCK that supports instructional reform in science classrooms. Developing PCK takes time, requires individuals to engage in ongoing discussions through collective inquiry with other members in PLCs, and requires an openness to criticism and instructional changes. It includes various techniques that have been developed over time on issues of content, activities and assessment. Teachers who participate in SSPLCs as well as GPLCs, may have better opportunities to develop their PCK. Learning to teach a particular subject matter requires not only understanding the content well enough, but also requires developing appropriate instructional strategies and skills to pass it on to others (Shulman, 1986).

1.5. Context of the study

The study took place at a private school that is well-resourced, situated in Johannesburg and that prides itself in offering a nurturing environment to all its learners. The school has a rich history of encouraging teachers to participate in professional development opportunities. The teachers at the school range from teaching grade zero (four-year-old children) all the way to grade twelve and consists of male and female teachers who range in age from 25 to 65 years of age. The range of ages taught, and the different subjects offered at the school, highlights the need for teachers to engage in a more rigorous, ongoing form of professional development opportunity as compared to simply attending isolated workshops.

The school is unique because both GPLCs and SSPLCs exist as professional development platforms, and it offered itself as a suitable site to investigate well-established GPLC and SSPLC groups. These professional development opportunities form part of the schools' strategy of whole-school development in teaching and learning practices to provide teachers with the required skills, knowledge, insight, and language needed to address the needs of their learners. All teachers at the school participate in both GPLCs and SSPLCs. The programme was designed and implemented by the head of professional development as a whole school strategy to improve instructional practices by providing teachers with platforms to engage with issues relating to education – namely, pedagogy, theories of learning, and assessment strategies.

The GPLCs are run by the head of professional development and include teachers from across the school who teach different subjects and grades. They meet every fortnight where they discuss theories of learning and best instructional practices. These discussions are generic because they need to make sense across subjects, so they do not necessarily involve PCK. During the GPLC sessions, teachers who have more experience, offer guidance on general instructional practices to novice teachers. The discussions are guided by a GPLC manual which was developed in collaboration with teachers from the different phases of the school. Some concepts, for example, the theories of learning were inserted by the head of professional development. During the GPLC sessions, teachers also develop collegial relations with teachers from other parts of the school. The teachers who participate in the Science SSPLC are teachers who teach Natural Science. The activities that form part of SSPLC include collaborative planning, implementation and observation of lessons, and reflecting on their observations

collaboratively. During the implementation and observation phase the participants also analyse learners' work by paying particular attention to the learning that is taking place. The reflections on the observations provide the stimulus for the SSPLC discussions. The activities of the SSPLCs concentrate on improving the pedagogy, content and best practices of the subject to enhance learner performance. Also, the SSPLCs serve as the platform that facilitates the changes and discussions proposed by the GPLC at the classroom level.

This study investigated how teachers create new knowledge to improve and develop their PCK through interacting in GPLCs and SSPLCs, and what SSPLCs draw from GPLCs to inform their pedagogical practice in the classroom. It is envisaged that the outcomes from this research may clarify the discussions about roles that the different PLCs play in professional development and ultimately teacher pedagogical reform. The school offers an ideal site to study how the interactions between and within subject/phase specialist teams and general teams, promote professional learning and teacher knowledge.

The findings from this study can contribute towards knowledge by providing detailed accounts of conversations that take place in two different kinds of PLCs, namely GPLCs and SSPLCs, and how these influence each other. The research may also provide valuable insight that shows how the activities that take place in the PLCs contribute towards teacher knowledge and help develop science teachers' PCK.

1.6. Problem statement

In the early years of their schooling, students seem to show particular interest and curiosity towards science, however, these attitudes which students display tend to decline as they progress through their schooling (Montes, Ferriera & Rodriguez, 2018). This decline in interest can be attributed towards a gradual loss of interest in the subject which can be attributed towards experiences of failure and boredom (Potvin & Hasni, 2014). Montes, Ferriera and Rodriguez (2018) suggest that the decline in attitude towards science can also be related to the content of the science curriculum which becomes more abstract as learners progress towards secondary education. Teachers who possess limited subject matter knowledge find the content in science difficult to teach. Teachers' modes of instruction in science directly influence learners' performance (Bolshakova, Johnson, & Czerniak, 2011). Bolshacova, Johnson and

Czerniak, (2011) posit that teachers' effectiveness in the science classroom, which includes their "curricular activities, classroom management, subject knowledge and their interactions with learners" is shaped by their effectiveness to produce an intended result (p. 963).

PLCs have been documented as a means for building competency, developing respectful relationships, and creating innovation within a school (Brodie & Borko, 2016; Fullan, 2005; Hord, 2004; Hughes & Kritsonis, 2006). There is consensus regarding particular traits of high-standard professional development (Brodie & Shalem, 2011). These traits involve: "a focus on learner needs, design of and reflection on classroom artefacts, and the creation and sustaining of communities of support for teacher professional learning" (Brodie & Shalem, 2011, p. 1). Teaching and learning improve when teachers question ineffective teaching practices and collectively investigate and discuss more innovative conceptions of teaching and learning (Little, 2002). Blankenship & Ruona (2007) suggest that PLCs create "a way for schools to reduce isolation and learn together to create sustainable change" (p. 1).

Traditional professional development modes that include whole school workshops, seminars and guest speakers are often perceived by teachers as not quite meeting their needs based on their experiences in their classrooms (Lieberman & Pointer Mace, 2008). Lieberman and Pointer Mace (2008) emphasize that "instead of creating the conditions for teachers to teach each other, support their peers, and deepen their knowledge about their learners, teachers are being given a 'one size fits all' set of professional development workshops that negate the variability of how teachers teach, and how they and their learners learn" (p. 227). PLCs present an opportunity for teachers to engage in a different kind of learning.

Blankenship & Ruona (2007) point out that while some schools have had some success in developing PLCs, others have experienced hurdles due to conditions that exist both internally and externally. They highlight "culture, organizational structure and leadership" (p. 1) as stumbling blocks that have either prevented or slowed down teacher development in PLCs. Similarly, Curry (2008) argues that while generic professional learning communities enhance teachers' collegial relationships and the capacity to undertake instructional improvement, these professional communities offer only partial support for teacher professional development in that they exert little impact on teachers' pedagogical content knowledge. Therefore, this study focused on the teacher learning that takes place in the GPLC and SSPLC which centres around generic knowledge and pedagogic content knowledge. The study aims to provide knowledge on how both types of PLCs may complement each other in creating and sustaining ongoing

learning to develop science teachers' PCK. More specifically, the researcher wanted to explore whether the SSPLC serves as a resource that influences teacher learning between the GPLCs and the classroom. Little (2002) argues that "relatively little research examines the specific interactions by which learning communities constitute a resource for teacher learning and innovation in practice" (p. 918). Hence, this research project examines these interactions.

1.7. The research questions

This study investigates how SSPLCs and GPLCs develop teachers' PCK and GK and demonstrates how teachers can work and interact within such learning communities to support teacher collaboration and instructional reform.

The main question guiding the study is:

> How do generic and subject specific learning communities co-produce knowledge, including generic and pedagogical content knowledge, with the aim of informing teacher learning in Natural Science teaching?

The following sub-questions were focused on to help explore the main question:

1. How does reflection through collective inquiry foster the development of pedagogical content knowledge?
2. What do teachers bring from each PLC in the form of artefacts and tools, to inform the other?

1.8. Rationale

Studies on school reform acknowledge the critical function that teachers play in the lives of their learners (Darling-Hammond & Sykes, 1999; Shulman & Sykes, 1983). The focus on the teacher is integral to instructional change because any change in instruction and pedagogy is interpreted by the teacher and is implemented in his/her classroom. Horn (2005) argues that teachers influence much of what happens in the classroom, as "teachers' beliefs, prior understanding, dispositions and practices have an impact on the ultimate implementation of reform" (p. 207). This study sought to understand how GPLCs and SSPLCs co-produce knowledge through activity to inform teacher learning. In attempting to understand the

influence of the teacher in implementing alternative practices to support learning, Thomas and Brown (2011) suggest that the teachers' individual and collective capacities are contributing factors towards instructional improvement progress. Highlighting the important role that the teacher plays in the instructional improvement process positions the teacher as an 'enabler' in supporting the access of knowledge to the learners in his/her classroom. Understanding how generic and subject specific learning communities co-produce knowledge through activity to contribute towards teachers' pedagogical content knowledge is crucial to understanding teacher knowledge.

Emphasizing teachers' individual and collective capacities as being instrumental in the instructional change process warrants an understanding of how and what teachers learn, and the different professional development (PD) offerings that are afforded to them in developing their capacity to initiate a change of practice in their classrooms. To contribute to the refinement of the instruction process and to highlight how learning is embedded in the professional lives and work conditions of teachers, PLCs are suggested as platforms to enable change (Brodie & Borko, 2016; Harris & Jones, 2010). It has been suggested that PLCs are environments that support teachers by encouraging them to "use their experience, classroom observations, and knowledge from research to decide what they need to learn and how they can learn it" (Brodie, 2011, p. 50). Putnam & Borko (2000) suggest that the learning communities in which discussions and debates take place "provide the cognitive tools, ideas, theories and concepts to make sense of experiences" (p. 5).

The ISPFTED (2011-2025) prepared by the Department of Basic Education (DBE) and the Department of Higher Education and Training (DHET) encourages the endeavours of professional learning communities, and suggests that professional development needs to be continuous, content rich and pedagogically sound (DBE & DHET, 2011). The main aim of PLCs, according to the DBE and DHET is to support ongoing interactions among teachers, provide opportunities for practicing teachers to access their curriculum knowledge, and "identify their development needs related to their specific teaching specialization" (Lotz-Sisitka, 2011, p. 79). This study could contribute to knowledge on how, and what types, of PLCs could be formed and supported in schools to help grow teachers' knowledge.

PLCs offer powerful means of engaging teachers in inquiry activities that call on them to reflect upon and improve their practice. Teachers' collaboration is not enough to improve teaching and learning as there are cases of teacher learning communities that struggle to produce the

expected outcomes (Hanushek, 2005; Sykes, 1996). Difficulties may arise, in part, from PLCs that do not consider learning to be part of the professional lives and working environments of teachers, and from PLCs that do not focus on subject specific knowledge (Clarke & Hollingsworth, 2002, p. 949).

Lave and Wenger (1991) theorize learning "as a social phenomenon constituted in the lived-in world, through legitimate peripheral participation in ongoing social practice" (p. 64). In other words, they perceive learning as a social practice that involves interaction and engagement among individuals, and they understand learning to be a developing, negotiated participation in a practice. It should be highlighted that the focus that is placed on the teacher, in his/her individual capacity as well as part of a subject specific community of teachers in their involvement in the professional learning communities, must be the focus of professional development. Teachers participate in PLCs not because they lack skill but instead come from an understanding that education is a "growing, dynamic, professional field" (Guskey & Sparks, 2000, p.16).

Findings from this research could serve as a platform for further investigation exploring how knowledge is transferred from generic to subject specific professional learning communities and vice versa to produce new knowledge and to support teachers' learning in their practice. The study provides analysis and findings on the impact that PLCs have on teacher development and learning as suggested by the ISPFTED and shows the complementary roles that the PLCs have on growing teacher knowledge which includes GK and PCK, to contribute to the realisation of the goals of the framework. This study can be regarded as being of assistance to the participants, as it provided them with the opportunity to reflect on their current practices and develop professionally. Further, the findings highlighted the artefacts and tools that are developed by each of the PLCs and how these artefacts and tools are used in the discussions as stimuli to facilitate and direct conversations as a means of improving teacher' practice. This study can be of benefit to institutions that are considering changes to instruction within their own schools by informing their professional development approaches. It provides school managers with knowledge on how PD can be facilitated through emphasizing a mutual relationship between the GPLCs and SSPLCs in informing classroom practice, rather than these two professional development platforms functioning separately.

1.9. An outline of the dissertation

This dissertation has been divided into six chapters. In this chapter (Chapter 1) I provide a brief background and set out the context of the study. I define the concept of a PLC and highlight two different forms of PLCs that contribute towards teacher PD namely, GPLC and SSPLC. I also explain the purpose, problem statement and rationale for this study. In Chapter 2, I explain the theoretical underpinning that informed this research. Thereafter I explore the literature on the role that professional learning communities (PLCs) have on improving opportunities for ongoing professional learning for teachers. The literature review also highlights instances where PLCs have been less successful in achieving their intended outcome of improving teacher practice. Chapter 3 focusses on the research design and methodology used to ensure that rigour and ethical considerations were maintained during the research process. Chapter 4 contains the analysis of the data obtained from the individual interviews with the three Grade Four science teachers. The analysis in Chapter 4 highlights the knowledge that was developed in each of the PLCs, the participants' experiences of participating in the SSPLC and GPLC, what they gained from each PLC in order to inform the other, and the influence that both these PLCs have in developing science teachers' PCK. Chapter 5 focusses on the analysis of data collected from my observations of teachers' participating in GPLCs and SSPLCs. I focus on the support provided by the community of teachers in the SSPLC and describe how the activities of the SSPLC contributed towards building educators' PCK and shifting practices. Then, I provide a description of the discussions that took place in the GPLC and explain how a focus on GK is needed to build teachers' knowledge and provide them with the language and tools required to inform their discussions and decisions around their practice. In Chapter 6 I conclude my research and discuss the findings that have been uncovered during the analysis process.

Chapter 2: Theoretical framework and Literature review

2.1. Introduction

In this section, I will discuss the theoretical framework as well as the related literature that guided my research. The theoretical framework that I use helped me understand and explore how teachers learn in PLCs and how reflection with colleagues can be used to develop new knowledge to inform teacher pedagogy. Since my exploration is on teacher learning the study was influenced by Lave and Wenger's theory of situated learning and Dewey's notion of teacher reflection. The research positions teacher learning as being influenced by and developed from the relationships that exist between an individual's own actions in relation to those of others within a context. In this section I will describe concepts that outline the situated character of teacher learning and the importance of reflection in the professional development programme being researched.

2.2 Theoretical framework: Situated theory of learning

2.2.1. A definition of learning

For the purpose of this study, learning is viewed as situated (Brown, Collins & Duguid, 1989; Lave & Wenger, 1991; Young, 1993). Brown, Collins and Duguid (1989) argue that "situations might be said to co-produce knowledge through activity and that learning, and cognition, it is now possible to argue, are fundamentally situated" (p. 32). There is an on-going changing relationship between the context and the participant where the context influences the participant, and the participant influences the context to add to existing knowledge or to create new knowledge. The contextual effects on the individual may vary, as the individual is unique. The individual also changes because of the personal experiences and engagement with the situation; hence, s/he is not static in this situation and engages, reflects, debates conflicting ideas and contributes to the context to affect and modify the situation. The complexities that are involved in learning lie not only within the individual, but in a complex dynamic of the learner-situation interaction (King, Young, Drivere-Richmond & Schrader, 2001). Being interested in how PLCs offer an environment to facilitate teacher learning compared to learning

being considered to take place entirely within the individual, I will adopt a situated perspective on learning as my theoretical framework to study how different learning environments in the form of GPLCs and SSPLCs influence and provide teachers with new knowledge to inform their pedagogy.

2.2.2. Situated theory of learning

Lave and Wenger (1991) argue that in contrast to cognitive theorists, learning should not be considered as a series of processes that take place inside the individual, but instead they position learning to be an important aspect of social practice. Learning, according to situated theorists, does not just entail a one-way transmission of knowledge where the receiver's role is to absorb information unquestioningly but rather learning is observed as being created within a social context where individuals discuss and negotiate meaning to create new knowledge. This is reflected by Greeno, Collins and Resnick (1996) who argue that learning involves processes in which connections of skills and knowledge are acquired through the application of a skill from one situation to another. Lave and Wenger (1991) add that learning involves the person participating in communities of practice where his/her participation and understanding grows over time. By increasing his/her contribution and involvement, the person gradually grows in the community of practice and adopts the thinking, ideas, and methods – 'the knowledge' of the community. It is through gradual participation and adoption of ideas and thinking that a teacher may be able to develop his/her PCK. The individual's existing understanding is challenged as the meaning and understanding of new knowledge is negotiated and adopted by the individual. Learning in this instance occurs through interpersonal relations. Lave argues that "learning is an aspect of changing participation in changing communities of practice everywhere" (Lave, 1996, p.150). Lave and Wenger (1991) suggest that the ways that an individual becomes a participant and adopts the practises of the community as his/her own is through a process called legitimate peripheral participation.

2.2.3. Legitimate peripheral participation

Legitimate peripheral participation centres around the idea that learning occurs as one participates in a community of practice and refers to a process of learning where individuals

enter into a community of practice as novices and their initial participation and knowledge is low. As the participant collaborates, reflects, listens, and observes the language, skills and practices of experts within the field with the aim of continuously learning and improving their practice, they progress towards full participation in the community. The main aim of participating in the community is to acquire the skills and knowledge of the community and eventually to become a full participant. Full participation means that the individual has developed their pedagogical content knowledge to a point where he/she is able to use the language of the community, has acquired and contributed towards the skills of the community and practices the protocols of the community in a manner that is acceptable by the community. Through the process of participation, the individual is not passive, he/she contributes towards the discussions and debates that arise and adds to the communities' knowledge and practices. Floding and Swier (2012) state that "the diversity of persons and experiences adds texture and richness to the community" (p. 197). While face-to-face engagement in a PLC is important, it does not necessarily have to take place in person (Cobb & Bowers, 1999).

The notion of 'legitimate' suggests that the individual is seen by experts in the field as already part of the community, either as a new teacher or intern to the school. The person is welcomed into the community and the experts reflect a generosity of spirit by assisting them by introducing them to other members of the community i.e., networking and freely sharing teaching aids, ideas, and resources with the aim of transferring and sharing the community's practices (Floding & Swier, 2012). Gradually, and through constant participation, observation, and engagement the individual gains more recognition and his/her participation takes on an essential function in the community. Floding and Swier (2012) state that "learning involves the whole person; it implies not only a relation to social communities but implies becoming a full participant, a member, a kind of person" (p. 193). Learning within communities revolves around participating in activities that are centred around the core practice, namely teaching (Morrell, 2003). SSPLCs are such environments that have their focus on developing subject specific PCK.

Lave (1993) suggests that learning can be interpreted as an active engagement in a social practice between participants, where knowledge is shared, reflected upon, discussed, and interrogated before it is accepted. Putnam and Borko (2000) agree by stating that teachers' learning is situated in their "daily practice" (p. 11), suggesting that teachers learn and acquire knowledge as they engage with the curriculum materials, learners, other teachers and peers, i.e. the school environment, which suggests that as much as the learning is situated, the knowledge

is also situated. Lave (1996) explains that as the person becomes more confident and his/her participation in the community increases, he/she tends to take on a new identity.

2.2.4. Knowledge as situated

Cognitive theorists view conceptual knowledge as being independent from the influences of its context (Brown, Collins & Duguid, 1989). Knowing is understood to be a mental activity and is interpreted as the development of concepts that are accumulated inside the mind. Brown, Collins and Duguid (1989), being early pioneers of situated learning, argue that knowledge cannot be separated from its context as the context is an integral component when creating meaning. They state that "knowledge is fundamentally situated in the situation and activity in which it is conceptualized" (p. 32). Engaging in PLCs involve social interactions as participants are continuously engaging with one another. Further, Brown, Collins and Duguid (1989) explain that the activity and the environment that is created to facilitate learning are significant elements to understanding, reasoning, cognition and learning in that the context where the knowledge is situated creates the meaning for the concept. One can conclude that reflection which forms part of the activity in GPLCs and SSPLCs are important for teacher cognition and learning. The view that knowledge is situated, creates a platform to question many of the assumptions of knowledge, one being that the abstraction of knowledge from situations enables and facilitates transferability. Brown, Collins and Duguid (1989) disagree with these perspectives by asserting that knowledge is a collaboration of one's mind and the environment and that knowledge production can be facilitated through participation in appropriate social contexts.

It is important to acknowledge that professional teacher knowledge can be principled and that some forms of practice-based knowledge are more situated than others. The knowledge gained from the GPLC is knowledge that forms the "big picture" in abstraction from the detail of the subject matter knowledge. The GK gained from the GPLC can make teaching both more effective and more efficient, by helping teachers create the conditions that support learners' learning and, in the process, develop a deep and connected understanding of teaching and learning. The teachers' conceptions of teaching and learning that are discussed in the GPLC can be abstracted within their practice when teachers coordinate their GK with their SMK to coordinate learning in the science classroom. In such a case, teachers may apply practice-based

knowledge from one context to another, making some forms of practice-based knowledge more situated than others. In PLCs it is known that knowledge is contextual but when teachers acquire the tools that they need within a structure of knowledge, teachers are able to apply these tools to different contexts and in the process acquire a greater understanding of that knowledge. The activities and discussions that take place in GPLCs and SSPLCs may create appropriate contexts for teacher learning and knowledge to be produced.

Wenger (2010) states that participants should consider two sets of data when creating understanding in social contexts, referring to such consideration as the "dual process of meaning making" (p. 1). Participants are first encouraged to take in data as they participate in the activity, participate in conversations and activities with other participants, and use their existing knowledge to create meaning and understanding of what they observe. Secondly, through discussions, debates, and engagement with other participants and through reflective practices in a social context, individuals co-produce physical and conceptual artefacts to make meaning of their experience. Brown, Collins and Duguid (1989) argue that knowledge is like language because "its constituent parts index the world and so are inextricably a product of the activity and situations in which they are produced" (p. 33), reflecting the situatedness of knowledge. The artefacts that are co-produced make meaning of the experience and can include words, definitions, rules, and processes that indicate the common contributions and experience of the learning community.

Wenger (2010) suggests the term "reification" in relation to these artefacts and explains reification as "making into an object" (p.180). These physical and conceptual artefacts contribute to the development of a language which participants of a PLC use to communicate, and novices need to acquire, to become full participants in a community. These artefacts also inform the environment, creating the context, knowledge and atmosphere that facilitate discussion among the participants that assist in the development of an individual's PCK.

2.2.5. Knowledge and tools

With a view of knowledge as being situated and constructed progressively through engagement and discussion in activity, we should re-consider any understanding of knowledge being independent of situations, self-sufficient, and separate from social pressure (Brown, Collins & Duguid, 1989). To conceptualize knowledge as being 'situated', Brown, Collins and Duguid

argue that “knowledge [is] in some ways similar to a set of tools” in that the communities’ knowledge can only be fully grasped in their use within a context (Brown et al., 1989, p. 33). SSPLCs and GPLCs are situated in an environment in which the knowledge of teaching is used and the conditions on how the tools are to be used in practice comes from the context of the activities of the community.

To explain further; just as tools are unique to a specific trade, they are adapted, designed, constructed and used to meet the needs that are specific to a community with the aim to improve and increase learning (Brown & Duguid, 2001; Hedberg & Holmquist, 2001). Knowledge has specific contextual meanings to a particular community and can only be fully understood in a particular context as the context provides the meaning to the words. In other words, teachers have specific pedagogical content knowledge and use a particular language that has been accumulated over the years and is specific to the community that they belong to. Brown, Collins and Duguid (1989) suggest that acquiring PCK from the community “entails both changing the user’s view of the world and adopting the belief system of the culture in which they are used” (p. 33). The participation of teachers in a SSPLC can facilitate the transfer of PCK and understanding of the knowledge among the participants of the PLC.

Through the use of the tools the teacher is able to manipulate his/her environment and his/her understanding is changed as s/he adopts the belief system and the culture of the community that they have been used in and developed. Brown, Collins and Duguid (1989) argue that individuals who adopt and use these tools become more proficient in their areas of expertise. As much as the participant changes and becomes more proficient, so does the community. The participant is not passive in the engagement and contributes knowledge and experiences which shape the community. Learning in this sense becomes a process as the communities’ knowledge is not static as the participants are continuously reflecting on their practices. This point is clarified by Brown et al., (1989) who suggest that “the understanding, both of the world and the tool, continually changes as a result of their interaction” (p. 33).

Community activities, in an effort to build the membership or to encourage learning, will support the externalization of insights gained. Any new knowledge that is acquired through the process of learning affects the pre-existing knowledge and beliefs that the teacher has (Kwakman, 2003). PLCs provide an ideal environment to support teachers to develop their existing knowledge about teaching and learning through discussions, reflections and debates

to that which is being recommended the community in a need for developing knowledge and practices.

Communication and collaboration among the participants of a community promote the development of a similar knowledge base, not only between teachers but also within the community, facilitating a common understanding, solidifying of concepts and the development of new organizational and pedagogical competencies (Tsai & Goshal, 1998). Participants in a GPLC and SSPLC generate common knowledge and understanding as they discuss, debate, share information on classroom experiences and help each other solve problems that have been reflected upon. This mixture of practice and discussions eventually becomes a common practice to improve proficiency in problem-solving in the classroom. Through the process of reification, the community transforms this communal knowledge into the tools and artefacts that represent the community. Teachers reflect on practices while participating in their GPLC and SSPLC to discuss possible solutions which may add to existing knowledge or create new knowledge that would inform future practices.

2.3. Teacher reflection

Dewey (1933) defines reflection as the "active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends" (p. 9). Valli describes reflective teachers as discussing and debating past practices to make informed judgements which are used to inform future practices (Valli, 1997). Brown, Collins and Duguid (1989) state that as teachers reflect on their practices, their reflection promotes abstractions and naturally involves individuals comparing, questioning and discussing their strategies with those of an expert or each other to produce knowledge that can be used to improve their practice.

Valli (1997) highlights a few examples of what teachers may reflect on. These include teaching aids, student collaboration and learning, instructional processes, and subject matter. Other examples of what teachers may reflect on include scaffolding of activities, student participation, teacher pedagogical practices, and lessons. Mavhunga and Rollnick (2016) show that reflection relates to SMK and PKC because seasoned teachers "consider various aspects about the content to be taught, such as: (1) learners' prior knowledge including misconceptions, (2) curricular saliency, (3) what makes the topic easy or difficult to understand, (4)

representations including powerful examples and analogies, and (5) conceptual teaching strategies" (p. 5). These examples focus on the goals of schooling and by highlighting them, can suggest a means for teachers to question the lenses they bring to teaching. In other words, to be a reflective teacher, to become part of the community, teachers should interrogate those aims and objectives that guide their work and engage in problem solving discussions with experts and each other (Zeichner & Liston, 1996). These notions of reflection will provide me with a lens to understand how and what teachers reflect on while participating in GPLCs and SSPLCs and how their reflections develop their PCK through the use of tools and artefacts that may assist their practice.

2.3.1. Reflection and learning

Korthagen (2010) argues that in improving teacher pedagogies, teacher learning cannot just involve educational knowledge being 'transmitted' to teachers as teachers bring with them past and present experiences, which inform their classroom practices. To ensure that teachers learn and enhance their PCK, teachers should reflect on their current practices and through debating and discussing with participants in their GPLCs and SSPLCs may create new knowledge that would inform best practices. Through the process of reflection teachers can develop an open and critical mind as they engage with the reasoning of others in the community which may present them with the opportunity to learn and grow as a professional. GPLCs and SSPLCs can offer teachers such an environment.

Further, SSPLCs offer an opportunity for teachers to reflect within a subject-specific collaborative environment. Riveros, Newton and Burgess, (2012) argue that Dewey did not view teacher reflection as an isolated activity but as an activity which forms an integral part of the practices that are embedded in community settings and represent an important position in teacher development. Jay and Johnson (2002) explain that reflection is an approach that teachers use to support effective learning. As teachers learn in communities, they sometimes come across knowledge or practices that do not work due to the practices being ineffective in producing gains in learning. Through collaborative reflection in a SSPLC teachers are able to identify student learning gaps and devise remediation strategies collaboratively and, in the process, create new knowledge that may be used to inform future actions (Brandt, 2003).

2.3.2. How do teachers reflect?

Jay and Johnson (2002) state that during the process of reflection, certain processes take place. These include being able to describe the situation, discussing practices and questioning pre-conceived understandings, criticizing classroom practices, and persevering with an approach that reflects an eagerness to learn with the aim of improving practices (Dewey, 1933; Valli, 1997). Dewey (1933) states that during the process of reflection the individual, "in a purposeful and deliberate way, thinks the problem out" (p.6). During this process knowledge is added to existing knowledge or new knowledge is created that would inform future practices. SSPLCs and GPLCs offer an environment to accommodate as well as prompt reflective practices with the intention of developing solutions and promoting learning. According to Dewey (1933, p. 9) reflection:

> does not consist of a series of steps or procedures to be used by teachers. Rather, it is a holistic way of meeting and responding to problems, a way of being a teacher. Reflective action is also a process that involves more than logical and rational problem-solving processes. Reflection involves intuition, emotion, and passion and is not something that can be neatly packaged as a set of techniques to use.

"A way of being a teacher" suggests that in order to be part of the community, one has to be able to reflect (Dewey, 1933, p. 9). Reflection enables growth and on-going learning. It has been suggested that "reflective teaching entails a recognition, examination and rumination over the implications of one's experiences, attitudes, knowledge, and values as well as the opportunities and constraints provided by the social conditions in which the teacher works" (Jay & Johnson, 2002, p. 75).

2.4. Literature review

The literature has expanded over the last decade and Google Scholar was primarily used to source these studies. The focus of the search included: professional development (PD) opportunities for teachers; professional learning communities in schools; successful professional learning communities; conversations in professional learning communities; and collaborative learning opportunities. In exploring the research in the field of study,

international, local, generic as well as subject-specific studies on PLCs have been analysed. This was done in order to understand how schools use the different principles of PLCs to shift teachers' practices and strengthen teachers' knowledge, with the focus on improving learning. Brodie (2014) argues that "such re-organisation of practice requires learning among practitioners, and this learning is itself a practice, which sets up its own regularities" (p. 236). The literature review also highlights instances where PLCs have been less successful in achieving their intended outcomes of improving teacher practice.

I begin my literature review by highlighting the knowledge that science teachers need in order to be effective in promoting learning. I then focus on the literature about the characteristics of effective PLCs, paying particular attention to how teachers use various artefacts from their own classrooms to engage in rigorous conversations on teaching and learning that shift their knowledge to inform their practice, and in the process, develop their subject matter knowledge (SMK) and pedagogical content knowledge (PCK). I highlight the essential features of PLCs and show how they have been shown to grow teacher knowledge and promote learning, as well as in some cases, impede teacher learning. The argument that I build in this literature review, shows that for PLCs to be successful, the focus of the inquiry should be on shifting teacher practice towards more powerful practices.

2.4.1. Knowledge for science teachers

Van Driel, Beijaard and Verloop's (2001) study that investigates the influence of teachers' practical knowledge in science education, suggests that teachers have practical knowledge that consists of "teachers' knowledge and beliefs about their own teaching practice, and is mainly the result of their teaching experience" (p. 138). They suggest that for there to be an impact on teachers' practical knowledge, teachers should participate in long-term professional development programs. Beyond just having practical knowledge, teachers should have a type of knowledge that combines pedagogical knowledge and subject matter knowledge. Shulman (1987) proposes the importance of developing pedagogical content knowledge (PCK). PCK is knowledge that is specific to teachers and consists of an amalgam of content knowledge and pedagogy (Shulman, 1987). PCK involves teachers' competence in synthesizing different forms of knowledge in order to facilitate learning. PCK can be developed through conversations that take place in a PLC (Brodie et al, 2016).

Magnusson, Krajcik and Borko (1999) argue that PCK is a domain of knowledge that is important for effective science teaching. PCK for teaching science consists of five components (Magnusson et al., 1999, p. 2). These components are:

(a) orientations toward science teaching

(b) knowledge about science curriculum

(c) knowledge about students' understanding of specific science topics

(d) knowledge about assessment in science

(e) knowledge about instructional strategies for teaching science.

To elaborate further:

(a) Orientations toward science teaching refers to the "knowledge and beliefs about the purposes and goals that teachers have for teaching science at a particular grade level" (Magnusson et al., 1999, p. 5).

(b) Knowledge about science curriculum includes knowledge of the goals and objectives for learners in the subject as well as the articulation of those guidelines across topics. It also includes knowledge of what learners have learned in different years in science.

(c) Knowledge about learners' understanding of specific science topics "consists of knowledge of the programs and materials that are relevant to teaching a particular domain of science and specific topics within that domain" (Magnusson et al., 1999, p. 5). An example would be: that a biology teacher should be knowledgeable about the curriculum in the teaching of biology. This type of knowledge is divided into two categories.

- Knowledge of requirements for learning: This type of knowledge involves any prior specific science knowledge that teachers should know before teaching a concept; knowledge of any skills or abilities that learners should have to assist them while developing understanding. Teachers should also have knowledge of the different approaches to learning to accommodate learners with different ability levels.
- Knowledge of areas of learner difficulty: This type of knowledge refers to teachers' understanding of what concepts learners find difficult to grasp and the kinds of errors that are common, especially for concepts that are abstract.

(d) Knowledge about assessment in science consists of two categories:

- Knowledge of dimensions of science learning to assess: This type of knowledge refers to what teachers perceive as being important to enhance scientific literacy.
- Knowledge of methods of assessment: This type of knowledge refers to a teacher's understanding that involves different methods and instruments of assessments used to assess learning which can be applied to a specific unit of study including the advantages and disadvantages associated with the particular instrument of choice.

(e) Knowledge about instructional strategies for teaching science is categorized into two groups:

- Knowledge of subject-specific strategies: This type of knowledge refers to the different types of instruction that teachers are familiar with for enacting science teaching.
- Knowledge of topic-specific strategies: This type of knowledge refers to "specific strategies that are useful for helping students comprehend specific science concepts" (Magnusson et al., 1999, p. 16). This type of knowledge is divided into a further two categories:
    - Topic specific representations: Teacher knowledge that refers to specific ways and means of communicating concepts to facilitate learning. This knowledge also includes knowledge of the advantages and disadvantages of these representations and teachers' ability to invent new and effective ways of teaching concepts to accommodate all learners. (Magnusson et al., 1999). Teachers should also know when and how to use these activities and representations to facilitate comprehension of concepts being taught.
    - Topic specific activities: These are knowledge of activities that teachers should have that will assist learners in grasping concepts easily. Examples of these activities are experiments, demonstrations, simulations. Teachers who participate in professional development programs are more likely to improve their knowledge of topic-specific strategies (Magnusson et al., 1999).

The knowledge that science teachers possess is unique to the field of science teaching and can be viewed as a way of knowing. To know and to transfer this knowledge involves making this knowledge explicit in a collaborative environment through collective inquiry and "using

special procedures and activities organized and supported in teacher education" (Krzywacki, Kim & Lavonen, 2016, p. 205).

2.4.2. Subject matter knowledge

Subject matter knowledge (SMK) refers to the "cognitive processes and understanding of facts, concepts and principles, and the ways in which they are connected and organized" (Even & Tirosh, 1995, p. 2). Therefore, SMK is an important aspect of teachers' practice, as "all teachers teach something" (Rollnick & Mavhunga, 2016, p. 5). Teachers should have two kinds of understanding of subject matter knowledge – knowing "that" and knowing "why" (Shulman, 1986). What this means is that not only must teachers have a good understanding of the concepts they are teaching but "they must also be able to explain why a particular proposition is deemed warranted, why it is worth knowing, and how it relates to other propositions, both within the discipline and without" (Shulman, 1986, p. 9). An excerpt from the National Curriculum Statement Grades R-12 emphasizes the principles of high knowledge and high skills: the minimum standards of knowledge and skills to be achieved at each grade are specified and all subjects are set high, but achievable standards. When it comes to the matter of progression, the content and context of each grade must show progression from simple to complex (p. 4). "A good teacher will tell the learners something of the arguments and confusion among the people who were the first to investigate this knowledge" (p. 4). Furthermore, science teachers are expected to touch on some science at the frontiers of the unknown: "Why is climate changing around the world? What is making the universe expand? What causes the earth's magnetic field to change?" (p. 8).

2.4.3. Conversations in professional learning communities

PLCs can promote discussions that are ongoing, and which can support the development of teachers' SMK and PCK in science. Brodie's (2014) study on how the collaborative nature of a PLC supported teachers to learn more about learner errors, found that the conversations that took place in a mathematics PLC enabled teachers to talk about and understand learners' mathematical errors better. The conversations that took place in the PLC shifted teachers' thinking about learner errors and "supported the teachers to re-think their own knowledge"

(Brodie, 2014, p. 234). Three shifts were identified in the study: from identifying to interpreting errors; from interpreting to engaging with errors; and from focusing on learner errors to focusing on teachers' own knowledge (Brodie, 2014). A participant in Brodie's (2014) study stated: "I wanted to say that that was a good example, that the teacher could have taken advantage of the misconceptions, extending it to say that equations can have more than one solution and again put an example of that identity, where this one is a special equation with many solutions" (p. 235). This example demonstrates how, through collective inquiry, teachers are able to safely critique their practice and in the process, develop their SMK and PCK.

Feldman and Fataar (2016) conducted research on five teachers' participation in a PLC where the dialogical characteristic of the PLC was used as a tool to elicit communication about their teaching and pedagogical dispositions. The initial engagement with the teachers highlighted an "absence of both a didactic language and a pedagogic reflexivity" which resulted in conversations that did not challenge teachers' practices but rather focused on discussions relating to learner behavior and class sizes (Feldman & Fataar, 2016, p. 18). The data collected enabled the facilitators to implement an intervention to facilitate, focus, and guide teachers' learning. The tool, comprised of three elements, was used to shift teachers' pedagogical orientations and contributed towards teachers' professional learning and developing participation in a practice. Feldman and Fataar (2016) argued that "vigorous 'habitus engagement' and reflexive dialogue are necessary if changes in pedagogical practices are to be achieved" (p. 22) and that the dialogical process of their PLC "enabled the teacher participants to begin to move towards a more multidimensional approach in their pedagogy" (p. 20). For participating teachers, a PLC is a safe space to engage in discussions that facilitate learning, as a first-year teacher in the study stated: "the PLC group for me is a place of support [….] and being in the physical environment does not come with support" (Feldman & Fataar, 2016, p. 21).

Brodie and Chimhande (2020) argue that the activity and content that form part of teachers' discussions in a PLC are key to their learning and "must relate to their teaching and their learners' learning" (p. 121). The content of the PLC discussions, which is the substance of what is being discussed, highlight what teachers consider as being important and "shows the extent to which they are enquiring into important aspects of their practice" (Brodie & Chimhande, 2020, p. 121). Any shifts in the content can signify the focus of the learning (Brodie & Chimhande, 2020). Their findings suggest that there is a correlation between different activities that a PLC engages in and the content of their talk, so as the activity changes in the PLC, so

does the content. When the focus of the activity was on test analysis, the content mainly focused on learners' understanding 42% and learner thinking 37%. When the activity focused on lesson planning, the content of the PLC discussions shifted towards mathematics 45% and 29% on discussions relating to practice while the discussions on learner understanding and learner thinking dropped down to 10% and 12% respectively. When the activity shifted towards lesson reflection, the content shifted towards practice 56% (Brodie & Chimhande, 2020).

The research completed by Lalor and Abawi (2014) found that participation in grade level PLCs disrupted teachers' complacency and challenged them to reflect deeply on their practice. By improving their PCK through conversation and participation in a community of practice, teachers were equipped with the means that enabled them to make shifts in their practice and engage with their learners more constructively. Brodie's (2011) study that focused on how teachers learn by engaging with learner errors, found that discussions and analyses of classroom practices among participants in a PLC helped teachers identify areas of improvement in their pedagogy, which in turn helped inform their classroom practice on questioning learners. Through the discussions that took place in the PLC, a participant in Brodie's (2011) study stated: "I had not allowed her to let me know that she had fully grasped the concept, I just kind of barked out the orders […] so I don't actually know that she can actually do these questions by herself now" (p. 4). The analyses of the lessons in the PLC informed the participant's practice and allowed the participant to see the value in asking more probing questions. The participant stated that she could have asked more probing questions such as "why do you think that", "how do you come to that", "take me through your thinking" to guide the learners in their learning (Brodie, 2011, p. 5).

However, research conducted by Supovitz and Christman (2003) that tracks the growth in teachers' instructional practice, revealed that there was not a noticeable difference between teachers who participated in communities compared to teachers who were not part of communities. A closer analysis revealed that these group practices were "generally static from year to year, suggesting that communities were not substantially deepening their practice over time" (Supovitz & Christman, 2003, p. 5). The findings from the study suggest that the focus of PLC discussions should be on the effectiveness of teaching and learning that is taking place in a teacher's class, and how practices can be improved to accommodate learners' learning (Supovitz & Christman, 2003). Vescio, Ross and Adams's (2008) collective review of 10 American studies and one English study, suggests that "well-developed PLCs have a positive impact on teaching practice and student learning" (p. 80). Eight of the eleven studies found that

learners' learning improved as a result of teachers' participation in PLCs and highlighted the focus of teacher collaboration efforts as being important.

For PLCs to really have an impact on teachers' PCK, PLC discussions and activities "should focus on teachers' practices and the knowledge required for these practices" (Brodie & Shalem, 2011, p. 2). Brodie and Shalem's (2011) research proposes that in order to develop the required knowledge to improve teacher practice, the notions of "challenge", "solidarity" and "accountability" are important constructs that promote and support learning in professional learning communities. Through the discussions that take place around teaching and learning in PLCs, teachers become accountable to one another and "begin to imagine new possibilities and, in turn, develop new professional knowledge and accountability to that knowledge" (Brodie & Shalem, 2011, p. 3). The constructs of challenge, solidarity, and accountability in a PLC enable teachers to rigorously reflect on their practices in a safe space and become more critical in their discussions around teaching and learning, thus guiding teachers to become full participants in the community of practice.

2.5. Features that promote and restrict conversations in a PLC

2.5.1. Cultural barriers

Zhang and Pang's (2016) findings on PLCs suggest that cultural barriers may "hinder the development and sustainability of the PLC" (p. 16). These cultural barriers may include participants of a PLC showing respect for older individuals and authority figures. Participants in the research mentioned that "given that they (older teachers) are more experienced, I am more reluctant to propose my new ideas. I feel a little weird. When critiquing teaching performance during open lessons, we mainly touch on merits, rather than weaknesses. You know, this is the Chinese culture." (p. 18). According to Zhang and Pang (2016), when the focus in a PLC is "on maintaining collegial relationships without truly engaging in collaboration, there will be a unified voice without diversified and conflicting views" (p. 18). These cultural barriers hinder changes and innovative practices and will impede and "go against the practices of PLCs" (Zhang & Pang, 2016, p. 12). Discussions thus operate at a superficial level. A participant in Zhang and Sun's (2018) study stated that "when it is my turn to comment, I usually echo what the elders said" (p. 451). Further, Harris and Jones's (2010) study highlighted a dominant culture in the school as being a barrier to innovation and any changes

that were made were met with "resistance from teachers who were not familiar with this way of working or who felt suspicious about the work of the group" (p. 178). Further cultures that serve as barriers include individualism, privacy, and conservatism (Harris & Jones, 2010). Changing a school culture poses many challenges in that it entails changing habits and long-held practices. For professional development opportunities to attain their goals of improving teacher practice, there needs to be a "responsiveness to the needs of educators and learners and to the contexts in which teaching, and learning will take place" (Darling-Hammond, Hyler & Gardner, 2017, p. 6).

2.5.2. Time

For PLCs to be effective in changing the culture of a school, teachers need time to participate in professional development. Rahman (2011) found in his study that "as time goes on the teachers became more comfortable and relaxed in sharing and discussing successes and failures of their teaching with their colleagues" (p. 11). However, teachers who have full timetables and then have competing demands placed on them may find that their participation and learning in their PLC is inhibited. In Brodie's (2019) research on teacher agency, a participant stated that "schools have their own programmes in place, so you find that sometimes [the facilitator] will come, you know, and by that time there's a staff meeting, or there's an intervention, you know. It kind of compromised the whole programme" (p. 8). Cereseto (2015) found that "requiring teachers to be involved in multiple support or school improvement programmes at the same time distracts teachers from their PLC work and disrupts attendance and participation" (p. 244).

Jita and Mokhele's (2012) study investigating the efficacy of science and mathematics PLCs in the Mpumalanga province of South Africa found that teachers should be given enough time to participate in professional development programmes and recommend that it "should happen while the teachers are engaged in their work and profession" (p. 581). In the study by Zhang and Pang (2016) participants stated: "every Tuesday afternoon, our English teachers will have no lessons. Such arrangements guarantee our free time for meetings" (p. 17). Professional learning then becomes part of the teachers' school day and is not seen as being an additional demand that they are expected to fulfil. Maloney and Konza's (2011) research found that teachers' attendance at PD sessions were affected when PD was done after school hours. A participant in the study reflected that "sometimes it is hard to effectively articulate my thoughts

due to tiredness" (p. 81). Some teachers may feel that participating in a PLC is overwhelming due to their teaching and home commitments. In Brodie's (2019) study on teacher agency, one of the findings for rejecting the PLC was that it took place after school and clashed with teachers' afternoon commitments. A participant who withdrew from the project stated that "you really find no time to give to this other project, because you know I have at least to give also my time to this because it's my contractual obligation […] with the workload that we had, it's overwhelming, you know, really, really it's overwhelming" (p. 8). To promote commitment and participation in PLCs, the activities should be relevant and engage teachers on matters relating to how they can improve their practice. The participants in Brodie's (2019) study who found the project work valuable to their teaching and learning made the time to meet. One of the participants noted that "what I've also learnt is that here on earth there's no time, but one has to make time for anything after all" (p. 8).

Supovitz and Christman's (2003) study highlighted that teacher participation in the PLC did not automatically translate into better instructional focus for teachers. For example, their research found that the teachers collaborated in the PLC and adopted a unifying theme with the intention that the learners would make connections between their subjects and the real world. While the aim of the unifying theme was to get teachers to plan, to integrate subjects, and to develop interesting and engaging units, the efforts at teacher collaboration failed to achieve the envisioned outcomes and resulted in isolated events being planned and carried out e.g., field trips and special assemblies. In the research conducted by Supovitz and Christman (2003) the rationale provided for the failure of the PLC to increase instructional focus among its teachers, was that the communities spent too little time discussing teaching practices and problems that surfaced during lesson time. When instructional topics arose during the collaborative planning sessions, "the interactions took the form of administrative matters and one-way transmission of information from one teacher to the next" (p. 5).

The research conducted by Doolittle and Rattigan (2007) suggests that a lack of common planning time for teachers, and lack of whole school support for ongoing professional development, can result in schools not focussing on efforts to improve learning, but rather reflects a school culture where teachers work in privacy and isolation. Nehring and Fitzsimons (2011) argue that teachers who plan and work in private are counterproductive in developing their teaching practices.

2.5.3. Providing support, development, and focus

Louis and Marks's (1998) study suggests that the participation of teachers in PLCs contributed towards a sense of support and development as well as a sense of collegiality and cohesiveness when it came to working towards achieving a common goal. The PLC participants in Louis and Marks's (1998) study commented as follows: "group discussions are collegial, open and different opinions are respected" (p. 149). The research completed by Smith (2016) suggests that a common goal supports a sense of community and mitigates some of the effects that emerge from differences in academic qualifications or hierarchies. A teacher in the study commented that there was a "working together irrespective of our different professional backgrounds – members feel accepted, and others are willing to assist whenever it's necessary" (Smith, 2016, p. 150).

PLCs provide participants with support to grow subject matter knowledge as well as specific strategies that may prove helpful in creating understanding for learners. In research completed by Hudson (2015) one of the participants stated that "PLCs made her a better teacher by listening to other teachers" (p. 34). The research conducted by Smith (2016) suggests that teachers' confidence increases due to the collegial support that is received as a consequence of collaboration and having a structured approach towards growing teacher knowledge. One of the teachers in this study stated that "my self-esteem has gone up through mentorship" (Smith, 2016, p. 146). Capraro et al. (2016) conducted research on the impact of sustained professional development across three urban schools in the USA. Their findings reflected an improvement in teaching strategies due to the collaboration of teachers in their PLC. One participant recalled that "improvement in teaching strategies has occurred because of the collaboration between new and old teachers" (p. 192). Chauraya (2016) found that in order to develop PCK, constructive collaboration requires teachers to be open to criticism and to be receptive to feedback from colleagues, especially about their own knowledge and teaching practices. Providing support to teachers facilitates growth and enables teachers to make those shifts in their knowledge and practice (Chauraya, 2016). A participant in Chauraya's (2016) study stated:

> Sometimes you feel that the information you get from that teacher, that colleague, it is not enough. It is rather better when you are in a team… and you find that you have more ideas rather than asking one person… Ja, because you may find that there is a problem, you go to another teacher you find that no, even from that teacher its difficult, but when

> you are here sometimes we get [inaudible] from you, so it helps… Uhm to me, I can say if we can continue, we learn a lot (p. 205).

The research conducted by Lalor and Abawi (2014) involving eleven teachers who were part of a phenomenological case study to gain a deeper understanding of their lived experience participating in PD, found that PLCs provided social and emotional support which strengthened teacher participation in PLCs. The teachers in the study felt safe to question and learn from their peers in the PLC, which resulted in teachers building knowledge, social, and emotional support amongst themselves. One of the participants in the study stated that "whenever I've had some queries, I've been able to ask" (Lalor & Abawi, 2014, p. 81). However, Wells and Feun's (2007) study revealed that participants highlighted many challenges when working in PLCs. Participants in the study described their colleagues as "abrasive", "negative", "threatening", "bullies", "loud", "screamers", "angry", and "uncooperative" (p. 154). Further, Maloney and Konza's (2011) research in Australia found that the participants' willingness to attend further sessions and contribute towards the discussions gradually decreased. This was due to teachers not feeling sufficiently confident in expressing conflicting views and opinions with those that had dominant views. For example,

> the focus on play as a medium for learning was an area that warranted robust debate. For Kindergarten teachers this was a strongly held belief, but for the Year 3 teachers learning through play took a significantly minor role in their day-to-day teaching; yet the Year 3 teachers were reluctant to take a stance, put forward a view and advocate for their belief of what play in Year 3 might look like. (Maloney & Konza, 2011, p. 81)

Reflecting on and discussing contentious points pertaining to ones' teaching practices among colleagues can also be a stressful activity as compared to a co-construction of knowledge (Maloney & Konza, 2011).

Brodie (2019) argues that even though teachers may seem not to engage and contribute actively to PLC discussions, they "always enact agency" (p. 3). The study conducted by Brodie (2019) focused on how teacher agency determined the level of participation from teachers in a PLC by either enabling or constraining participation and influencing teachers' decisions to either continue or withdraw their participation. The study focused on understanding the reasoning behind learners' mathematical errors and revealed three categories of teacher agency: "engaging with communities, abstaining from communities and rejecting communities" (p. 3). The findings from the study suggest that teachers who withdrew from the PLC found the focus

"irrelevant to their current teaching and demoralising" (p. 7). A participant in the study queried "Where, what, how do I benefit from this… it was nice arguing, identifying some of those errors made by learners, trying to think why they made these mistakes, how, why, you know, those different views from learners, people justifying those wrong answers, it was fun, it was fun, but you know, in as much as it was fun… I couldn't link what we were doing with what we are doing in the classroom" (p. 7). Other reasons for teachers enacting their agency and withdrawing or abstaining from the PLCs included a lack of time, high workloads, teachers not wanting to work with colleagues, a lack of trust and having conflict with the schools' administration (Brodie, 2019). The teachers who enacted their agency by continuing their participation in the PLCs appreciated the focus of the PLC, were able to make connections between the activities of the PLC and their classroom work and saw the benefits and support that it provided for their learning.

Furthermore, the teachers who continued with their participation, did so because of the support that was provided by the leadership of the school, and they appreciated collaborating with other teachers. Trust amongst the different stakeholders in the PLC played an important role between the participating teachers and those who chose to withdraw. A participant in the study who chose to continue with participation stated that "we can talk to the community members freely without, how can I say, stage fright. We are confident because we are talking with colleagues, knowing that no-one is judging you" (p. 10). However, a participant who withdrew from the study stated that "I thought that maybe this is just someone's project, or maybe we are just facilitating research for the project" (p. 10). Having a shared focus among participants of a PLC encourages active engagement among participants whilst a focus that may not be relevant to participants of a community may result in participants leaving or choosing not to attend (Brodie, 2019).

To support collegial relations among participants and to promote collaboration in a PLC, Ono and Ferreira's (2010) study investigating professional development involving secondary school science teachers in Mpumalanga, highlighted key points to consider when collaborating and engaging in activities in SSPLCs. During a post-lesson discussion in their study, participants of the PLC focused their discussion on the instructional skills of the presenter which resulted in the participants losing confidence. They suggested that to avoid demoralizing teachers, participants of the PLC "should learn what to observe during lesson study and how to record their observations" (Ono & Ferreira, 2010, p. 67). These include: "firstly, identify positive

aspects of the lesson; comment on the lesson, not the presenter; use the lesson instead of the teacher; identify the areas to improve with suggestion(s)" (p. 67).

Teachers should feel safe and secure amongst the other participants in their PLC, and they should create an environment where teachers are allowed to show vulnerability in asking for assistance or guidance. Brodie and Shalem's (2011) research illuminates "that as teachers accounted to each other for their lesson designs and analysis, they built a professional community characterized by both challenge and solidarity, and that the processes of challenge and solidarity in the teachers' interactions supported them to be vulnerable, as a group, to make their tacit knowledge explicit, to imagine new possibilities, and thus to be accountable" (p. 9).

The participants in Brodie and Shalem's (2011) study also displayed accountability. The discussions focused on the processes of solving equations where learners needed to balance scales with different amounts on each side. After the PLC session, the group made changes to some of their tasks to accommodate suggestions from PLC participants to include more examples on their balances of the equal to sign "where previously all their examples had expressions with variables on the left-hand side of the equal sign" (p. 12). The changes that were made to their lessons on balancing equations were a consequence of the participants' accountability to their original lesson plan as well as to the challenge made by participants of the PLC (Brodie & Shalem, 2011). A participant in Capraro et al.'s (2016) study stated that the rigour in their PLC enabled them to learn and grow. A participant in their study observed that "this has been my first-year teaching chemistry, so without the [professional learning communities], I wouldn't have been able to improve with my kids, to teach, to complete everything because […] we help each other all the time. We talk. We share comments [and] concerns when we get together" (p. 192). Creating an environment where teachers are able to challenge one another's lessons and activities promotes learning, and having solidarity for each other in the PLC enables participants to be comfortable and confident in challenging each other's practice.

Brodie's (2014) study shows how participation in PLCs supported shifts in teachers' knowledge on learner errors by "supporting each other to interpret both what was valid and not valid in the learners' thinking" (p. 231). Solidarity among participants in a PLC grows and strengthens when participants share experiences of teaching and learning similar to those of other members in the community. An example of this is that of a teacher in Brodie's (2014) study who stated: "you know what, the same thing happened in Sarah's lesson, a kid came up

and did exactly the same thing, he labelled the positive part of the y-axis with negatives, all the way down" (p. 230).

Teachers share common knowledge in teaching and learning and can identify with each other's challenges. These common, shared experiences develop more congenial relationships and help build solidarity within a group. The participants in Brodie and Shalem's (2011) study were able to identify with each other's successes and constraints, indicating that under similar conditions they would have made the same choices. This support enabled the teachers to participate fully in "accounting for their teaching and making suggestions for new teaching practices" (Brodie & Shalem, 2011, p. 10). The support and solidarity that was expressed among the teachers enabled and helped develop a safe environment where teachers could be critical and challenge one another on matters relating to teaching and learning and in so doing create new knowledge (Brodie & Shalem, 2011).

2.5.4. Developing shared values

Teachers that share similar personal and professional values that are associated with education can build trust and develop collegial relations more easily. Louis and Marks's (1998) study suggests that a professional community enhances classroom practices and occurs as a consequence of teachers developing joint values and accountability through collaborative work that is focused on the well-being of learners. Having shared values is important for teachers when learning is involved (DeMatthews, 2014). DeMatthews (2014) highlights taking collective responsibility as an important value that teachers should have. Teachers who took collective responsibility for learning "rarely have excuses for failure, and believed that their PLCs and the dialogue, reflection, and problem solving that occurred were the tools for improving their practices and their schools" (DeMatthews, 2014, p. 193). Another shared value that is important to the success in a PLC is persistence (DeMatthews, 2014). One of the participants stated that "we have a lot of challenges, but challenges aren't excuses. We come together to address those challenges" (DeMatthews, 2014, p. 193). When the discussions in PLCs have a shared and common focus and are centered around the development of PCK the "outcomes produce significant growth in student learning and performance" (Supovitz & Christman, 2003, p. 5). Having shared values enables teachers to work towards a common goal

and assist in overcoming many challenges by using the collective expertise and knowledge of teachers within the PLC.

2.5.5. Trust

Research suggests that trust amongst participants contributes towards the success of PLCs attaining their intended outcomes by improving learning opportunities. If teachers are required to contribute towards discussions, to be vulnerable and open-minded about their teaching practices, participants of a PLC must trust one another and be honest about their intentions. In the context of a school, there should be trust in the principal, colleagues, parents, and learners (Lee, Zhang & Yin, 2011). The study conducted by Smith (2016) revealed that there are three contributing factors towards building trust in a PLC. These include "a culture of openness and acceptance; the dependability of those in leadership roles and a collegial disposition among members" (Smith, 2016, p. 148). Gray's (2011) research on PLCs and the role of enabling school structures and trust found that the greater the participants' trust in the principal, and collegial trust of the school, the more successful the PD will be in attaining its outcomes. In the study completed by Hipp, Huffman, Pankake and Olivier (2008) one participant stated: "I think our administrators trust their teachers with their ideas and what they think about their students because, after all, we know our students. And they trust us and it's mutual" (p. 184).

Trust is based on the ethical behaviour of all participants in a PLC and to facilitate honest and open collaboration requires its participants to trust one another. When teachers question the outcomes as not being beneficial to them, trust among participants can become compromised. A participant in Brodie's (2019) study demonstrated distrust in the process, and consequently, withdrew from the PLC and stated the reason for leaving the study was: "because at the end of the day, we would see it as research which benefits someone and not us really" (p. 10). Honest behaviour can be shown through "integrity of character, authenticity and accountability for one's actions" (Tschannen-Moran & Gareis, 2015, p. 260). Brodie and Shalem (2011) suggest that a combination of challenges and solidarity among teachers support accountability conversations among each other in a PLC and as a result, teachers are able to engage in deep discussions where their practice can be challenged with the aim of developing "new professional knowledge and accountability to that knowledge" (p. 3). However, past experiences may restrict the development of trust among participants, and this may

compromise honest discussions among participants. A participant in Brodie's (2019) research had trouble with trust as she was concerned about being judged. Brodie notes that "her concern came from her experiences during apartheid, where school inspection was judgemental, and inspectors held a lot of power over teachers' careers" (p. 10).

Teachers who are reliable and helpful and considerate of the needs of the PLC and its members are often seen by the participants as individuals who can be trusted. Participants develop confidence in their peers' recommendations and are more willing to discuss and ask for advice from someone who is seen as being informative in classroom instruction. A teacher in Hallam, Smith, Hite, Hite and Wilcox's (2015) study stated that "I think when everyone comes to the team meetings prepared and has done their jobs, trust is there" (p. 201). Another participant in the study stated that "trust is built through listening to everybody's complete thoughts – not jumping in the middle of them and disagreeing, but listening" (Hallam et al., 2015, p. 202). For trust to be built amongst participants, they should feel supported and not feel as if though they are being judged. In the research completed by Hallam et al. (2015) it was noted that after three years of participation in the PLC, many of the staff had created a bond of trust with one another as a result of sharing personal information in their PLC. The sharing of personal information enabled teachers to develop solidarity amongst each other. A fifth-grade teacher observed that "when you are willing to share not only your successes but the things that you're struggling with, that is a sign of trust" (Hallam et al., 2015, p. 201). In an environment of distrust, teachers disengage from the discussions, and this can compromise the authentic collaboration that needs to take place in a PLC.

2.5.6. Learning through collaboration

The process of collaborating in a PLC encourages deliberate, ongoing, collective and systematic professional learning with the aim of improving teacher practice and learner outcomes (Brodie, 2018). Brodie's (2018) review of the Data Informed Practice Improvement Project (DIPIP), which is a teacher professional development (TPD) programme for high school mathematics teachers in South Africa which supports curriculum and pedagogical reforms, suggests that participation in PLCs enabled teachers to make shifts in their practice towards the needs of their learners. The findings from the study suggest that teachers who

participate in a variety of developmentally sequenced activities in their PLCs are able to make shifts in their PCK as well as their own SMK due to the focus of the PLC conversations.

Hudson's (2015) research on teachers' perceptions of the influence that PLCs have on their classroom decisions found that PLCs influence the decisions that teachers make regarding their instruction. One of the participants in the study stated that "by participating in PLCs, I have learned to take ownership of my learning, which has caused me to change my instruction. I focus on learning and teaching; not just teaching practices" (p. 34). The collaboration amongst the participants reflects a mutual relationship where participants in the relationship contribute, benefit, and grow from learning from each other. Zhang and Pang's (2016) research, however, provides us with some caution on administrative requirements for teacher collaboration. They argue that "teachers may stress the ends more than the means, and focus only on how to get the same results rather than involving in genuine and in-depth dialogues" (p. 17). Consequently, this may lead to superficiality and conformity. A participant in their study stated that "(b)ecause we always discuss together and require the sameness, now our teaching styles are quite alike, so are our ways of thinking" (p. 18).

Jita and Mokhele's (2012) study found that the collaboration amongst the participants in their cluster enabled the teachers to go beyond just discussing specific content knowledge, allowing teachers to discuss problems relating to pedagogy and classroom practices. This collaboration was enabled through the support that was provided in the cluster and teachers sharing their experiences (Jita & Mokhele, 2012). Louis and Marks's (1998) research suggests that teachers are able to create new knowledge and build capacity through collective inquiry in a PLC and, as one teacher reflected, "I wouldn't give my partner up for lottery. We really have it [teaching together] down and really complement and supplement one another. I couldn't ever imagine teaching without a partner again" (p. 24). Similarly, a participant in Zhang and Pang's (2016) research mentioned that "we work together a lot in teaching preparation and producing teaching aids, and we enjoy working together very much." (p. 18). Teachers get to understand each other through discussions and working in teams. The collaborative space creates the environment for teachers to be innovative in who they collaborate with and what they collaborate on. Furthermore, Jita and Mokhele (2012) stated that collaboration amongst participants in their study "soon became convenient vehicles for networking and fostering subject-specific collaborations" (p. 580) to improve their PCK.

Dogan, Pringle and Mesa's (2016) review investigating the impact of PLCs on science teachers' practices and knowledge state that a teacher's change in practice involves the "incorporation of instructional techniques, integration of new materials, curriculum implementation or basic improvements in teaching process and classroom setting" (p. 3). Collaboration amongst participants in a PLC helps facilitate these changes. PLCs offer a means for teachers to reflect upon and improve on their practices (Harris & Jones, 2010). For example, in research conducted by Harris and Jones (2010) it was found that when teachers wanted to develop a greater learner voice, through collaboration and reflection on practice with other teachers in a PLC, materials were developed for learners to use to support their learning conversations. Harris and Jones's (2010) study found that, "PLCs allowed the school to develop pupil voice in a meaningful way and has engaged teachers in changing the style, content and nature of their interactions with pupils" (p. 177). An alignment of the PLC activities with the various stakeholders that are involved in professional development "helps build the shared vocabulary and common goals required to sustain instructional improvements through rigorous feedback" (Archibald et al., 2011, p. 4). PLCs play an important role in assisting teachers to use their knowledge effectively to promote learning (Vescio et al., 2008). One of the participants in Hipp et al.'s (2008) study stated that "It's amazing to watch how much people can learn just feeding off of each other" (p. 180). Harris and Jones (2010) foreground professional networking and collaboration as major contributors for change in PLCs.

A study conducted by Owen (2015) focused on how teacher learning within a PLC context translated into improved learning outcomes where discussions were centered around teachers' learning, planning, teaching, and assessing collaboratively within PLCs. Teachers from the case-study schools valued working in their teams and stated that their community provided them with the necessary support to change their practices around teaching. One of the findings from the study suggested that co-planning and co-teaching can help guide teachers develop more engaging learning approaches that meet the needs of the learner and improve learning in science (Owen, 2015). This is consistent with the findings from Louis and Marks's (1998) study on communities informing and supporting a change in practices. The change in practices were attributed to the teachers developing joint values, collaborative work, using inquiry approaches focusing on the needs of the learners, and taking shared responsibility for other members in the community (Owen, 2015). The following comment typifies the benefits of collaborative inquiry and team teaching in changing teaching practices:

> we sat down and we had a lesson plan. Both of us went, 'oh that's just boring, like it's easy and it's boring. But let's try and do something new, let's try and make it interesting and stuff. (Owen, 2015, p. 62)

Collaborative planning allows teachers to feed off each other's enthusiasm and provides teachers with the confidence to try new approaches to teaching and learning in science. Beyond just planning co-operatively in the PLCs, teachers are actively engaging in their pre-planning as well as post-planning sessions, re-evaluating and unpacking activities and pedagogies by reflecting on learners' progress in order to create knowledge that will, it would appear, inform their PCK and ultimately future practices. The following comment made by a teacher illustrates this reflective practice:

> So, we meet every week, every Monday, to not just plan ahead but also [to] reflect on what went well. (Owen, 2015, p.64)

The reform initiatives, using the PLC model, reflected a positive influence on shifting the instructional practices of teachers in Owen's (2015) study. Research conducted by Owen (2015) showed "improvements in literacy and numeracy, whole classes of learners achieved higher for specific skills than other classes from previous years" (p. 65). Learner feedback supported the idea that varied teacher explanations due to team teaching contributed towards their increased understanding of concepts (Owen, 2015). Further, collaboration among teachers in the form of collective planning led to more innovative teaching aids and resources being developed to teach scientific concepts. Comparative results from the previous year's examination results reflected an increase in performance from 65% to 83% (Owen, 2015). Mkhwanazi (2014) also argues that "it is not the existence of these communities that brings about professional learning but teacher collaborations and the conditions that encourage that collaboration" (p. 430).

2.5.7. On-going nature of professional development

Steyn's (2013) study investigating collaboration in implementing ongoing PLCs in South African schools, suggests that professional development which includes one-day workshops, which they may create awareness around general topics, do not necessarily lead to "improved practice" (p. 282). Kempen and Steyn's (2016) study found that the contributing factors that

lead to the participants' commitment in a PLC is the on-going nature of the professional development, which, according to the participants in the study "led to a feeling of ownership, a sense of direction and purpose followed by excitement and accountability" (p. 36).

Jita and Mokhele (2012) found that participants preferred the ongoing nature of their PLC and that this structure enabled them to gain "knowledge through sharing information with other teachers" (p. 579). Richmond and Manokore (2011) suggest that "sustainability is the outcome of both the physical and social capital" (p. 23). A participant in their study stated that "I am thinking about the possibility of continuing. We need other types of grants to come and help us continue" (Richmond & Manokore, 2011, p. 23). The on-going nature of PLCs can provide teachers with ample opportunities to help one another with the necessary support regarding instructional reform. Further, in the research conducted by Jita and Mokhele (2012), the ongoing nature of the PLC enabled participants to form smaller subject-related groups and "to share knowledge and expertise under the facilitation and support of university-based subject matter experts" (p. 579). This feature of their PLC enabled teachers to network, share, and collaborate with other individuals involved in education, to improve their teaching and learning and ultimately their PCK. This collaboration may include discussions on knowledge about the different methods and instruments of assessments in science. Participation in a PLC requires intensive, committed, and continuous involvement from teachers. However, as Katz and Earl point out: "Erratic participation in PLCs does not yield the envisaged outcomes of PLC initiatives" (Katz & Earl, 2010, p. 41).

Singh (2011) conducted a qualitative study from two different contexts: structured, and unstructured learning programmes. This involved participants completing a questionnaire in Limpopo Province, South Africa. One site had implemented a structured staff development programme. The other site offered sporadic staff development opportunities that were not necessarily relevant to their needs. The workshops that the staff attended, in structured programmes, were on contextual issues that staff identified with, and these workshops were presented by members of the staff themselves. The findings from this study revealed that the teachers felt that the PD programmes that were implemented were "tailor-made for them and their school environment" (p. 1633). Focused, organized and on-going activities facilitated shifts in teacher instruction. The teachers commented that "they felt part of a team because all of the staff were involved, and they were able to socialise with one another" (p. 1633). The findings from the second sample reflected that PD activities in the sporadic staff development programme did not address the needs of the teachers and were therefore ineffective. Singh

(2011) recommends that "schools should use a model of staff development that is tailored to suit the individual needs of their teachers and school" (p. 1633) and that staff development should be an on-going process that is dynamic. This is particularly relevant for South African schools where learners and teachers come from diverse socio-economic and cultural backgrounds.

The literature that has been explored thus far suggests that PLCs can be an effective and powerful means of developing collegial relations among participants in a community, and that they support teachers in engaging in ongoing professional development to re-organize and shift their instructional practice (Brodie, 2014; Stewart, 2014; Owen, 2015). For PD to be effective in improving teachers' practice and learners' learning, professional learning must connect teachers to the learning that is happening in the classroom by analysing assessments and learners' work, watching videos of lessons, and questioning and critiquing teacher' practices. The literature has shown that there is a strong link between the activities and content of the conversations that take place in the PLCs. This is particularly important for my study as the participants are participating in two PLCs namely, GPLCs and SSPLCs, and will provide me with insight into the content of the conversations as well as which activities elicit deep discussions on learner thinking and teacher practices. Characteristics of PLCs have been identified in the literature that both support and impede learning. This suggests that teachers do enact agency in regard to PD: either by engaging with communities, or abstaining from participating in communities, or by rejecting communities. The discussion in this literature review will now move on to looking at teacher learning in science subject-specific PLCs as well as GPLCs.

2.6. The influence of subject specific PLCs on teacher development

Subject specific professional learning communities can help facilitate changes in teachers' PCK about the goals and objectives for learners in science as well as the articulation of those guidelines across topics. These shifts in knowledge demonstrate that teachers are developing their knowledge base in the subject, and ultimately, their PCK. In the five-year study conducted by Richmond and Manokore (2011) that was planned to improve science teaching in urban areas through teachers' community of enquiry, a participant who was part of the study stated that "I am now comfortable with my project colleagues more than my peers in this building […] we share about how to teach science better to our kids" (p. 559). PLC sessions allow

teachers to develop their discipline-specific knowledge through interactions with their PLC colleagues. Another participant in the study stated: "I needed more science knowledge because my discipline was not science in college; I wanted more content knowledge and teaching strategies. This project gave me professional courage to discuss best methods to teach each unit. I learned more from this project and nothing from my colleagues in the building" (Richmond & Manokore, 2011, p. 560).

Furthermore, Ratts et al's (2015) research found that "PLC members who reported observing peers, providing feedback related to instructional practices, working with colleagues to judge the quality of student work, and collaboratively reviewing student work to improve instructional analysis, were more likely to improve the quality of their teaching. These practices were found to improve learning outcomes for students" (p. 57). SSPLCs can offer participants support and confidence to use different methods of instruction and in the process develop their PCK and SMK. In the study completed by Richmond and Manokore (2011) a participant in the study stated that "the best overall contribution to me is that it (the project) gave me a new level of confidence to teach science well, to understand the standards, to wade through the trivial, focus on solid science concepts and teach it well. The evidence is in my students' test scores. My students are doing well […] they understand science" (p. 561). Participation in SSPLCs can help teachers develop their knowledge about the purposes and goals that teachers have for teaching science to a particular grade.

Brodie and Borko (2016) argue that "professional learning requires a deliberate, collective focus on issues of teaching, learning and schooling" (p. 155). They further argue that "collectivity is important because professions grow through the collective development of knowledge" (Brodie & Borko, 2016, p. 155). In SSPLCs, teachers learn about topic-specific strategies and practical ideas for teaching science. In another study conducted by Rahman (2011) it was shown that through discussions in the PLC participants were alerted to gaps in their SMK and PCK. For example,

> Teacher 14 agreed with Teacher 13 that his emphasis was more on recall, or the recognition of the facts, rather than understanding of the concept of solution. His claim also included: that students might understand how they can make saturated solutions from an unsaturated solution, but they were still not clear about how different variables (for example, solvent, solute, temperature) worked to make a saturated from unsaturated

> solution and vice-versa. Teacher 14 then agreed that he needed to focus more on these issues. (Rahman, 2011, p. 12)

Furthermore, in the same study "Teacher 13 was also convinced by the claim by Teacher 14 that his way of taking account of students' prior knowledge was not effective for the lesson" (p. 12).

Teachers in SSPLCs participate in different activities to develop topic-specific representations – which include reflecting on learner achievement – to gain knowledge to improve their SMK and PCK and as such also improving their means of communicating concepts to facilitate learning. Brodie's (2014) study highlighted how on-going teacher collaboration informed teachers' understanding of learner errors and shifted how they talk about learner errors. Brodie (2014) suggests that through on-going collaboration on learner errors, teachers make three shifts in their learning which enable them to think deeply about these learner errors. These shifts are: "from identifying to interpreting errors; from interpreting to engaging errors; and from focusing on learner errors to focusing on their own knowledge" (Brodie, 2014, p. 221). These shifts in learning can help teachers develop SMK as well as their PCK.

Liebenberg (2016) draws on Brodie's work on learner errors and suggests that teachers' discussions about their practices and their learners' misconceptions are used as stimuli for discussions into engaging teachers in critical reflections on their own practice. Brodie (2014) goes on to note that conversations among teachers "can support them to learn to engage with their learners' errors in appropriate ways" (p. 224). The focus on the type of conversations in PLCs is important in determining what is learned. Brodie and Chimhande's (2020) study used the data collected from the DIPIP project to analyse how teachers' participation in developmentally sequenced PLC activities "shape the content and depth of their conversations" (p. 119). Four content areas were used to analyse the PLC conversations. These included learner, mathematics, practice and learner thinking. A cycle of six activities were designed to focus teachers' enquiry and involved: "test analysis; curriculum mapping; learner interviews; readings and discussion; lesson planning and lesson reflection" (Brodie & Chimhande, 2020, p. 120). Participation in these activities enabled teachers to identify and discuss the "reasoning underlying learner errors and provided opportunities for discussions of learner thinking, teachers' own mathematical knowledge and practice" (Brodie & Chimhande, 2020, p. 119). In the test analysis activity, teachers identified the learner errors and discussed some possible reasons behind these errors. Following this discussion, conversations were held around how

teachers' practice, or the curriculum could be linked to learners making these errors (Brodie & Chimhande, 2020). Based on the conversations around learner' errors, teachers collaborated and planned lessons to consolidate their understanding of the critical concept that was identified. Readings that were provided during the PLCs provided teachers with possible contexts as to why these errors occurred. Teachers then discussed strategies on how to teach this critical concept. During the lesson planning stage, the conversations focused more on mathematics (45%), which meant that teachers' discussions were centered around teachers developing their content knowledge SMK. The other three content areas focused on discussions that centered around PCK. During the lesson reflection stage, the focus of conversation was on practice (56%), which reflected teachers' conversations that focused around developing their PCK. Conversations on teachers' own mathematical knowledge enabled teachers to grow their SMK. Community conversations about teachers' practice enabled teachers to shift their practice and, in the process, develop their PCK. For example, in their study, when the focus of the discussions in the PLC was more on the learners as compared to teachers and their lessons, "(t)eachers spent substantial time trying to understand how the learners were thinking when they made errors" (Brodie & Chimhande, 2020, p. 125). In the same study, when the focus of the collaboration was on lesson planning, the teachers spent 29% of their time on discussions on practice, 10% on learner understanding, and 12% of the discussion time on learner thinking.

The focus of PLC discussions is important in eliciting the type of conversations needed for gaining knowledge of subject-specific instructional strategies in science. In the study completed by Liebenberg (2016), the teachers were challenged to reflect critically on their knowledge, their pedagogical decisions, and their learners' errors, with the intention to learn, create new knowledge, and improve on their practice. In that study, one participant stated that "for me, it is about giving the learners the self-confidence to use the knowledge that they do have" (Liebenberg, 2016, p. 70). Liebenberg's study also highlights that teachers learn from conversations that reflect on their own practices, and from using evidence in the form of learners' work to determine how effective they are in their teaching. Cereseto's (2015) research suggests that by focussing the PLC discussions on learner errors, the teachers focus on trying "to understand the root of misconceptions and to understand learners' thinking" (p. 260). So too, Stewart (2014) feels that the focus on understanding the specific needs of the learners has been found to improve teaching practices. These needs include knowledge of areas that learners find difficult to grasp, and the kinds of errors that are common, especially those science concepts that are abstract.

Stewart (2014) states that "the mission of a PLC is to gain a deeper understanding of how students learn content and then apply that understanding to how content is taught" (p. 29). This type of knowledge also includes any prior specific science knowledge that learners should know before teaching a new or unfamiliar concept. In gaining a deeper understanding of how learners learn, teachers make shifts in SMK and PCK as they interpret learners' thinking through collective inquiry. A change in teachers' instructional practice is more evident when they are given the opportunity to participate actively in their own learning. These include learning from reviewing learners' work with colleagues, observing other teachers' lessons, and being given the opportunity to practise what they have learned in their classroom (Archibald et al., 2011). Brodie (2014) suggests that "challenge" in a PLC is important to move people out of "their comfort zones to create new ways of thinking about and interacting with their learners" (p. 226). Vescio et al's (2008) review recommends that "to demonstrate results, PLCs must be able to articulate their outcomes in terms of data that indicate changed teaching practices and improved student learning" (p. 82).

The research study conducted by Cereseto (2015) on SSPLCs, suggests that the support and guidance from the school leadership, particularly the support from the Head of Department (HOD), plays an integral role in teachers participating in SSPLCs. HODs have more interaction with teachers and can guide and focus PD opportunities. HODs can offer academic and supportive roles in a SSPLC by coordinating and guiding "teachers on the latest ideas and approaches on the fields within which their subjects are based" (Christie & Monyokolo, 2018, p. 170). These discussions are subject-specific and contribute towards building more engaging pedagogies and ultimately the teachers' PCK. Brodie's (2018) review of the DIPIP project suggests that the participation of the HOD in one community and the deputy in the other community contributed towards the two communities in the same school making the most shifts in the practice. The role of the HOD in the PLC is not an authoritative role, but one of support, with the focus of developing knowledge and skills to improve teaching and learning. However, the findings from Capraro et al's (2016) research also highlighted negative aspects of school leaders in PLCs. Three focus groups in their study revealed that school leaders interrupted PLC meetings (Capraro et al., 2016).

2.7. The impact of SSPLCs on science teachers

Dogan et al's (2016) review of fourteen articles investigating the impact that PLCs have on science teachers' knowledge and practices suggests that PLCs play an integral role in the "systematic reform efforts supporting science teachers' learning" (p. 2) and in the process developing their PCK. Twelve out of the fourteen articles reviewed suggested that teachers' participation in PLCs led to changes in their practice (Dogan et al., 2016). Changes in teaching methods imply that teachers can make shifts in their PCK by implementing the practices discussed in the community. Changes in practice come about as a result of encouragement from peers during collaborative discussions where instructional techniques are deliberated upon and teachers are encouraged to be innovative and try new instructional practices (Dogan et al., 2016). For example, in the review Dogan et al, (2016) explains that, during the PLC sessions the science teachers talked about how they could identify science knowledge in other sources, so as to make science more accessible to their learners. Sirum and Madigan (2010) suggest that science teachers' talk about discipline-specific knowledge enables teachers to highlight learners' misconceptions and develop material in the form of interactive teaching strategies that will promote learning.

Sirum and Madigan (2010) conducted research in the USA on the role that science teaching learning communities (STLCs) experienced in promoting sustained change in science department teaching behaviours and attitudes. Their findings suggest that STLCs can promote change in how science teachers act that in turn can lead to improved learning. In a study conducted by Rahman (2011) on how science teachers' learning in a PLC influences the way in which participant teachers learn about and develop their practices, it was suggested that collaborative discussions with colleague teachers are important, as discussions help to change teachers' culture of professional practice. In Rahman's research, one teacher stated: "I do not know how I can go; I am not used to discussing anything face to face with my colleagues before" (p. 11). In the same research, after attending a few PLC sessions, teachers felt more comfortable participating and discussing issues which indicated a change in their culture of learning and level of confidence. As another teacher observed, "today I feel more relaxed as I know what we have to do" (p. 11). Another teacher noted: "I feel more comfortable than the first day; I understood that the discussion helps us a lot to clarify our ideas about teaching, so I like to share my mistakes and failures with my colleagues openly" (p. 11). One of the main focuses of science PLCs is the focus on community members spending time interrogating the

learners' work to learn and gain new knowledge to improve on their practices (Louis & Kruse, 1995).

The research reviewed above shows that the discipline-specific character of professional learning communities does provide support for teachers in the form of SMK and PCK, as they can apply what they have discussed and learned in their learning communities. This support provides the teachers with feedback and confidence which can lead to a change in the culture of teaching science, towards teaching scientifically, and talking about their teaching (Sirum & Madigan, 2010). Richmond and Manokore (2011) state that in their science PLC sessions teachers did not only discuss which concepts their learners found difficult, or how to motivate their learners, they also discussed best pedagogical practices which offered participants the opportunity to learn, to increase their confidence in science teaching, and to strengthen their own PCK. The participants commented that "the project was worth the experience; the whole experience was beneficial, and the collegial contacts I made were great! I can call my (PLC) colleagues and talk to them about science teaching anytime" (p. 555). The science PLC serves as a resource for science teachers to discuss their SMK and PCK. Another participant stated, "it is important to talk to others. I have learned a lot from them (colleagues), and I am getting better every year" (Richmond & Manokore, 2011, p. 558).

2.8. Generic professional learning communities and their impact on teacher professional development

An overview of the literature on SSPLCs suggests that SSPLCs' focus is on subject specific professional learning which has the potential to change teachers' practices and the capacity to improve learners' learning by using examples of learners' work and examining practices to improve learning. In the process teachers' SMK and PCK would be developed. Participation in GPLCs as another form of PD can also play an integral role in PD and can contribute towards developing and supporting teachers to change their practices. Furthermore, GPLCs offer an opportunity for teachers to collaborate, participate in learning conversations that are generic, contribute towards the development of GK, and create common meaning and understanding of concepts which helps develop whole school focus.

There is consensus that the quality of experiences that learners are exposed to depends on the quality and knowledge of the teachers (Vescio, Ross & Adams, 2007). Changing teachers' practices requires teachers to build on their own knowledge in an environment that is conducive

to learning and supports the development of knowledge. GPLCs are collaborative environments where generic conversations can take place that facilitate the learning of teachers. In a study completed by Onodipe et.al. (2020) various tools e.g., Blooms taxonomy, books about modifying teaching strategies and technology tools were used in the Faculty Learning Communities (FLC), a form of GPLC, to develop participants' knowledge and support them in implementing the flipped classroom approach to learning. Their findings indicated that the participants used the knowledge gained from the FLC to "experiment with different techniques in their flipped classrooms and thus expanded their repertoire of pedagogical skills" (Onodipe et.al., 2020, p. 3). The participants in the study reported that their understanding of flipped classrooms deepened due to their participation in the FLC.

Participating in multi-disciplinary teams support the development of teachers' practices (Owen, 2015). A participant in the study conducted by Owen (2015) recalled their learning process "I tended to use a lot of PowerPoints in my teaching, and I think I felt comfortable… So, it meant it was already up on the screen, that I could keep up with the kids" (p. 63). Observing lessons being taught by other teachers caused the participant to re-think his strategy. He explained that he "found that […] does a lot of board work, and I actually found sometimes the board work is really useful for kids in their learning because you can actually see how things develop. (Owen, 2015, p. 63). These findings are supported by Onodipe, et.al. (2020) who suggests that acquiring a deep understanding of "instructional techniques lead to the rethinking of instructional delivery and teaching styles" (p. 3).

Maloney and Konze's (2011) study in Australia consisted of twelve teachers and eight educational assistants who participated in the GPLC. The study sought to explore "what processes are used to develop an effective professional learning community" (p. 78). Part of the activities in the PLC included teachers examining "their own perceptions, knowledge and pedagogy, and elements of effective early childhood education" (p. 80) through discussions around pre-determined questions. The participants of the PLC also participated in debates that centred around strengths, challenges and opportunities for the different year levels. Additional activities included teachers participating in conversations and discussions with the intention "to further negotiate and articulate a shared understanding of principles and the associated practices that could form the basis for the school policy" (Maloney & Konze, 2011, p. 80).

Harris and Jones (2010) conducted a study on a GPLC which involved the participation of six schools. The PLC participants involved teachers who teach at different levels, each having

different expertise and experience. The PLCs identified innovations that should be implemented in their schools e.g. thinking skills, curriculum, and pupil engagement, and with the help of the other schools, worked on implementing these innovations. For example, in response to year 7 learners not engaging in the teaching activities, teachers developed alternative programmes that included greater use of IT and practical activities in their teaching (Harris & Jones, 2010). Another PLC group wanted to develop greater learner voice in the school and engaged in activities that involved researching "how greater co-construction and pupil involvement in decision-making could be achieved" (Harris & Jones, 2010, p. 177). Once the research was completed, participants of the PLCs developed materials, for both teachers and learners, to support their learning conversations.

Teachers who receive communication that is consistent and ongoing regarding best teaching and learning practices are better suited to change their knowledge around teaching and learning practices (Archibald, Coggshall, Croft & Goe, 2011). In the research conducted by García-Carrión et.al. (2020) on a community-based school model, a form of GPLC, "the ongoing professional dialogue between newly appointed and more experienced teachers" (p. 10) enabled new staff to increase their self-confidence and build relationships in the school" (p. 10). Lola, a participant in the study recalled how the learning that took place in the learning community caused her to rethink her practice. The discussions in the learning community encouraged her to support her students who were special needs students in their classes as compared to removing them from their classes and working with them independently. She stated, "and when I got here, they said to me: "No, you're going to work within the classroom with these children, supporting the class teacher, you take part of a community. And I don't know why, why I fell in love with the project, and I was hooked right away" (p. 9). Owen (2015) suggests that "developing joint values, through collaborative work, with practical activities focused on students, using inquiry approaches and having responsibility for other team members and sharing leadership and leadership support" (p. 62), supports teachers to make changes to their practices. A participant in the study stated:

> I did not believe in this style of education, I was just a bit wary of it, and […]'s presentation] concerning innovative work done by students in several year levels and the skills they had develop and the student-produced video evidence] … I thought 'Oh wow, oh yeah, this could happen'… I was really inspired, And I thought 'Wow this does really work'. I was wrapped… It really helps with who you actually are working with, and

> having those weekly meetings. Being able to bounce off style of each other was fantastic. Now everything is discussed and shared (Owen, 2015, p. 63).

Learning conversations in GPLCs are generic and cover an overview of best teaching and learning practices which can be used to grow teachers' GK. PLC engagement among participants does not always work smoothly and can be impeded by various structures in an organisation. Harris and Jones (2010) highlight that "organizational structures and strong subject boundaries can prove to be barriers in building whole school learning communities" (p. 178). In the study conducted by Maloney & Konze (2011) one of the challenges of ongoing participation in the PLC was maintaining interest and enthusiasm as "the level of interest and enthusiasm demonstrated by several of the teachers dissipated" (p. 81). Another challenge included teachers having the confidence to challenge dominant views in the PLC (Maloney & Konze, 2011). While there are challenges that are experienced by participants in a GPLC, the literature on GPLCs reflect that engaging in these forms of PD have a significant role to play in developing teacher knowledge. GPLCs support teachers with providing them with knowledge of alternative forms of instruction and support them in implementing alternative approaches to teaching and learning. Besides developing collegial relations among participants, GPLCs have a positive influence on the environments within which schooling takes place and teachers' efficacy.

2.9. Conclusion

The overview of the literature review on PLCs suggests that while PLCs are a facilitative environment that contributes significantly to school reform, cases have been documented in the literature where learning in PLCs have been impeded. Overall, though, PLCs are an alternative option and can be a powerful means of professional development – a move away from teachers working in isolation, towards teachers working collaboratively in a community of practice. The collaborative inquiry among participants of a PLC highlights the social experience of learning that is guided and informed by conversations around various teaching and learning artefacts within the community of practice, with the aim of developing teachers' SMK and PCK. While GPLCs create a supportive and collegial environment for teachers to collaborate and develop GK, the literature informs us to improve instructional practices, the focus of the discussions should also be on teaching and learners' learning which occurs in the SSPLC.

The literature also informs us that a change in teachers' practice requires a re-organization of existing knowledge and practices that require teachers to engage with teaching and learning differently. The literature review also highlights that culture, time, support, shared values, trust, collaboration, and the on-going nature of PLCs, are norms that can either promote or impede conversations and collaboration that are essential to learning. The literature review has highlighted that in some cases, PLCs can promote superficiality and conformity in teachers' practice. Dominant cultures within PLCs may restrict constructive learning conversations among participants, and in the process impede learning. Harris and Jones (2010) state that individualism, privacy and conservativism among participants in a community can also restrict learning. A lack of trust among participants and past experiences may also contribute towards PLCs not achieving their intended outcomes. Therefore, conversations that enable learning, solidarity, challenge and accountability are important in a PLC. The literature suggests that the focus of a PLC, as well as the type of activities and artefacts that PLCs use in their inquiry, are important in eliciting the types of conversations that are needed to shift teachers' practice.

While there is agreement that PLCs help improve teacher knowledge and skills, the research does not tell us how two different PLCs can work together to support teacher learning and grow teacher knowledge. The opportunity presents itself to conduct my particular research study that focusses on comparing the learning opportunities that are created by GPLCs as well as SSPLCs, and to then analyse the complementary roles that the PLCs have on growing teacher knowledge to support science teachers' collaborations and instructional reform.

Chapter 3: Research Design and Methodology

3.1. Introduction

Creswell and Miller (2000) suggest that the researcher should engage and build an argument for their chosen approach in the various discourses which are available on methodology and methods, in a thorough and methodical manner, to ensure the credibility, validity, and reliability of the study, and ultimately its findings. The previous chapter focused on the theoretical framework and the literature review. In this chapter, I will explain how I collected and analysed the data on the roles that the GPLC and SSPLC played in promoting teacher learning and informing teacher practices in the classroom. I start by focussing on the research approach which the study adopts and move on to explain the research design, research methods, research strategies, data analysis, ethical considerations, and credibility of the study.

3.2. Research approach

My research questions required me to determine how GPLCs and SSPLCs co-produce knowledge to contribute towards teachers' pedagogical content knowledge (PCK). It was necessary to observe teachers' participation in both of the PLCs over time. Participating in GPLCs and SSPLCs views learning as being situated in a context. As discussed in my theoretical framework in chapter 2, a person's intention to learn is engaged and the meaning of what he/she is learning is formed "through a process of becoming a full participant in a social cultural practice" (Lave & Wenger, 1991, p. 29). I was interested in understanding how teachers use the collective knowledge developed in the PLCs through discussion and reflection on their practices, learners' work, and collaborative planning to inform their learning.

A qualitative research methodology is suitable for this study, as qualitative methods allowed me to explore and understand the development of teachers' PCK as they participated in their GPLC and SSPLC. An essential feature of a qualitative approach is that it seeks to "explore human behaviours within the contexts of their natural occurrence" (Hatch, 2002, p. 7). A qualitative approach allowed me to "see things through the participant's eyes" (Du Plooy-Cilliers, Davis & Bezuidenhout, 2014, p. 173). Furthermore, a qualitative approach helped me to collect rich, descriptive data on the complexities of the existing phenomenon, which

provided a deeper understanding of what the participants' views and experiences of the two learning communities were, and how these communities worked together to influence teachers' learning and pedagogical practice.

3.3. Research design

A case study helps to determine the boundaries of a study. In other words, what the actual focus of the study is, for the researcher to demarcate or "fence in" (Merriam, 1998, p. 27). My study is an "empirical inquiry that investigates contemporary phenomena within its real-life context" (Yin, 1994, p. 13). Case studies are an account of a "single unit or system bounded by space and time" (Hancock & Algozzine, 2017, p. 11). In the context of this study, the bounded system refers to intermediate phase (Grades 4-6) science teachers participating in two PLCs: GPLCs and SSLCs, where the discussions centre around teaching and learning. Observations in the SSPLC included teachers participating in collaborative planning, lesson observations, and post-lesson reflections. Observations of teachers participating in the GPLC included teachers discussing different theories of learning, examples of lessons, difficulties experienced in teaching and personal challenges that teachers may have experienced. One of the strengths of using a case study is that it enables one to "observe effects in real contexts, recognising that context is a powerful determinant in both causes and effects" (Cohen et al., 2007, p. 253).

A further advantage of using a case study is that different sources can be used to gather data (Maree, 2007). I found an exploratory case study design to be best suited to my research as it enabled me to gain a comprehensive and in-depth understanding of teacher learning in real situations within the context of participating in GPLCs and SSPLCs. By adopting an exploratory case study, I was able to understand the teachers' perceptions of events, which I would not have been able to access through quantitative means. The data sources that I used in this case study came from teachers who were part of the same research setting and were comprised of teacher interviews and observations, which allowed me to capture the case in its complexity. The methods used in this case study helped me to obtain rich data that had depth and accurately portrayed what it was like to participate in the PLCs. In turn, a close-up reality was highlighted through thick descriptions of the participants' lived experiences (du Plooy-Cilliers et al., 2014).

3.3.1. Selecting the participants

The school

This study had to be conducted in a school where teachers participated in both GPLCs and SSPLCs as part of their professional development. The school is where I teach, hence my interest in these communities. As indicated in chapter 1, the professional development programme was designed and implemented by the head of professional development as a whole school strategy to improve instructional practices by providing teachers with platforms to engage with issues relating to education – namely, pedagogy, theories of learning, and assessment strategies.

The objective for teachers participating in these learning communities is to build PCK. The school is situated in the northern suburbs of Johannesburg and is an independent school that comprises four phases in one school, namely: a nursery school, junior preparatory, middle school, and senior school. Although each phase has unique pedagogical, organisational and instructional needs, all phases are connected by shared values and a common mission. This provided an excellent environment in which to conduct the study.

Being an independent school, there is more flexibility and independence to tailor professional learning programmes for its teachers. It also has more funding and varied resources at its disposal to invest in teacher professional development programmes. Furthermore, the school's management team have been working hard to develop a strong professional learning culture in the school as a means to improve teachers' practices and pedagogical reasoning. GPLCs and SSPLCs serve as environments where issues of teaching and learning can be discussed and shared. In 2018, generic as well as subject specific professional learning communities were introduced to assist teachers to acquire new skills with the aim of developing their PCK, improving learners' learning and to facilitate a common language about teaching and learning among the staff.

The GPLCs consist of a diverse group of around 9 to 14 staff members who teach in the different phases of the school, and as mentioned in chapter 1, is run by the head of professional development. A GPLC may have teachers from the nursery school, junior preparatory, middle school, and from the senior school. To accommodate all the teaching staff members, there are eight GPLCs which are referred to as Thinking about Thinking and Teaching (TaTT) sessions. These communities meet every fortnight and follow a structured curriculum where the

discussions centre around theories of teaching and learning. The aims of the GPLC are to develop generic knowledge, facilitate community, support personal and group pedagogical knowledge, and to improve working relations among staff who teach in the different phases of the schools. For the purposes of this study, data was sourced from one of the GPLCs.

In addition to the GPLC, the school's professional development model also includes SSPLCs. The SSPLCs include teachers who teach the same subject in the same grade or phase. In total there were 26 SSPLCs functioning in the different phases and subjects of the school. Data for this study was sourced from teachers who participate in the intermediate phase (Grades 4-6) Natural Science SSPLC. These teachers meet once a week to collaboratively develop teaching materials, discuss content, share experiences, and explore various means to deliver best teaching practices that are specific to their subject and relate to the context of their classrooms. There is a structured planning and inquiry process that is followed by the teachers in this PLC. Planning units of study in science is done collaboratively and the teachers take into consideration how relevant the activities and knowledge are to real life situations, reflect on their learners' learning to design and scaffold the activities accordingly, and discuss best pedagogical practice that could be used to teach the unit of study. Once the planning phase is completed, the lesson is then taught. During the final phase, the team meets at the next SSPLC session and uses learners' work, examples from what they have viewed on the video-recordings and observations of how learners have engaged with the lesson and activities in an effort to identify concepts that learners find difficult, and through discussions, come up with alternative activities and instruction techniques that will promote learning and, in the process, develop their pedagogical practice. The rationale for this model as a means to promote professional development is that teachers need to have a deep and broad understanding of the content they are teaching, and to have an opportunity to build their PCK.

This study aimed to investigate whether the GPLCs and SSPLCs, with their focus on the relationships between theories of teaching and learning, instructional practices and student work, can work together to improve teacher PCK and practices. The professional development opportunities at the school provided me with an excellent environment to study the extent to which the two learning communities support one another to promote improved practices in the classroom.

The teachers

Du Plooy-Cilliers et al. (2014) state that sampling helps the researcher identify the candidates who could be of assistance in obtaining answers to the research questions. The teachers in the study formed a purposive sample, which involved participants in the study who have been chosen because of "some defining characteristic that make them holders of the data needed for the study" (Maree, 2007, p. 79). As my research question required me to focus on teachers who teach science and participate in GPLCs and SSPLCs as a means of improving their practice, I selected three Grade 4 teachers who teach in the intermediate phase of the school and are active participants in both communities. As intermediate phase teachers, the participants teach all subjects in Grade 4. The focus for this study is on their science teaching and their participation in the science SSPLC and the GPLC.

For ethical reasons, pseudonyms will be used to protect the identity of the teachers. Frank has a Bachelor of Arts (Psychology) Honours degree with 10 years of teaching experience. Ravi has a Bachelor of Education with 12 years of teaching experience, and Sarah has a Bachelor of Education with 23 years of teaching experience. Ravi and Sarah have been working at the school for five years and six years respectively and have been participating in the professional learning communities from their inception in 2018. None of the teachers have specialist science qualifications and Frank has a Bachelor of Arts degree and has not taught science before. Ravi and Sarah have completed a Bachelor of Education with all subjects. Frank has been at the school for 3 years and is an active participant in the PLCs. Studying these teachers' discussions, reflections, and practices gave me an opportunity to understand how the two learning communities work together to inform teacher practices.

Table 3.1: Selection of teachers

Participant's pseudonym	**Number of years teaching**	**Number of years at School X**	**Participating in GPLC**	**Participating in SSPLC**
Teacher Frank	10 years	3 years	3 years	3 years
Teacher Ravi	12 years	5 years	3 years	3 years
Teacher Sarah	23 years	6 years	3 years	3 years

3.4. Research methods

The aim of the study was to investigate how two learning communities namely: GPLCs and SSPLCs support one another to promote teacher learning. Putnam and Borko (2000) state that "discourse communities provide the cognitive tools – ideas, theories, and concepts – that individuals appropriate as their own through their personal efforts to make sense of experiences" (p. 5). The research methods adopted to collect the data to address the research questions were in the form of interviews and observations.

3.4.1. Data collection

Data collection took place from June 2020 – March 2021, much longer than anticipated because of the COVID-19 pandemic. I experienced intermittent delays during the data collection process as a result of the various lockdowns. During the initial alert level 5 lockdown, the school closed, and the participants could not meet face-to face. The SSPLC meetings were held online using google meets from June 2020 to November 2020. The SSPLC participants were comfortable meeting online and this continued even when the school opened during October of 2020. As soon as the teachers returned to school, I conducted face-to-face interviews in October to November 2020. During this period, I was able to video record two lessons, one of Frank and another of Sarah teaching their science lesson. These recorded lessons were used in the SSPLC reflection session to elicit discussions among the participants. However, soon after the restrictions were lifted, the government implemented a lock down again and the school closed. The GPLC sessions could not be accommodated online due to timetable constraints and only resumed in February 2021. The GPLC sessions could only be recorded from February 2021 to March 2021 when the schools were allowed to open under strict protocols.

Interviews

I used interviews in my research, as according to my theoretical framework, knowledge is something that is generated between humans, rather than the view of knowledge as something that is external to individuals. Hatch (2002, p. 91) suggests that interviews "uncover the meaning structures that participants use to organize their experiences". The interviews were

semi-structured and face-to-face. Semi-structured interviews, which are more flexible, provided me with an opportunity to identify new emerging lines of inquiry that had become apparent during the interview and which related to the research topic. Opie (2004, p. 118) describes a semi-structured interview as:

> a more flexible version of the structured interview which will allow for a depth of understanding to be ascertained by providing opportunities to probe and expand the interviewee's responses. It also allows for the deviation from a prearranged text and to change the wording of questions or the order in which they are asked.

In my approach emphasis is placed on the social situatedness of knowledge which aligns with my theoretical framework. An interview is a conversation between two individuals with the aim to collect data about views, interpretations, opinions, and behaviours (Maree, 2007). In addition, an interview places human interaction and engagement central to knowledge production and "emphasizes the social situatedness of research data" (Kvale, 1996, p. 14).

I conducted two individual interviews with each participant. Each participant was interviewed separately. I trialled the interviews with a Natural Science teacher in order to fine-tune the data collection processes and questions that were planned (Yin, 1994). These first interviews were conducted at the beginning of the data collection process and the interview took about an hour each (see *Appendix A*). The first interview with each of the teachers focused on obtaining data about the type of activities and discussions that the teachers engaged in while participating in the SSPLC and GPLC and how each of these PLCs contributed to and supported the development of their PCK. Further, this initial interview also focused on highlighting the teachers' knowledge about the vertical and horizontal curricula for science. Vertical curricula refer to the SMK that is covered in a particular subject in the different grades and horizontal criteria refers to the SMK that is covered in the subject over the year in one grade.

The second interview also took an hour each and focused on the teachers' PCK (*Appendix B*). The questions that were designed for this interview aimed to elicit conversations on the teachers' practice and if any changes to their practice was as a result of their participation in the PLCs. My focus in this interview was to elicit discussions on the teachers' PCK. I wanted to find out what the teachers' orientations were towards teaching science as well as their knowledge about the various curriculum materials that they used for teaching a particular concept. I conducted this interview at the end of the SSPLC collaboration cycle. Conducting the second interview after one of the SSPLC collaboration cycles allowed me to clear up any

misunderstandings and provided me with an opportunity to probe more to get rich data. The second interview also served as a means of validation where I could confirm that what the teachers were saying was a factually correct account of what had taken place and as a check to see whether the essence of the first interview has been captured accurately.

In the interviews, the teachers were able to provide me with details of their experiences of participating in the PLCs, as well as the influence that each of the PLCs may have had on their instructional decisions and the use and choice of particular curricular materials. I was guided by the questions in the interview schedule and where the opportunity arose for me to dig deeper to obtain richer data, I deviated from the schedule to probe these issues. Recording of the interviews using an audio recorder ensured a more consistent and accurate transcription (Creswell, 2012). I conducted both sets of interviews after school in a safe and comfortable environment, and at a time that was convenient for each of the teachers.

Observations

In addition to using interviews to collect data, I used observations from video-recordings of teachers teaching lessons as well as collaborating during SSPLC and GPLC sessions to capture the data that I needed. These observations served as another source of data for a more powerful analysis. Two lessons showcasing Frank and Sarah teaching the lessons, using the planned methods of instruction, and learners engaging with the activities, were videotaped, and used as a tool for practice to facilitate discussions at the post-lesson session of the SSPLC. Each of the lessons were forty-five minutes in length and offered me the opportunity to observe how the planning was being implemented and the outcomes thereof. The lessons covered a section on diseases in the body systems which included the skeletal system - osteoporosis, muscular system – muscular dystrophy, digestive system – irritable bowel syndrome and healthy diet - anorexia, and involved learners working in groups, collaborating, and conducting research to create an understanding of their assigned disease. Unfortunately, Ravi's lesson could not be recorded due to the Covid-19 restrictions.

The SSPLC discussions took place online as explained above. To continue with the SSPLC, Google meets was used to host the SSPLC sessions. Google meets has a function that allows meetings to be recorded. The GPLC sessions were recorded when the participants were allowed back to school. At the inception of the study, the participants of the study initially attended

different GPLC sessions. At the time of the data collection, due to the timetable changes implemented by the executive head, all three participants ended up attending the same GPLC. An assistant helped with videotaping the GPLC sessions. Observing teachers participating in the SSPLC and the GPLC using video-recordings enabled me to analyse the conversations that took place, as well as how artefacts and tools were used to elicit debates and discussions to create new knowledge that could inform teacher learning. I looked for teachers' conversations that went beyond just describing the content of the lesson or artefacts but focused more on the explanations, analysis, reflections, and debates of what worked, what did not work, and why it did not work. Using observations as part of my data collection process validated the data that was collected through the interviews and supported my analysis.

The observations consisted of ten sessions of the SSPLC which included: four planning sessions, three implementation/observation sessions and three post-reflection sessions. I also observed three sessions of GPLC as discussed above. The planning stage was informed by the content that needed to be covered. Teachers discussed what activities and resources would be best suited to teach the content. Teachers also discussed what assessments would be used to assess the learning. My observations focused on the discussions and debates that had taken place amongst the teachers and how the insights obtained from the discussions and debates informed the type of instruction and activities that were used by the teachers.

In the next three sessions, the teachers spoke about how they implemented the activities that they planned. My observations focussed on the implementation of the lesson planning to determine how the learners were engaging with the activities. The participants made use of observational tools which included class visits and collaborative subject specific discussions which were used to elicit discussions that would inform the participants on the approaches that they would need to adopt to facilitate learning. The class visits occurred when the children could attend school, however, the classes were limited to fifty percent capacity. The focus of the discussions during the implementation/observation stage was on the engagement of the learner and the teaching materials, sharing new practices as well as conversations on assessment.

Finally, I observed the post-lesson reflection which focused on observing teachers from the SSPLC unpacking their observations which they had made in implementing the lessons and to see how teachers use this data in a collaborative environment to inform future lessons and classroom interventions. The reflection stage of the collaboration took place after the theme

was taught which allowed the participants to reflect on and analyse their practices in order to understand which activities promoted learning and which practices and activities they found challenging. These reflections challenged their knowledge about their teaching practice. The reflection stage provided the participants with knowledge on the effects of their practices and provided the participants the opportunity to link the theory of teaching and learning with practice which in turn informed their discussions in their future planning sessions.

I also videotaped three sessions of the GPLC which included the three participants of the study and eleven teachers from different phases of the school. Including the three grade four teachers there was one nursery-school teacher, six junior-school teachers and four high-school teachers. I listened to the participants discussions about instructional strategies, theories of learning, classroom challenges, and teaching concerns with participants of the GPLC community to understand how the teachers' participation in the GPLC contributed towards their GK and informed their decisions in the SSPLC and vice-versa. The GPLC sessions took around an hour. Videotaping three GPLC sessions enabled me to observe the gestures, emotions, movements, and expressions of the teachers.

Shulman (1986) suggests that video-recordings are an important "means for developing strategic understanding, for extending capacities toward professional judgement and decision-making" (p. 13). Video recorded lessons also allowed me to view the lessons more than once, and without any distraction of noise or needing to go to my next lesson during the analysis process. Robson (2002) explains that observations provide a "reality check in that what people do may differ from what they say they do" (p. 310) and so observations also served to verify what the teachers said during their interviews. Cohen, Manion & Morrison (2007, p. 305) state that observations allow the researcher to witness "things that might have unconsciously been missed, to discover things that participants might not freely have talked about during the interview" (p. 396).

Cohen, Manion, and Morrison (2002) state that video-recording also provides richer data and can catch any non-verbal communication which the researcher may miss using other means of data collection. These video-recordings enabled me to go back multiple times and review the data carefully during the analysis period in an effort to report as accurately as possible. The video-recordings allowed me to analyse events in greater depth and to "supplement field-note analysis" (Hatch, 2002, p. 127). Marshall and Rossman (1995) state that "other researchers can validate individual interpretations by going back to the original recorded data" (p. 273).

3.5. Data analysis

I analysed the data using a content analysis approach. Content analysis can be described as a "systematic set of procedures for the rigorous analysis, examination and verification of the contents of written data" (Cohen et al., 2002, p. 475). Hsieh & Shannon (2005) state that qualitative content analysis can be described as "a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns" (p. 1278). Content analysis can be used to analyse data from various sources such as interview transcriptions, documents, video and audio products. It focuses on "meaning in context, is systematic and verifiable" (p. 475) and provides knowledge and understanding of the case (Cohen et al., 2002). During the analysis phase of the study, I transcribed all the interviews, the two video-taped lessons, the recorded GPLC and SSPLC sessions, and wrote detailed summaries of each session. I analysed each of the summaries, looking for who said what and their reasons. I searched for "presences and absences in what they said" (Brodie & Shalem, 2011, p. 7). This process enabled me to identify key themes in the data. In addition to using emergent themes that developed during the analysis phase to categorize and reduce the data, a content analysis approach allowed me to interrogate and reduce the text using the existing categories that had emerged during my theoretical as well as in my literature review. The data that was transcribed was in the form of text, and by using content analysis, verification through re-analysis was made possible (Cohen et al., 2002).

A content analysis approach includes the idea that texts do not carry just one meaning. Cohen et al (2002) argue that the meanings that need to be obtained are located in the contexts and "meanings have to be drawn in context" (p. 475). Cohen et al (2002) state that a content analysis approach describes the characteristics of conversations, its antecedents and its consequences. A content analysis approach allowed me to observe the purposes behind the communication, the context of communication, and its effects amongst teachers participating in the GPLC and SSPLC.

My first step in analysing the data, using a content analysis approach, involved identifying the different sources that I used from which to transcribe the data. These sources included participant interviews and observations. The second step involved transcribing all the data from one source at a time. The data that was transcribed was in the form of text, and by using content analysis, verification through re-analysis was made possible (Cohen et al., 2002). Once all the

data was transcribed, my third step involved reading all the text that had been transcribed. I read through the texts to get a general idea of the data that had been transcribed and I made notes in the margin to record my thoughts on what major themes seemed to be emerging from the text. To start building the concepts from my data source, I needed to unpack the text, examine it closely looking for similarities and differences, and expose the meaning and thoughts that emerged from it. I did this through the process of coding. While analysing my data, I allocated specific colours to the different codes that linked to my literature review. New codes that emerged from the data, some subsuming others, were also allocated colours.

My fourth step involved re-reading the text thoroughly, but this time I highlighted the dominant points and started categorizing the data according to the codes. This process allowed me to become familiar with the data to the extent where I was able to identify interesting patterns, contradictions, common characteristics and any unexpected features. I also highlighted emerging themes that I thought were important so that I could revisit them later during the analysis. The fifth step involved categorizing. As part of step five, I analysed the codes and looked for similarities, and put repeated codes together and grouped them so that I could reduce the number of codes, and also so that I did not repeat any codes. The process of grouping codes allowed me to notice new things as I thought about the data, which resulted in me having to go through the data set more than once to ensure consistency and rigour in the analysis.

The sixth step involved me waiting for a week, before moving on to the next step. I then took a section of my transcribed text and applied steps one through to five to see whether I came up with the same codes and categories. Making a "comparison like this is known as convergent validity" (Cohen et al., 2002, p. 150). This process added to the credibility and trustworthiness of my findings. My seventh step involved categorizing the codes onto an excel spreadsheet based on their similarities. I looked for codes that could be grouped to form sub-categories and then linked these to the main category. Cohen et al (2002) argue that "categories will need to be exhaustive in order to address content validity" (p. 479). My eighth step involved writing out summaries of the findings during the analysis. I analysed each of the summaries, looking for who said what and his/her reasons. The summaries were analysed, matched, contrasted, aggregated, and compared, which allowed me to focus and narrow my study (Hsieh & Shannon, 2005). For my ninth step, I added my interpretation, highlighting any interconnections between codes that seemed to emerge, and linked these to the literature.

3.5.1 The coding

The codes that I used to categorise my data for my interviews were based on themes that I discussed in chapter 2 which included trust, time, collaboration, challenges, and collegial relations. The new codes that emerged from the data included questioning practice and environmental support. In some cases, subcategories of codes emerged during the analysis, for example, for the codes: trust and challenges. During the analysis two forms of trust emerged, one being trust in the colleague and trust in the colleague's knowledge. For the code, challenges, the data reflected two forms of challenges: environmental challenges and personal challenges.

When analysing the two lessons that were taught by Sarah and Frank the codes that were used were lesson structure, learner engagement, teacher role and activities. During the analysis of the SSPLC sessions the codes that were used were informed by the learning cycle: planning, implementation/observation, and reflection. During the planning stage the new codes that emerged included content, activities, assessment and support, and collegiality. During the analysis of the implementation and observation stage the codes that emerged were questioning practice, sharing practice, assessment, reviewing activities and reviewing learners' work. During the reflection stage the codes were restructuring activities, sharing practice, collegial relations, and reflection on lesson. During the analysis of the GPLC sessions two main themes emerged: general discussions and focussed discussions. The focussed discussions were focussed on the learning manual. The subcategories of general discussions were: sharing experiences of Protea walks, sharing classroom experience and emotional support. Protea walks are where teachers voluntarily invite other teachers into their classroom to share their students' learning process and experiences. The subcategories of focused discussions were: change, courage; knowledge of AGES model, knowledge of SCARF model and discussions on assessment. The AGES acronym refers to: Attention, Generation, Emotion and Spacing and is suggested to assist with the retention of information and enabling individuals to retain information for longer. The SCARF model involves five domains of human social experience which include: status, certainty, autonomy, relatedness, and fairness and is suggested to help learners work effectively with one another by understanding human behaviour.

The tables below are a summary of my codes, a definition of each and some examples. An example of the process that was used to code the interviews can be located in *Appendix C*. A sample of the coding that was used to code the GPLC and SSPLC sessions can be viewed in

Appendix D and *Appendix E* respectively and a sample of the coding that was used to code the videotaped lessons can be located in *Appendix F*.

Table 3.2. Coding used for interviews

Codes	**Definition**	**Examples**
Trust	Having confidence in the practices and knowledge of colleagues.	• "*just being able to sit around the table and openly discuss issues and things will show trust enough*" • […] felt that she did not have to trust her "*TaTT [GPLC] session people as much as I need to do my subject specific [group]*".
Time	Teachers have time to attend PLC's.	• "*most people are willing to collaborate if it falls within [one's] working hours*"
Collaboration	Colleagues sharing practice and discussing ideas.	• "*we all contribute ideas, we all contribute to the workload […]and we all contribute our experiences to that particular scheme of work*".
Challenges	Limitations that restricted participation.	• "*was very insecure*" "*when I first started at [School X] or a couple of years in, I was always very nervous to say I didn't know how to do something or […] help me.*"
Collegial relations	Colleagues working effectively together.	• "*feeling of being connected to a big campus with a lot of colleagues*".
New codes that emerged		
Codes	**Definition**	**Examples**
Questioning practice	Participants questioning colleagues about their practices.	• "*we discuss each other's teaching methods, and we discuss what worked and what didn't work and then we take*

		from each other… it actually gives me a better picture you know, makes me understand children differently and how they learn differently".
Environmental support	Support provided by the organisation.	• "*how we can bring filming into the classroom. Having teacher 13 there to share that with us in the learning environment really brought new knowledge into my world*". • "*I do feel, this environment in particular that I have found myself in, the time here, […], is very nurturing".*

Table 3.3. Coding used for SSPLC sessions

SSPLC Session: Planning		
Codes	**Definition**	**Examples**
Content	The subject matter knowledge that was discussed.	• "*healthy diet and how a healthy diet affects the skeletal, digestive and muscular systems. So, if we look at the skeletal system, from a knowledge point of view, we just want the children to have an understanding of the different parts of the skeleton and the functions of the skeleton"*.
Activities	The tasks designed by participants for learners to complete.	• *"teach the class what they have learnt and make a google slide presentation".* • *"We have worksheets that consolidate everything*".
Assessment	A tool used by participants to measure learning.	• *If you can answer these questions that is what success looks like*". Ravi

		suggested that learners should "*teach the class what they have learnt and make a google slide presentation. So, they basically have to understand what they have learnt because they are teaching everybody else.*"
Support	The guidance provided by colleagues.	• "*I would really appreciate some ideas to make sure that we can push this through."*
Collegiality	Colleagues working effectively together.	• "*Sarah and Ravi have been helping me with that*" • "*That's great Sarah [Showing examples of models that could be built] Sorry, I have never seen that! Oh my gosh! That is fascinating*!"
SSPLC session: Implementation/Observation		
Codes	**Definition**	**Examples**
Questioning practice	Inquiring about the effectiveness of the instruction to promote learning.	• "*Yeah, that's a learning curve*" • "*Uh, the idea with this project is to do group work, how to work together as a group, and that's what we trying to upskill the kids in or is it about being able to research*?" Sarah contributed towards the discussion by explaining that "*it's a combination, so we do want them to learn how to collaborate with each other but then we also want them to learn how to access and use information from different sources*"

Sharing practice	Sharing ideas of alternative forms of instruction.	• "*we need smaller groups*" • "*maybe we can insert a self-reflection rubric at the end of every week to assess themselves and the group"*.
Assessment	A tool used by participants to measure learning.	• "*What I would like to know, I'm assuming we would give the kids the rubric beforehand so that they know what they are being assessed on and what they should be looking for?*"
Reviewing activities	The assessment of the effectiveness of planned activities.	• "*previously we thought we didn't have to look at the three questions and their research because we trusted that they will do it, and not everybody did it [the research]. So, what we have to insist on now, in order to assess their learning, is that every child should submit the three questions and their research*".
Reviewing learners' work	The assessment of examples of learners work to measure learning.	*instead of just marking the work as incorrect again, I gave the learner a few questions to answer to better guide her towards completing the activity.* 1. *What type of nutrients are absorbed into your blood stream?* 2. *Where do the nutrients go to once they are absorbed from the intestines?* 3. *Where does most of the digestive process take place?*
SSPLC session: Reflection		
Codes	**Definition**	**Examples**

Restructuring activities	Changing the requirements of the activity.	• *"almost feels like we have to almost prep them [learners] on how to do research before we give them a task, so if we really want the kids to have the knowledge then that might need to happen towards the end of year topic but at the beginning of year maybe we teach them how to research, how to be a project manager.*"
Sharing practice	Sharing ideas of alternative forms of instruction.	• "*I showed them how to read sentence by sentence and write it in their own words so that is something we should do at the very beginning"*
Validity of content	Colleagues working effectively together.	• "*that is a valid point and definitely something we will look at for the new year*".
Reflection on lesson	Using knowledge gained from past experience to improve a lesson.	• "*I quite enjoyed the twist that this project took this year. I liked all the different ideas that we used. We chopped and changed what we initially started off with, and it turned out to be pretty good*" • "*I should've got my desks into groups first because it took us a long time to get them into groups.*"

Table 3.4. Coding used for GPLC sessions

GPLC sessions: General discussions		
Codes	**Definition**	**Examples**
Sharing experiences of Protea walks	Discussions about observing lessons of peers who teach other subjects.	• "*was the most worthwhile thing for me because I learned, and I actually wrote this down; do this next time, do this*".
Sharing classroom experiences	Discussing experiences of lessons that have been taught.	• "*what we initially planned was they [learners] would present to the other groups and the other groups will have a chance to ask questions but as I say we didn't quite achieve it this week. We need to find a way where we can still have that but hold them accountable in some other way. I would really appreciate some ideas to make sure that we can push this through because I think it's a lovely learning opportunity*".
Emotional support	Acknowledgement of colleagues' emotional experiences.	• "*it's been a long and difficult year you know. A lot of things have changed just in our curriculum because of the way we structured our program to accommodate online learning*." Teacher 11 affirmed this with an "*Absolutely!*". Teacher 12 acknowledged that "*I never thought in a million years I would be teaching 10-year-old children with their parents sitting next to them and the fear that comes with that, you know.*

		Talk about courage and vulnerability".
GPLC session: Focussed discussions		
Codes	**Definition**	**Examples**
Change	Teachers talking about alternative forms of instruction in their practices.	• "*you get everything from the learners*" • "*they love it when they have to be the teacher*."
Courage	Teachers stating when they don't understand or disagree with colleagues.	• "*willing to take risks that come your way*". • Teacher 3 added that courage was being "*willing to take risks that come your way*".
Knowledge	The content that informs practices.	• "*the hippocampus runs along the innermost lip of the brain's cortex. It registers those experiences that are to be remembered when they occur, and then can later re-activate the relevant brain regions, in appropriate synchrony, across the whole cortex, facilitating recall of those memories*"
Assessment	Tool used to measure learning.	• *I enjoy the idea of regular testing.* • *we don't do testing. We don't have formal assessments although we have continuous assessments.*

Table 3.5. Coding used for videotaped lessons

Codes	Definition	Examples
Lesson structure	The format of the lesson	• Frank said to his class "…*your task for today is to conduct research on Osteoporosis*" • "*I want you to go outside, read that document to each other and discuss it*"
Learner engagement	How the learners participated in the lesson	• Frank asked his learners the following questions "*what is it? How is it caused? What treatment is advocated? And any other interesting information*". What is advocated? • Learner: *To advocate something is to recommend – to say that this is good, you should definitely use this.* • A learner asked a question "*Mr Frank, my question is while we are investigating, how will we work*?
Teacher role	How the teacher facilitated the lesson	• Frank then intervenes and reminds the rest of the class that these guiding questions are "*not just for the skeletal system*" • "*Hello! Grade 4's, So, I have got the roles on the cards here. So, you are going to choose. The cards have information that explain the group roles to you*"

3.6. Ethical considerations

3.6.1. Official ethics permission

Ethics approval was received from the University of the Witwatersrand Ethics Committee (Protocol number: H19/11/31). All protocols were followed. Informed consent was obtained from each of the participants and consent was obtained from the school to conduct the study.

3.6.2. Informed consent

Cohen et al (2002) state that informed consent includes "the procedures in which individuals choose whether to participate in an investigation after being informed of facts that would be likely to influence their decisions" (p. 51). The participants were informed that participating in the study was totally voluntary and if they declined to participate in the study, it would not count against them in any way in their current and future work. The participants were given an option to discontinue participation at any point if they felt uncomfortable in any way. Confirmation was provided to the teachers and the principal of the school that the data collected would be exclusively used for the purposes of research and would only be divulged to my supervisor and members of the research group.

The participants in the study included the three teachers who teach science and are part of the SSPLC, the learners in their classes and the teachers who participate in the GPLC. Letters were sent to the parents of the learners who participated in the study, informing them of the research being conducted and the extent of their child's involvement. The parents were asked to complete a consent form granting permission for their child to be part of the study and to be videotaped. I also gave the learners letters informing them of the research and asked them to fill out an assent form.

I approached the learners and discussed with them the points of the study and the objectives of the study. I encouraged them to ask questions to ensure that they knew what the study was about. I explained to them that the data would be used only for research purposes. Learners who did not give consent to be part of the study were not disadvantaged. They were seated in the same seats that they would normally sit in and engaged in the lessons as normal. I did not use any of the work produced by these learners in my study. The video was edited to mute their

participation and I pixelated their images on the video, so that no one can recognize or identify them.

A letter was also given to the teachers who participated in the GPLC informing them of the research being conducted and I invited them to be part of the study. The teachers were asked to complete a consent form which requested permission for them to be part of the study and to be videotaped. The three science teachers who are part of the SSPLC, and whose teaching was the focus of this study, were invited to complete two consent forms. One form invited them to be participants in the study and the second form requested permission for the participants to be interviewed, audiotaped, and their lessons to be videotaped. Permission from the principal was requested and obtained.

3.6.3. The researcher's role in the study

As the researcher of this study, I also played an integral role in both the PLCs. I am a facilitator of one of the school's GPLCs – but not the one that formed part of this study – where my role is centred around facilitating discussions about theories of learning and conversations around teachers' practices. The participants of this study who are Grade 4 class teachers, however, attended a GPLC that is run by another facilitator. I wanted to observe the teachers' participation, to listen to their discussions, opinions, and perspectives around teaching, learning, and instructional practices. In the SSPLC, my role was not as an observer but as a facilitator. This meant that I participated in the discussions that centred around learner performance and instructional practice. I contributed towards the planning of the units of inquiry and I formed part of the team that discussed and unpacked the post-lesson observations. I understand that my role in the PLCs undoubtedly influenced my role as the researcher and how my colleagues saw me as the researcher. I will discuss this below.

3.6.4. Managing potential conflicts of interest

As the head of department (HoD) of science and facilitator of the SSPLC, there were potential conflicts of interest. In order to mitigate these, I explained to the participants that my intention was to find out how GPLCs and SSPLCs could work together to support teacher learning, and that the only purpose was to observe teacher learning. I made it clear to the teachers that in no

way would the data be used for appraisals or promotions in the school. Neither the principal nor the head of professional development would have access to the data and no conversations that occurred in the study would be discussed with other members of staff or management.

I provided the participants with a letter explaining the research, what I was looking for, what was expected from them and the duration of the study, and I then invited them to participate in the study. The participants were given adequate time and opportunity to think about the ethical considerations and pose any questions they had before making their final decision to participate in the study. I suggested to them that they could hand in their consent forms (either agreeing to or not agreeing to participate in the study) to the principal and not directly to me thereby eliminating concerns about social penalties arising from their choice either to participate or not to participate. The principal agreed to assist in this role and monitored the wellbeing of the Grade 4 participants. The principal informed me of the teachers' decisions to participate in the study. Furthermore, the teachers were informed that the principal would be monitoring my engagement with them during the study. If they felt that they had been disadvantaged or coerced in any way, they could talk to the principal, which would not result in any ill-effects for them whatsoever.

This process prevented manipulation, undue influence, or coercion from me as the researcher, as I was accountable to the principal and bound by the ethical commitments to the University of the Witwatersrand Ethics Committee. I also provided the teachers with the details of the school's psychologist should they experience any discomfort or require debriefing. This could take place at no cost to them. Alternatively, if the teachers had any queries, concerns, or complaints regarding the ethical procedures of this study, they were informed that they were welcome to contact the University's Human Research Ethics Committee and given the contact details. At each stage of the research process the participants could report to the principal if they were no longer willing to participate in the study. There would be no consequences should they choose not to participate.

All the participants that were approached, participated in the study. At no stage of the research process did any of the participants approach the principal to complain about the research process. On a positive note, the research process motivated one of the participants to apply to start their own Masters degree.

3.6.5. Anonymity

I have made certain through the descriptions used that the settings and participants would not be identifiable in the research. The location and descriptions of the settings were disguised to appear similar to those of other schools. Code names in the form of pseudonyms were used when referring to either the teachers, learners, or the participating school (School X).

3.7. Limitations of the study

Cohen et al (2007) suggest that a weakness of using a case study design is that the results from the research may not be generalisable. Nonetheless, the findings from the study can be a source of research data that informs or contributes to other studies in the field. Furthermore, generalisability of the findings can be achieved in contexts "where other readers/researchers see their application" (Cohen et al., 2007, p. 256). A camera as well as a 'stranger' in the classroom is not part of the learners' and teachers' everyday classroom experience. This could have affected the way the teachers and learners normally would participate in the class as they would have either tried to impress me or the presence of the camera. So too, a 'stranger' could have caused them to become nervous, and subsequently reserved. However, as I observed the learners and teachers, they did become more relaxed as the lesson progressed. This may, however, still have had an adverse effect on the validity of my findings.

The effects of the Covid-19 pandemic were being felt by the country during the data collection process. The emotional toll that the participants were going through during this time as a consequence of family members getting sick, or colleagues and family members dying cannot be disregarded and this may have influenced how they participated in the SSPLC sessions. Covid-19 level 5 regulations prohibited the gathering of individuals. The SSPLC meetings had to be held online via Google Meets. Not being able to meet face-to-face could have influenced how the participants responded to one another and to the questions that were asked during the SSPLC discussions. Online meetings also restricted my ability to observe the body language of the participants during the SSPLC meetings.

3.8. Rigour in the research

In this section I will discuss the different strategies that I used throughout the research process to increase the validity of the data and establish trustworthiness.

3.8.1. Potential bias as researcher and participant of the study

Cohen et al (2002) argue that the researcher can become biased during data collection and analysis, which may result in the study becoming less reliable. Since I am also the facilitator in the SSPLC and the HoD of Natural Science, there was a possibility that I may have had participant bias or unconscious bias. As a consequence of researcher bias the findings from a study may be prone to distortion. For instance, in either understating or overstating the case. Although bias cannot be fully eradicated from the study, it can be reduced. Various measures were taken to reduce bias in this study. For example, I informed the teachers that my only interest in the study was for the research and that what I collected and found would not be used in any other way. I made sure that the interview questions did not contain any leading questions that might have directed the interviewee towards an intended outcome. The parameters of how the PLCs function were discussed and agreed upon by all the teachers. The discussions and procedures were guided by the measures that were put in place. Some of these measures were that the focus of discussion was on improving instructional practice, and the discussions that take place in the SSPLC would follow the order of a three-phase cycle: the planning phase, the implementation/observation phase, and the post-reflection phase. The GPLC is guided by a manual that contains activities and theories of learning around which discussions are centred. These features restricted me from making any changes as to how the PLCs were functioning or steering discussions in a direction other than its intended purpose. The principal of the school agreed to monitor my engagement with the teachers and the research process.

I also reduced bias using reflexive analysis or reflexivity. Krefting (1991) states that "reflexivity refers to the assessment of the influence of the investigator's own background, perceptions, and interests on the qualitative research process" (p. 218). As both a participant in the PLCs and the researcher, it was important for me to be aware of and to reflect on the influence of these roles on the study. As part of the reflexive process I reflected on my engagement with the participants and examined what effect this had on the data gathering and

analysis process. I made ongoing use of a field journal to describe and interpret my behaviour and experiences while participating in the study. Krefting (1991, p. 218) suggests that the field journal should include three types of information:

> The first includes the daily schedule and logistics of the study. The second includes information about the methods log in which decisions about methods and their rationale are described. The third type of information will include the researcher's thoughts, feelings, ideas and hypotheses generated by contact with informants.

I also wrote down any questions that came to mind, as well as problems and frustrations that I experienced in the research process. Writing in the field journal alerted me to any biases and preconceived assumptions that I was developing. My supervisor also focused on issues of potential bias and alerted me to them where necessary.

3.8.2. Credibility

Credibility is the "adequate representation of the constructions of the social world under study" (Bradley, 1993, p. 436). I used triangulation of data methods as a strategy for upholding the accuracy of my data and enhancing the credibility of my study. Triangulation of data methods involved that I collected data using various methods from multiple sources of evidence over a period to ensure the richness and trustworthiness of the data being collected as well as to ensure that all aspects of teacher learning were investigated by cross checking data and interpretations. These methods included collecting data using interviews and observations.

While there are many benefits to using triangulation as a strategy to enhance the credibility of one's study, there are disadvantages. Thurmond (2001, p. 256) highlights the following to be disadvantages of triangulation:

> (a) the increased amount of time needed in comparison to single strategies, (b) difficulty of dealing with the vast amount of data, (c) potential disharmony based on investigators' biases, (d) conflicts because of theoretical frameworks, and (e) lack of understanding about why triangulation strategies are used.

There will always be a risk of human bias when conducting research. I have taken steps to minimize the risk. When conducting the interviews, to ensure that the data reflects exactly what the participants have said, I recorded the interviews using the easy voice recording app, which

I had downloaded onto my phone. The audio-recording app was able to capture the voice of the participant and the researcher. During the transcription process, I was able to go back and replay the sessions to capture exactly what the participants had said. Once the transcriptions were completed, I handed them over to the participants to check for inconsistencies and to confirm and validate whether this reflected their thoughts. To ensure further credibility of the data, I engaged with the teachers over a prolonged period. This ensured that I maintained adequate immersion in the research setting, enabling recurrent patterns to be identified and verified (Krefting, 1991). The teachers were interviewed in a neutral setting.

3.8.3. Transferability

Transferability relates to the extent to which the data collected and the findings from the study can be compared and transferred to other groups and contexts with other respondents (Anney, 2014). Lincoln and Guba (1986) indicate that in order to ensure that the data can be transferable to other contexts, the data must provide rich and detailed explanations of the research collected, so that other researchers can interpret the findings in relation to other contexts. A qualitative approach was chosen for this study and the analysis provided in chapters 4 and 5 is rich with in-depth descriptions of the participants' experiences through participating in the two different learning communities which "facilitates the transferability of the inquiry" to other possible contexts (Anney, 2014, p. 278). Gomm, Hammersley and Foster (2000) argue that "case study research is clearly capable of contributing to the resources available for naturalistic generalization by providing vicarious experience" (p. 2).

3.8.4. Dependability

Dependability refers to "the coherence of the internal process and the way the researcher accounts for changing conditions in the phenomena" (Bradley, 1993, p. 437). I used various means to collect data, i.e. triangulation (Cohen et al., 2002). By collecting data using various means I was able to "explain more fully the richness and complexity of human behaviour by studying it from more than one standpoint" (Cohen et al., 2002, p. 141). Further, by using triangulation, the inadequacy of one method of data collection can be compensated for by another method. I assured the dependability of the data collected by ensuring that similar

questions were posed to the different teachers. The transcripts were sent to the participants for validation to verify that what had been captured, reflected what they had said (Cohen et al., 2002). To increase the dependability of the study, I applied what Krefting (1991) calls the "code-recode procedure" (p. 221). I coded some of the data that I had collected. After a week I recoded the same data and compared the results to see if I came up with similar coding. Additionally, I conducted the interviews in a familiar location i.e. the classroom. This section has shown, in detail, how the data was collected, recorded, and analysed. The next section argues the confirmability of my results by presenting measures and procedures that I put in place to promote this.

3.8.5. Confirmability

To ensure confirmability and to collect data to "obtain corroborating evidence" (Anney, 2014, p. 6), I used multiple methods which included: interviews and observations. This method that is used to ensure confirmability is referred to as data triangulation which uses different participants to ensure authentic data is collected from the various sources (Anney, 2014). Confirmability refers to "the extent to which the characteristics of the data, as posited by the researcher, can be confirmed by others who read or review the research results" (Bradley, 1993, p. 437). Confirmability helped ensure that the interpretations and findings were authentic and represented the data that was collected and that the data was not fabricated. I ensured that the participants that were invited to take part in this study were teachers who participate in both GPLCs and SSPLCs and this in turn ensured that I got a first-hand account of their understandings, experiences, and practices. I allowed for confirmability by ensuring an audit trail of evidence to show that "the researcher did not simply find what he or she set out to find" (Bowen, 2009, p. 307), but followed a clear, explicit process of organizing and coding the data.

I used inductive content analysis to analyse the transcribed material, which was captured verbatim, emphasizing the actual words used by the participants. By using codes, I aimed to reduce the transcriptions into more manageable data from which I identified patterns and themes by reading and re-reading the data, making notes, and highlighting prospective patterns and themes as I read. The highlighted sections, together with the notes which I made, was transferred onto a spreadsheet. The data was then grouped into similar categories as I identified shared communications. Zang and Wildemuth (2009) state that "the detailed documentation of

data handling also provides a means for confirmability checking" (p. 9). Through the process of writing up the findings I checked and rechecked the data by collaborating with a PhD student and asked her to check the data collected as well as the analysis, and to provide her opinion on the findings.

3.9. Conclusion

This chapter has argued that in the context of researching how generic and subject specific learning communities co-produce knowledge (including generic and pedagogical content knowledge), with the aim of informing teacher learning in Natural Science teaching, a qualitative case-study approach was deemed to be the most appropriate. Furthermore, detailed descriptions of the data collection, as well as the data analysis process using the content analysis method were made explicit. Finally, to ensure validity of the data and establish trustworthiness, the chapter focused on the ethical considerations that were adhered to. In the next chapter, I begin the presentation of my analysis by focussing on the teacher interviews.

Chapter 4: Analysis of data from teacher interviews

4.1. Introduction

This chapter presents an analysis of the data obtained from the individual interviews with the three Grade Four science teachers. The focus of the interviews is to highlight the teachers' experiences of participating in the GPLC and the SSPLC. The analysis will highlight the knowledge that was developed in each of the PLCs, the participants' experiences of participating in the GPLC and SSPLC, what they gained from each PLC in order to inform the other, and the influence that both these PLCs had in developing science teachers' PCK. To remind the reader of the participants, the names (pseudonyms) of the teachers are Frank, Sarah and Ravi.

The argument that was built in Chapter 2 shows that for PLCs to be successful, the focus of the inquiry should be on providing teachers with the necessary support they would need in order to shift their existing practices towards more powerful practices. The purpose of this chapter focuses on comparing and analysing the data that was collected from the interviews on the complementary roles that GPLCs and SSPLCs can have in growing teacher knowledge and shifting teachers' practices to inform their PCK. I start the discussion by highlighting the role that the SSPLC plays in supporting the development of discipline specific knowledge and pedagogical content knowledge. In the analysis I will unpack the different elements of the SSPLC which promoted and restricted participation. I aim to show how the different elements of the SSPLC contributed towards modifying teachers' thinking and how the participants used newly acquired knowledge to inform their instruction.

The discussion will then move on to the complementary role that the GPLC played in contributing towards the development of the participants' GK. The discussion highlights the importance of developing generic knowledge and the role that this type of knowledge plays in developing teachers' knowledge base around teaching and learning. Through the analysis I will attempt to show how acquiring ongoing generic knowledge may provide the participants with a cauldron of knowledge from which to draw upon when engaging in discussions in their SSPLC. The argument that I build is that a symbiotic relationship exists between the two PLCs where participants are supported with GK and PCK that work together to alter the participants' thinking around teaching and learning and that could place them in a favourable position in the

science classroom. I will start my analysis by discussing the building of discipline specific knowledge in the SSPLC.

4.2. Building subject matter knowledge in the SSPLC

Teachers who were interviewed described their participation in their SSPLC as providing an avenue to ask questions in developing their SMK. This included a unit on "*body systems or differences between water cycles or atoms*". One of the participants in the study, Frank, stated in his interview that when he started teaching Natural Sciences at the school, he "*didn't really know what he was doing*" but because of his participation in his SSPLC, he has a "*much stronger grasp*" of the content that he is now teaching. Frank stated that in his previous school, he "*never taught science"* so he believes that the SSPLC "*is a resource*". Having not taught science before, Frank has limited SMK and PCK and, this experience of having to teach the subject for the first time, may have caused him some discomfort. Frank believes that if you expose learners "*to certain material"*, you must *"understand the material you are teaching them*" to develop learners' understanding. Ravi, another participant, affirms that the SSPLC has helped in developing her SMK. She concedes that "*I had to have clear guidance from colleagues with specific concepts*." Ravi also acknowledges that the SSPLC discussions provided her with knowledge on the content of "*what it is that we are planning to teach the kids for this week*."

Teachers who have acquired a strong grasp of the SMK, tend to feel more confident in their lessons and may be more willing to explore and implement alternative practices in their teaching. Frank explained that he continuously relied on his SSPLC to make sure that his "*concept knowledge is where it needs to be*". The nurturing context provided by the SSPLC enabled Frank to ask for explanatory assistance in terms of content and to admit to his colleagues when he did not know something – whom he positioned as having "*a lot more experience in this field*". Acquiring the skills and knowledge of the community is one of the main aims of participating in a PLC. Participating in the SSPLC provided Frank and Ravi with the SMK and guidance that they needed to facilitate learning in their science classes. The teachers' development of SMK came about because of deliberations among participants where each felt secure enough to ask questions and obtain clarification. Frank acknowledged in his interview that their discussions in the SSPLC were very specific and centred around "*planning*

the topics related to what part of work we will teach from the curriculum. Where we are moving to and what we want them to teach". Ravi agreed with Frank and affirmed "*yes, yes, absolutely it's helped me to make sure that I am knowledgeable about what it is that I want the kids to know*". Sarah also added that "*a colleague will bring something new or will introduce different research that they have found on that topic, so that's of great assistance because sometimes there are things that I hadn't heard about so when we discuss within our meetings, we learn from each other*". The SSPLC provided a platform for teachers to collaborate and deliberate their decisions carefully around SMK and in the process develop their SMK collectively.

The evidence from the video-recorded lessons highlighted how Frank was able to transfer what he had learnt from the discussions in his SSPLC about what he should teach in science. In his lesson Frank projected the task onto his whiteboard and asked one of the students to repeat what they should focus on in their research. The student calls out "*Osteoporosis, what is it? How is it caused? What treatment is advocated? And any other interesting information*". Frank then intervenes and reminds the rest of the class that these guiding questions are "*not just for the skeletal system*" but should also be used by the groups who are researching the other topics. Evidence is provided by the videotaped lessons that Frank is developing his knowledge about learners' understanding of specific science topics.

The SSPLC discussions were ongoing, and the participants obtained knowledge about where their students were with their learning. Sarah stated in her interview that taking part in the activities of the SSPLC helped her improve her skills as a teacher. She explained that the SSPLC discussions helped her to "*understand where the children are at with their learning*". The SSPLC discussions also provided her with knowledge of what learners know and what they still need to know. Reflecting with other participants in the SSPLC offered her the opportunity to question the effectiveness of the current activities and provided her with the knowledge on how to scaffold the content efficiently and, through collaboration with the other teachers, come up with creative ways to support the learners and improve their learning. For example, Sarah explained that she tried to explain a concept to the class but there were learners who did not quite grasp the concept. Through the deliberations Sarah noted that "*we discuss each other's teaching methods, and we discuss what worked and what didn't work and then we take from each other… it actually gives me a better picture you know, makes me understand children differently and how they learn differently".* Sarah explained that she then decided to adopt a peer teaching strategy to teach the content and noted that "*we asked peers to relay the*

information. The children seemed to understand their peer's language more than ours". Ravi affirmed this in her interview and stated that the discussions of the SSPLC allowed her to "*think of practical ways to make things work for the children*". Sarah explained that what she learned from the discussions is that learners "*don't always learn the way we expect them to learn*". The discussions about SMK and methods of instruction were not just adopted by the participants in the SSPLC but rather there was a process of deliberation and questioning that took place among the participants where the advantages and disadvantages of using a particular practice were highlighted. I will now focus the discussion on the factors that contributed towards the building of PCK in the SSPLC.

4.3. Building teachers' pedagogical content knowledge in the SSPLC

The activities that the participants in the SSPLC engaged in were "*about science specifically*" and, as Frank noted, included discussions on "*whether we are using the correct methodology*", "*what type of material we want to expose them [learners] to*" or considering whether the concepts being taught would require the learners to work individually or whether they would require them to engage in a more group centred approach. Similarly, Ravi mentioned that during the SSPLC sessions the focus was on planning. She stated that "*we talk about science specifically"*. Ravi further explained that the SSPLC discussions were done in a collaborative environment where teachers "*brainstormed"* what content they were "*planning to teach the kids*" for the "*week and for the rest of the term"* as well as how they were "*planning to teach it*".

The feedback provided by the discussions in the SSPLC provided the participants with knowledge to inform their practice. Ravi confirmed that the participants of the SSPLC engaged in ongoing reflection on the practices that worked and the ones that did not work and then they would "*try to come up with new ideas*". These deliberations provided the participants with deeper insight about the processes involved in the different practices in order to create understanding and be flexible in their teaching when implementing a new method of instruction. Especially for Ravi who admitted that it is "*always a challenge*", and for Frank who is teaching science for the first time, these conversations provided them with the much-needed SMK and PCK. During his lesson that was videotaped, Frank started believing more in his learners' abilities and allowed his learners to work in groups as compared to him being the source of knowledge. An extract of the transcription from the video acknowledges the change

in his PCK "*Okay skeletal system group please stand up, okay, right, I want you to go outside, read that document to each other and discuss it. You got three minutes*". Sarah also acknowledged that the discussions in the SSPLC helped her to "*adapt and change my practice accordingly*". Evidence was provided from her videotaped lesson, where, instead of giving the students group roles, Sarah created information cards and created a learning environment where the students could read the information and select their own roles. Sarah announced to the class "*Hello! Grade 4's, So, I have got the roles on the cards here. So, you are going to choose. The cards have information that explain the group roles to you*". Teachers are required to be creative and flexible in their practice to meet the learning needs of their learners and cannot adopt a 'one size fits all' approach if they want learning to be successful for their learners. Collaborative subject specific discussions offer much needed support to understand the processes involved in order to become confident in implementing these practices and promoting learning. As Sarah noted, the discussions in the SSPLC made her realize that "*sometimes it takes longer for children to reach the same goal that everybody else has and sometimes they require more support*".

Other discussions that formed part of the SSPLC, as Sarah noted, included exploring the "*knowledge that the children already have*" around the concept being taught. Sarah noted that being informed on what prior knowledge learners have around a concept assists them in scaffolding the learning and "*where to go from there*". For Sarah, it appears that the activity of engaging in discussions provided her with knowledge that she needed before teaching the concept as well as a knowledge of any skills or abilities that learners should have to assist them while developing understanding. Acquiring this knowledge guided Sarah's decisions to select useful tasks and content to expose the learners to, so that the learners were in a better position to learn. This is similar to Brodie and Chimhande's (2020) findings that suggest that the activity and content that form part of teachers' discussions in a PLC is key to their learning.

The focus of the discussions in the SSPLC aimed at improving teachers' knowledge of those areas that learners find difficult. This type of knowledge that was being discussed may be underpinned by teachers' understanding of what concepts learners find difficult to grasp and the kinds of errors that are common, especially when it comes to abstract concepts (Magnusson, Krajcik & Borko, 1999). Sarah affirmed that the discussions helped her to "*understand where the children are at with their learning*". Understanding what learners know and what they still need to learn suggested to Sarah that she might develop alternative approaches to teaching and, in the process, informed her PCK. Similarly, Frank felt that "*what really helps is to see where*

the different kids are at" – suggesting that teachers use the knowledge gained from the discussions to help understand what the learners know about the concepts being taught. Such information can help teachers scaffold their lessons, design activities and meet the needs of the learners accordingly. Frank explained that his participation in the SSPLC had informed his practice:

> *I learned this in my subject specific community here at [School X], and I feel like it's more interactive, more akin to real life practice when you're learning in a new job or new environment.*

Frank stated that his practice had developed due to his participation in the SSPLC. He associated the type of learning that he was engaging in, to real life contexts which he acknowledged has helped him to understand how learning is connected to his classroom. He noted that prior to attending his SSPLC he "*had less confidence in the ability of my students […] to learn in an interactive environment*" which suggests that Frank's PCK in teaching science was limited to teacher centred approaches. These sentiments were shared by Sarah and Ravi who stated that prior to participating in their SSPLC, their teaching was "*pretty much textbook based*" and "*teacher centred*". Ravi explained that she resorted to traditional practices which included the learners having to complete "*individual work to make sure that they have a clear understanding*". Sarah stated that her teaching had changed a lot because she "*has learned from her colleagues to do things differently*". Similarly, Frank noted that his teaching had evolved and is now changed. He stated: "*Absolutely! It has changed. Compared to the beginning of my career my teaching has become a lot more planned and deliberate*". Ravi agreed with her colleagues and explained that participating in the SSPLC caused her to "*challeng*e *her own thinking*" and her teaching has also changed after participating in the SSPLC. She noted "*it has helped me to assess during lessons… I have started using more technology – getting the children to make little videos*". Ravi also explained that the deliberations and reflections in the SSPLC on how learners engaged in activities helped inform how they plan and approach the next theme. She clarified that it is so "*we don't make the same mistakes*". These findings are similar to Dogan et al. (2016) as they suggest that changes in practice come about as a result of encouragement from peers during collaborative discussions where instructional techniques are deliberated, and where teachers are encouraged to be innovative and try new instructional practices.

Furthermore, the SSPLC facilitated discussions on knowledge of topic-specific strategies. This type of knowledge refers to "specific strategies that are useful for helping students comprehend specific science concepts" and refers to the different types of instruction that teachers are familiar with for enacting science teaching (Magnusson et al., 1999, p.16). The knowledge of topic-specific strategies enabled teachers to be more informed in their practice as Ravi admitted in her interview. She said that sometimes, as teachers, "*we fall into a rhythm and get stuck in doing things a certain way*". She further suggested that she needed the discussions to challenge her own thinking. Sarah supported this by stating in her interview that the discussions in the SSPLC around the re-working of certain activities caused her to challenge and reflect on her own thinking and opened her mind to different opportunities that were relevant to meeting the needs of the learners:

> *Well, if we look at this year for example when we […] plan a scheme of work, this is the idea that we have in mind, but it does not always go that way. Sometimes while we are going through the learning, we realise this didn't work. Maybe I need to ask more questions, maybe I need to break down the task a little bit.*

The knowledge that science teachers possess is unique to the field of science teaching and can be viewed as a way of knowing. Sarah suggested that the discussions in the SSPLC facilitated reflection on and the questioning of the validity of practice used by teachers in the science class. Using class activities as artefacts to reflect on, informed, and reminded the participants in the SSPLC of how the learners engaged with the activities. Acquiring knowledge through collaborative reflection on learners' work can inform teachers to scaffold the activities more and, in this case, come up with solutions to ask more questions to address the gaps in learning.

Frank explained in his interview that he was teaching science for the first time and said that his teaching practices revolved around imparting knowledge using a power point presentation where he was the source of knowledge. His lack of PCK hindered his participation in the SSPLC and he stated that he found it difficult to understand "*how one would choose to teach something*". Not being able to contribute productively to the community caused Frank to experience some tension. He stated that this was a real "*challenge for him*" and affected how he engaged with the other participants in the SSPLC. Frank indicated that he found it difficult to say, "*I don't understand*". He also felt that he could not contribute effectively towards the selection of appropriate activities and practices during the planning stages of the SSPLC, and he accepted what was being suggested by the other participants without questioning the

effectiveness of the practice. Frank noted in his interview that one of his hurdles was not being able to "*criticize*" the practices that were being suggested by the other participants in the SSPLC.

The teachers affirmed, during their interviews, that the sharing of practices during their SSPLC discussions helped inform them of alternative types of instructional strategies and provided them with knowledge to make meaning of their experience which they could then use to enhance the learning process. For example, Sarah acknowledged that "*today I tried to do the group work with the spelling activity, and it was a little bit of a disaster because we had children who did what they were expected to do and were waiting to share with the others and the others did nothing. So, what I think we must do is that when we get to this research task is that we must allocate beforehand what each child must do so that they get on with it*". Sarah's reflection on the outcomes of her lesson during the SSPLC session has allowed her to evaluate its effectiveness, highlight what the constraints were and alter her practice on an upcoming research task. Ravi explained that the discussions helped inform her on "*how we approach it [a concept], what works, and what doesn't work*". This practice of engaging in discussions that centre around best practice appears to have assisted teachers in identifying areas of improvement in their pedagogy and contributed towards the development of their PCK. In addition to facilitating the questioning of practices, the discussions in the SSPLC provided participants with the skills that they needed to facilitate learning in the classroom. Ravi noted in her interview that "*it helps me a lot to just think of practical ways to make things work for the children. So, it's, it's giving me actual tools which I love, so it's helping me to have those practical tools to do it [teach science]*". Participating in the SSPLC appears to have developed Ravi's confidence in teaching science. She feels she has acquired some skills that she is able to use in her teaching and is feeling more confident in engaging in teaching practices where learners are more involved.

4. 4. Features that promoted and restricted participation in the SSPLC

4.4.1. Time

The data from the interviews reflected that sufficient time to participate in the SSPLC was important in allowing the teachers to connect with one another. Frank claimed that having

enough time to collaborate in a SSPLC "*keeps us all connected and on the same track*". Ravi affirmed that what enabled the collaborative culture in their SSPLC was "*time to do so, within our timetable.*" Allocating teachers time within their timetable to enable them to engage in professional development is integral to their participation and learning. For Frank it was important for him to have time to connect with the other teachers, as he was a new science teacher and relied on the meetings and discussions in the SSPLC to determine whether his pacing and implementation of the activities was done correctly. Ravi observed that collaboration takes "*time*" and if this time is not made available within their teaching time, then collaborative planning becomes "*difficult*". Ravi clarified by saying that he thought "*most people are willing to collaborate if it falls within [one's] working hours*".

As professionals, teachers are expected to engage in some form of PD after hours as they are required to demonstrate a certain level of skill and knowledge. However, expecting teachers to engage in PLC discussions outside of their teaching time may cause them to experience tension and stress as they could feel that they are being expected to do too much and may feel stretched. Sarah felt stressed at participating in the PLCs because of a lack of time due to her teaching and co-curricular commitments. She exclaimed: "*Oh my goodness! We are so busy. What is the value of this? Why are we doing this now? It just adds work*". This finding is similar to Maloney and Konza's research (2011) where they found that teachers' attendance at PD sessions were affected when PD was done after school hours. During the Covid-19 pandemic, participants could not gather in one venue to meet due to the social distancing protocols that were in place. Using technology as a resource to facilitate SSPLC meetings made a difference in managing teachers' time efficiently and offered teachers a means and a platform to collaborate. Teachers met using Google Meets which proved to be beneficial as teachers could meet in the comfort of their homes and not worry about picking up children, managing the traffic, or arriving home late.

4.4.2. Building trust

The literature review in Chapter 2 highlighted that trust amongst participants contributes towards the success of PLCs attaining their intended outcomes by improving learning opportunities. The literature review further explained that if teachers are required to contribute towards discussions and expected to be vulnerable and open-minded about their teaching

practices, participants in a PLC must trust one another and be honest about their intentions. The data from the interviews reflected that developing trust takes, as Ravi inferred, "*time and practice*" and as teachers become more comfortable with one another, the space becomes more relaxed and provides a means to learn and grow. This sentiment was also shared by Frank who reflected: "*Ah time, time, over a period of time, I have really grown fond of my colleagues*". This had not always been the case as Frank also noted that "*I think in the beginning they were trying to see who I was, and I was trying to see what they were about*". His insecurity in his lack of PCK may have prevented him from initially trusting his colleagues and sharing more openly as he may have felt that the feedback that he received from the other participants of the SSPLC could have been "*a personal attack"* on him because of his limited PCK. He also felt that *"this means that I am not worthy*". Feeling unworthy may have caused Frank to feel worried and scared and could have affected how he engaged in the SSPLC. He admitted that he "*was very insecure*" at first. Teachers who are not familiar with how PLCs work may experience stress and tension and any challenges that are made to their teaching may affect their practice.

The data from the interviews revealed that having trust was also associated, according to Ravi, with being able to "*rely*" and "*depend*" on one another. Ravi felt that she did not have to trust her "*TaTT [GPLC] session people as much as I need to do my subject specific [group]*". Relying on her SSPLC suggests that Ravi's PCK in science is still developing and she needed to have total faith in her SSPLC participants to provide her with the reliable knowledge that she needed to develop her PCK and be successful in the teaching of science. Ravi maintained that the reason why she needed more trust in the SSPLC was that she was *"willing to take on the ideas*" and taking on the ideas of the group meant that she believed that the practices would enhance her teaching. In the GPLC, the focus was more on the development of generic knowledge and the experiences that the participants used to make sense of the theories of learning. Teachers were able to share their practices openly with a diverse group of participants with the emphasis being on the sharing of knowledge. Ravi explained in her interview that "*just being able to sit around the table and openly discuss issues and things will show trust enough*" in the GPLC. The sharing of knowledge openly in the GPLC may develop the participants' confidence and willingness to share their practices in a forum and may have altered the participants' understanding of the purpose of sharing teaching and learning experiences.

4.4.3. Collaborative culture in the SSPLC

The collaborative culture in the SSPLC was supported by the teachers' commitment to their teaching. Frank affirmed this by suggesting that the collaborative culture in the SSPLC was encouraged by "*a commitment and a loyalty and a devotion towards our class*" and as collaboration is the culture of the institution, "*it is almost compulsory".* The collaborative culture has made Frank feel "*part of the team".* This is different to his previous teaching experience where he planned and prepared his lessons on his own. He stated that the collaborative culture has *"informed my practice and […] is extremely beneficial to me*". It seems that due to the collaborative planning and ongoing discussions of the SSPLC, Frank has modified his thinking and adopted some practices from his PLC. While Frank may have benefitted from the collaboration, there might be instances where the participants could become over-reliant on the contributions of a small group of individuals in the SSPLC. This may lead to the recycling of just a few ideas and practices, especially when participants continuously agree with each other's suggestions because as Ravi suggested we "*are like-minded in our thinking and approach*". This may not necessarily contribute towards the development of new ideas. Ravi, however, felt that the engagement with a diverse group of participants in the GPLC provided the teachers with ongoing knowledge on "*different ways of teaching*", which she felt helped "*challenge your way of thinking*" about teaching and learning in the SSPLC and helped to create new knowledge.

The loyalty and devotion that Frank has for his class made him eager to collaborate with his colleagues, as well as learn and improve his practice. The collaborative culture amongst the participants extended beyond the SSPLC where participants continuously reminded each other of the activities that were planned and, as Frank stated: "*sometimes we touch on, oh don't forget to, just reminding you, which once again really cultivates a lovely relationship*" among the participants and contributes towards building the community. These ongoing conversations served to remind and guide Frank to ensure that he was pacing the activities correctly, and which he appreciated, all the while adding to his growing PCK. The process of collaboration should build a culture of learning that is focused on modifying thinking for the purpose of improving one's practice.

Additionally, the interviews reflected that the collaborative culture of the SSPLC was maintained by mutual sharing and the sharing of the workload. As Sarah stated in her interview: "*we all contribute ideas, we all contribute to the workload […]and we all contribute our*

experiences to that particular scheme of work". Mutual sharing of experiences is important in a collaborative environment. The sharing of experiences enables participants to identify with one another's successes and inhibitions. In the SSPLC the sharing of the workload was facilitated by using technology in the form of a Google document [Figure 4.1].

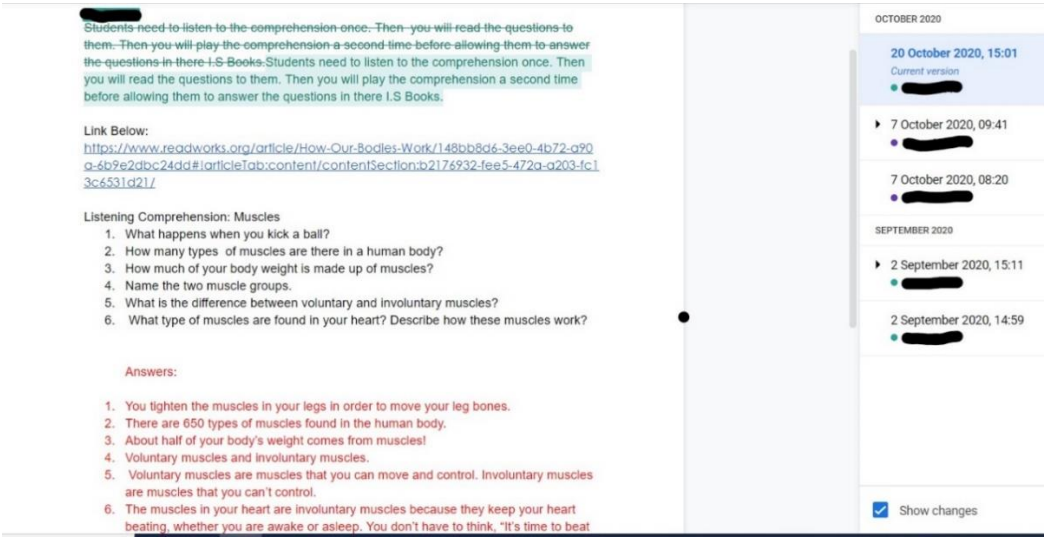


Figure 4.1. Collaborative Google document

Sarah commented in her interview that "*we would create a Google document that can be […] edited by everybody. I mean our collaborative learning community, and obviously everybody can work on the document and simultaneously contribute their ideas and make suggestions. So, what we usually do, is that we have our document open during the SSPLC meeting and as we discuss, we edit, and as we contribute, we all add to the document*". The use of technology in the SSPLC as indicated in Figure 4.1. appears to help with collaboration and mutual sharing of ideas and activities. The focus of the collaboration facilitated directed conversations around practice which appears to have enabled participants to reflect on their practices and modify their thinking based on the discussions in the SSPLC.

Sarah suggested that the collaborative culture of the SSPLC also "*depends on the people that you are working with and how open they are to working together because although you can work with a group of people, they're very set in their ways, not eager to change*". This could hinder progress in the SSPLC as participants may fear the unknown and want to stick to the practices that they know. This feeling is also shared by Ravi who stated that *"it's an attitude, it's the people, they need to be willing to collaborate*". Sarah suggested that to facilitate collaboration and sharing of knowledge and experiences on teaching and learning in the SSPLC

"*you must be able to show them how open you are to their ideas, you know, that kind of thing*". Engaging in a collaborative environment requires participants to reciprocate with ideas by contributing towards discussions.

The evidence from the interviews shows that the SSPLC provided its participants with a supportive and nurturing environment that also supported their learning. For example, Frank stated that "*I do feel, this environment in particular that I have found myself in, the time here, […], is very nurturing and I understand […] that teachers, in particular, have a really tough time with saying that I don't know, I need help, can you explain this to me*". Consistent with Frank's assertion, Ravi affirmed that the SSPLC supports her every day and gives her "*time to reflect*" on her lessons. The following discussion will focus on analysing the interviews that focused on the impact that participating in the GPLC had on developing teacher practice in an effort to highlight the conversations that promoted learning.

4.5. Learning from the GPLC

Participation in GPLCs as another form of PD can also play an integral role in teacher development and can contribute towards developing and supporting teachers to change their practices around teaching and learning. The participants in the GPLC teach different grades and different subjects. Additional teachers are referred to by number while the primary participants retain their pseudonyms.

During a GPLC interview Sarah stated that "*when I first started at [School X] or a couple of years in, I was always very nervous to say I didn't know how to do something or […] help me.*" suggesting that when Sarah started at School X, she did not have the confidence to seek help from those around her. This may have caused her some discomfort. She explained that she "*was just so worried about what everybody else is going to think".* Sarah came from a context where the teacher was the centre of knowledge and this created a perception that teachers should know everything. This perception may have hindered her from being comfortable in seeking help from her peers. When Sarah was informed that all the participants in the GPLC are all learning themselves, it changed her perception and she felt more comfortable in collaborating. Normalizing the concept of learning in the GPLC allowed Sarah to be more open to learning. Similarly, Ravi suggested that her ongoing participation in the GPLC allowed her

to understand the participants better and made her comfortable to "*challenge ideas to receive feedback*" in order to create understanding of the knowledge being discussed.

Teachers' knowledge about teaching and learning play an important role in how and what they teach in science. Teachers' knowledge about teaching may lead them to focus on what they are comfortable with. For a teacher to shift towards a new belief requires him/her to participate in ongoing activities that support learning in order to question existing knowledge and reorganize their thoughts in an ongoing guided and supportive environment. The GPLC at School X provided a supportive and non-threatening environment which enabled the participants to be open about their practice and created a space where they could speak about their insecurities in teaching. Sarah explained in her interview that "*now I feel so confident to say I don't know! How to do that? Please show me. And I think the way we've been going [talking about participating in the GPLC] has actually made me feel more comfortable in being able to say, 'I'm not sure*'". The discussions and activities of the GPLC appear to have enabled Sarah to reflect on her practice through collective inquiry which she then used as a basis for altering her thinking about her practice. The GPLC, according to Sarah, created an opportunity for her to collaborate in a safe space and in the process helped to develop and shift her knowledge regarding teaching and learning.

Sarah further explained that the activities that the teachers engaged in during the GPLC provided her with knowledge on learning: It "*helps me understand the children. It helps me understand if they do things a certain way, why they do it that way*". It was important for Sarah not to only develop her knowledge of practice but to understand how to create alternative approaches to improve learning. She was able to gain this understanding by engaging in collaborative discussions with participants from the GPLC which, she indicated, helped shift her knowledge on the benefits of learning in the GPLC. Teachers should see value and relevance in the knowledge that is being discussed. Hence, the activities and discussions that form part of the GPLC should be relevant to the needs of the participants to draw their attention.

For Frank, the GPLC activities provided him with knowledge on "*what's happening in the world of technology*". This knowledge was relevant to Frank's needs and added to his growing PCK on how technology can be used to support learning. He recalled in his interview that he learnt "*how we can bring filming into the classroom. Having teacher 13 there to share that with us in the learning environment really brought new knowledge into my world*". Adopting new technology, for Frank, created much stress initially, as he was not familiar with using this

technology as a tool to teach – he came from an environment where he lectured, and his learners listened passively. Having someone with the knowledge and experience of filming in his GPLC provided him with the knowledge and security that he needed to develop his PCK. Having participants with an understanding of new knowledge that is to be shared and discussed is important as this individual can share and unpack this knowledge and provide the necessary support that participants in the PLC would need during its implementation.

Ravi, in her interview, mentioned that she had learnt about learning through doing and play from the discussions that had taken place in the GPLC and that this had contributed towards the development of her PCK. She reflected that she used this knowledge to inform her practice when contributing towards discussions on different practices in the SSPLC. She acknowledged that the discussions with her peers in the GPLC provided her with a better understanding of knowledge on alternative teaching practices as compared to the "*teacher standing in front of the class giving information*". Having careful deliberations with participants in a PLC around issues of different practices can help teachers unpack the different facets of learning and, in the process, according to Ravi, "*create understanding*" that then contributes towards altering her practice.

Participating in the GPLC provided the teachers with the opportunity to move outside their comfort zones, away from teachers that they knew in their SSPLC, and exposed them to individuals that were diverse, had a variety of teaching experiences and a depth of pedagogical knowledge. Ravi recalled a conversation from an Early Learning Centre (ELC) teacher that "*there was building happening at the school and you know they wanted to teach the kids about transport, and then they had a whole discussion on how they got the kids to go and look at the building and how they had to learn and then some kids got interested in wheels'*. In her interview Ravi highlighted that the conversations in the GPLC have helped her to "*to step away from that teacher role"* and to adopt "*more of a facilitator's role*" in her classroom. Listening to someone from a different section of the school enabled Ravi to get a different perspective on learning. She noted that "*that whole learning through play was a very interesting discussion for me".*

4.6. GPLCs build generic teaching knowledge

During her interview Ravi recalled that the GPLC discussions helped her to improve her knowledge of the "*way we approach teaching, not just learning*" and the "*different approaches that are relevant in the different age levels as well*". Different types of knowledge that are shared by participants of the GPLC can facilitate the development of new knowledge and understanding. Ravi shared that the conversations in the GPLC had helped her to "*think wider and broader, in terms of not just my subject, but all kinds of subjects, in teaching in general."* This generic knowledge can add to an individual's growing PCK and can be used as a cauldron of diverse knowledge from which teachers can draw when contributing towards the planning of activities in their SSPLC.

While developing generic knowledge around practice is important, developing good people skills to support them in the development of this knowledge is just as important. These skills are essential in helping participants communicate and interact with participants in their PLCs. Ravi reflected in her interview that discussions in her GPLC also centred around "*how to approach different people with different skills*". Being sensitive to participants and accommodating their different personalities also contributed towards successful collaboration in the PLCs and helped develop a sense of collegiality among participants. For instance, Sarah confirmed this when she observed that "*there are some members of the GPLC that are very quiet the entire time. They […] are really quiet, and so then you have to say: what do you think about this? […] so, you have to say what is your opinion on this? Or how do you feel about this? So sometimes they're very quiet and you need to encourage them to make a contribution*". Developing good people skills would mean that participants would be able to form better relationships with participants in their PLCs which could contribute to influencing and altering an individual's decisions around practice when planning activities in the SSPLC.

Building on the knowledge of teaching and learning involves teachers engaging in discussions around teaching and learning. In his interview, Frank stated that during the GPLC sessions the participants engaged in discussions dealing with "*different theories"* and *"sharing our experiences in relation to those theories in the classroom*". Conversations in the GPLC allowed teachers to build on their knowledge regarding teaching and learning. Consistent with Frank's opinion, Ravi stated in her interview that the discussions in the GPLC made her challenge her own way of teaching and that "*it gives you time to reflect on what you are doing as a teacher within your classroom*". Ravi further mentioned that "*it is very important to have that big*

picture conversation and not only the subject specific discussions". For Ravi, having the big picture and the subject specific conversations helped her to better understand approaches that involved learners more. Having diverse conversations around teaching and learning appears to have helped participants in sharing their existing knowledge with a diverse group of individuals who questioned, offered additional examples, supported, or refuted the ideas. This process could lead to participants rationalizing their thinking and internalizing any new knowledge that was discussed.

Discussions in the GPLC on theories of education such as Vygotsky and Piaget's theories of learning as well as discussions on best practices that can promote learning, provided teachers with the necessary knowledge and language which they could use to support their discussions in their SSPLC. Sarah stated in her interview that they "*moved on to recognizing the developments in the neuroscience of learning, which is developing a growth mindset*". This new knowledge made Sarah reflect on her own knowledge, embrace learning and modify her thinking. She affirmed in her interview that after participating in the GPLC discussions, she "e*mbraced that learning is about trying, making mistakes, examining, and reflecting on mistakes, retrying with newly acquired knowledge and skills*". The discussions in the GPLC provided teachers with a common focus when discussing learning in the SSPLC. Frank stated that the discussions in the GPLC "*re-emphasized the fact that every child is different and that if I want to […] perform to the best of my ability, I need to take into consideration best practice*" which included allowing learners to engage in "*multiple learning opportunities*". The reflection on the discussions that took place in the GPLC can modify teachers' thinking and they could use it as a basis for altering their instruction.

The kind of knowledge that was being discussed in the GPLC was rigorous and relevant to meeting the specific needs of the teachers and the context. As already mentioned earlier, Sarah explained in her interview that "*when I first started this, I thought, Oh my goodness! We are so busy, what is the value of this, why are we doing this now? It is just added work".* The initial feeling about participating in the GPLC appears to be one of agitation. This caused Sarah to feel distressed at how she was going to cope with the extra expectations and work. As Sarah engaged with the participants in the GPLC as well as the content, the agitation appears to have transformed into calmness and excitement as she saw the opportunity in the learning. She explained in her interview that when "*I started attending the TATT [GPLC] sessions and learning a little bit more about why children think the way they do, it actually helped me to understand the children in my classroom a little bit more*". Furthermore, the knowledge that

was discussed in her GPLC helped her to understand that if the learners do things a certain way, why they do it that way. Sarah used a mathematics example to illustrate where she used this knowledge in her teaching, saying that when she "*did the first few with the child using the blocks [illustrating using blocks to add the fraction of a quarter plus a quarter], I just did the first three or four with her and she was able to complete the rest of it so for me. That was like a lightbulb moment. Wow! You know this actually is true.*" Her expression, "Wow! You know this actually is true" undoubtedly reflects a change in her knowledge around her teaching and learning practice as she was able to see the benefits of what she was learning in the GPLC in action during her lessons. This discussion highlights how the theory that was being discussed in the GPLC supported the teacher in understanding the processes that learners use in order to learn. This enabled teachers to plan appropriate activities in their SSPLCs and in the process also develop their PCK.

The data from the interviews also reflected that in addition to discussing different theories of learning in the GPLC, participants also brought learners' work that had been discussed in the SSPLC to the GPLC sessions to show how the theory that had been discussed in previous GPLC sessions was being implemented to facilitate learning. Sarah noted that "*we use their work to show where there were misconceptions and how we bridged that gap or how we scaffolded the activities for that child to actually understand*". The sharing of knowledge and expertise between the PLCs indicated a process of meaning-making for the participants and reflected how the communities' resources were distributed among its participants. According to Sarah, participating in the GPLC has helped her to "*understand the […] development in the child and you know, depending on the different theorists, how children develop and what they understand and when they understand it and what they need at that particular stage in their life. So, it was very informative for me"*. Having these ongoing conversations by using examples of learners' work, appears to have helped teachers gain a deeper understanding of their practice and enabled them to think systematically about the changes that could be made to their practice. Sarah continued by saying that "*it is going to help me in my growth as a teacher. It will help me […] change the way we do things […] so it is changing my expectations as a teacher and helping me to improve […] you know my teaching techniques*".

4.7. Features that promote and restrict participation in a GPLC

4.7.1. Time

The data from the interviews done for this study indicated that the participants saw participating in the GPLC as "*very much necessary*". In his interview Frank said that he found it challenging that GPLC meetings occurred at different times of the day. He observed that "*it comes at different times of the day for everyone*" which suggests that he would have preferred sessions to take place on a dedicated day at a particular time. This concern was also highlighted by Ravi when she stated that "*time is always an issue, so I think that's a challenge*". Furthermore, teachers' workloads contributed toward the negative feeling of teachers attending PD sessions. Ravi stated that "*I think oftentimes even though it's so lovely to have it, teachers have so many other things on their mind so when you have marking to do and now, you're sitting in a TaTT [GPLC] session, so I think it is a challenge.*" She suggested that management should "*set that time apart and just be focused*". A lack of common planning time for teachers can result in schools not focussing on efforts to improve learning. Rather, it could lead to more frustration and fatigue due to the excessive workloads.

4.7.2. Collaborative culture in the GPLC

During the interviews it was highlighted by all the participants that collaboration in the GPLC provided its participants with a "*feeling of being connected to a big campus with a lot of colleagues*". This collaboration and networking among participants appeared to have helped facilitate the "*gaining of insights into different perspectives about what other teachers are going through and sharing those perspectives with each other*" thereby developing a common understanding and a sense of collegiality amongst the staff. Ravi stated that "*as teachers we all at School X are all very much from different walks of life to a certain extent and we all have quite rich experiences […] here. So, it's always interesting to me to go to other teachers' classrooms and see their approaches to teaching and also, you know, the way they will […] approach a certain subject matter*". The collaborative culture in the GPLC provided its participants with diverse knowledge of different practices and was further supported by the conversations that the teachers focused on. Ravi stated in her interview that discussions that

centred around "*anecdotes, things that were really happening in class*" promoted the collaborative culture in the GPLC as well as "*discussions about different ways that we can bring our subjects together to teach the same thing*". The collaborative culture of the GPLC nurtured collaboration, developed collegiality amongst the participants and was promoted by evidence from the context.

This study highlights the fact that collaboration among participants in the GPLC is enabled because it is an existing structure within the organisation. Sarah, in her interview, noted that "*it was something that was always here*". These findings are similar to Kempen and Steyn's (2016) study in that they found that the contributing factors that led to the participants' commitment in a PLC were the on-going nature of professional development. Furthermore, the data showed that for collaboration to be successful, the PLC required participants to value intellectual and personal growth. Ravi stated that "*I think it is necessary in order to be successful in what you are doing*" which suggests that there is personal value in developing her practice by participating and learning in the GPLC.

Frank stated that "*a good leader, a general understanding why we there and […] course work*" were important in developing a collaborative culture amongst participants in the GPLC. Sarah suggested that deciding on what activities they "*were going to work on together*" also facilitated the collaboration as the teachers had a vested interest and a feeling of ownership towards the learning material. Discussions in the GPLC that centred around real-life examples of teachers' classroom experiences also created interest among participants and facilitated collaboration. Ravi noted that "*I think it's valuable to have those discussions of what's really taking place with our students*". Teachers can connect to the learning if they are able to identify with what is being taught hence using actual examples from their classes appear to support and encourage learning.

During their interviews the participants stated that the activities that encouraged participation and collaboration among the participants in the GPLC included "*role playing exercises, visiting classrooms, asking questions and creating our own summaries of coursework*". Engaging in these activities was important for Frank because it "*feels like we are moving to a clear objective*". Sarah also agreed that collaboration among colleagues was "*necessary in order to be successful in what you are doing*".

A lack of confidence among the participants can create fear and uncertainty and may result in a lack of eagerness to contribute towards the GPLC discussions. This is also true when

participants' ideas and practices are challenged. In this study, Frank also felt that he was "*a bit threatened and a bit […] anxious and worried whether I am on the right track"* when his ideas and practices were challenged. Upon reflection, and because of the dialogical character of the GPLC, Frank later felt that "*understanding where they were coming from solves the whole issue*". Comprehending this was based on the mutual understanding among the participants of the GPLC that the focus and challenges of the discussions were to build PCK. This mutual understanding gave Frank "*licence to ask questions […] and to whatever I am feeling, it's okay that I am feeling that way […] and say guys, this is how I am feeling. I am feeling like I am lost please help me, that's okay*". Sarah stated that she was comfortable when colleagues challenged her practice because she saw the challenge as "*an area of growth for myself, you know and if you are challenging me and you are giving me a better picture of what you are doing and why your suggestion is better than mine, then I am all for it*". An important point that Sarah brought out was that the challenge of an idea was followed by an alternative suggestion.

According to Ravi the environment is important in developing this culture of challenge: "*I don't think I would feel as […] insecure when it's in that kind of environment because we all come from such different areas*". However, this culture of challenging ideas and practice takes time. Frank noted that it took some time before "*we got very much accustomed to each other. I would say three weeks, and then, all of a sudden we were having a very good discourse*". This was facilitated by the idea that the purpose of these collaborative discussions was to come up with the best way for the learner and as teachers "*we all want what is best for our children*". This practice has appeared to have helped the participants of the GPLC to listen during the discussions, question the effectiveness of practices and think about their own practices and link ideas with the focus of altering and developing their practice. Sarah confirmed this when she noted that "*I feel that it has helped me understand children a little bit better than I had before I started this*". Sarah is thus acknowledging that participating in the GPLC activities has helped develop her PCK.

4.8. How teachers experienced the PLCs during Covid-19

Participating in PD during times of crisis is important and should be ongoing, as these sessions provide teachers with the necessary support for the changes that are taking place. During the Covid-19 pandemic schools were expected to adhere to the Covid-19 restrictions which

involved learners not being able to attend school for a period of time, and when they were allowed back, they attended in small groups to adhere to the social distancing protocols. This meant that some attended school while others were expected to learn from home. The support that was provided by the PLCs during the initial stages of the Covid-19 pandemic provided much needed guidance to teachers. Frank stated that when they began the online process due to Covid-19, the GPLC sessions helped him "*to figure out exactly how we had to present ourselves online*". Frank found this beneficial as "*none of us really knew about how to do that until this [Covid-19] happened*". He further stated that "*those sorts of workshops in our learning community were very useful and I definitely took a couple of tips from it.*" He explained that he *"changed what I was wearing, where I was sitting, how my camera angle was faced*". Frank pointed out in his interview that "*again, I think it's giving me […] tools like actual tools. 'Cause if you are speaking to someone who's doing what you're doing and they've got something that works, so that sharing of ideas, sharing of tools to teach […], that has helped me tremendously*".

Having to teach online required teachers to be proficient with using technology to reach the learners who were at home. Ravi explained in her SSPLC interview that "*children were online this year, we worked on some wonderful apps like google forms, clips, QR codes*" to ensure that learning was taking place. Ravi further felt that learning how to use this technology was "*necessary*" to ensure that the teachers were reaching the learners who were at home, and it helped her to "*grow*" as a teacher. The SSPLC also offered the participants a platform for teachers to discuss any observations of their learners' learning while working online. Sarah explained in her interview that she would listen in on her students' conversations while they were working collaboratively using Google Meets. She went on to further elaborate that she would relay examples of activities that her learners were having trouble with in her SSPLC and ask her colleagues for advice on how to support the learners who were working online. Sarah noted that the conversations in the SSPLC guided her towards asking more "*more questions and to break down the task a little bit more*" for the learners who were working online.

4.9. Conclusion

In this chapter I have analysed the interviews in an effort to understand the complementary roles that GPLCs and SSPLCs can have in growing teacher knowledge and shifting teacher

practice to inform their PCK. The analysis reflected that each PLC played a specified and complementary role in the development of the teachers' knowledge which contributed towards their PCK. The PLCs provided the teachers with the support and guidance in the form of GK, SMK, and crucially for this study, PCK.

The SSPLC provided an opportunity for the participants to engage in subject specific discussions which centred around what content knowledge to teach, prior knowledge that learners have and the knowledge that learners find difficult to grasp. The discussions that took place by engaging with various artefacts provided the participants with ongoing data to reflect on and in the process also develop their SMK and PCK. These reflections allowed teachers to discuss the teaching and learning that was taking place and helped teachers understand where the learners are with their learning. According to the participants, this knowledge was used to alter their practices to accommodate the learners' needs and, in the process, offered an opportunity to learn and develop their own PCK. The deliberations among the participants allowed new ideas to be developed and created an understanding of the expectations around these new practices.

The GPLC provided the participants with generic knowledge that helped them to develop people skills and which contributed towards promoting collaboration among diverse individuals. The analysis reflected that the GPLC provided its participants with an opportunity to move out of their comfort zones of engaging with a selected group of individuals and offered a platform for the participants to engage with a more diverse group of individuals whose skills vary in SMK and experience. The evidence provided through the interviews suggests that the discussions in the GPLC unpacked the learning for the teachers. The use of context examples drawn from teachers' classrooms and the SSPLC discussions created an environment in the GPLC where it was possible for teachers to acquire knowledge and skills for teaching.

Participating in the GPLC and SSPLC discussions allowed teachers to explore conversations and experiences in context. From the interviews it became clear that the dialogical conversations that occurred in the GPLC and SSPLC brought the two dimensions of knowledge-building that included GK and PCK into a productive relationship where teachers were able to use the opportunities afforded through ongoing collaboration and knowledge-building and in so doing create a deeper understanding of teaching and learning which could all have contributed towards developing their PCK.

Chapter 5: Analysis and findings of SSPLC and GPLC discussions

5.1. Introduction

This study investigated how GPLCs and SSPLCs develop teachers' GK and PCK and sought to demonstrate how teachers can work and interact within such learning communities to support teacher collaboration with a focus on improving practice. In Chapter 4 I presented my analysis on data collected from interviews about the teachers' experiences in the SSPLC and GPLC. In this chapter I will focus my analysis on the data collected from my observations of teachers participating in SSPLCs and GPLCs. Firstly, I will provide a brief description of the SSPLC. I will focus on the activities and support provided by the community of teachers in the SSPLC and describe how the activities of the SSPLC contributed towards building teachers' PCK and shifting their practices. Then, I will provide a description of the discussions that took place in the GPLC and explain how a focus on generic knowledge is needed to build teachers' knowledge and provide them with the language and tools needed to inform their discussions and decisions around their practice. I will argue that there exists a mutual relationship between the two PLCs which contribute towards the building of teachers' PCK. Lastly, I will highlight the factors that influenced teachers' learning in the SSPLC and GPLC and include those factors which hindered their progress in acquiring new knowledge.

I will demonstrate by providing evidence from the data collected that by engaging in the two professional learning communities, SSPLC and GPLC, teachers are able to bring the two dimensions of knowledge-building (which includes PCK and GK) together to build their knowledge. In so doing I aim to create a deeper understanding of the teaching and learning that is afforded by the two PLCs. I will also discuss the processes involved that appear to have promoted and restricted the development of teachers' practices. To start off the analysis I will provide a brief description of the SSPLC.

5.2. A brief description of the SSPLC

As I discussed in Chapter 1 SSPLCs are an ongoing form of professional development that focus on grade-level collaborative teaching teams organized to discuss matters relating to curriculum, lesson planning, assessment strategies, and learning that takes place in a subject.

The focus on subject-related professional development activities can help teachers develop a more robust understanding of learners' needs, grow their PCK and guide teachers in their ongoing planning to ensure learner success. Table 5.1. provides a summary of the focus of conversations in the SSPLC.

Table 5.1.: A brief description of the focus of SSPLC discussions

Activity	**Focus of discussions**
Planning	• Content to be covered • Activities and resources needed to facilitate learning • Assessment to evaluate learning • Support and collegiality
Implementation/Observation	• Analysing learning – questioning practice & evaluating the pacing of tasks • Sharing practice – new ideas • Assessment conversations • Reviewing activities • Reviewing learners' work
Reflection	• Alternative options to structure activities • Sharing practice – new ideas • Validity of content • Reflection on lessons

Table 5.1 shows that the SSPLC engaged in three distinct activities: planning, observation, and reflection. Having teachers engage in activities that focus on planning, implementation/ observation, and reflection on teaching and learning in the SSPLC provided the participants with the focus to direct their discussions. It also gave them the motivation needed to continue to engage with each other around issues about their practice. The implementation/observation stage took place when the teachers were implementing the planned activities. The ongoing nature of the sessions provided the participants with ongoing feedback about the effectiveness of their instructional practices which caused the participants to think about their practice and make the necessary changes that would promote learning. The participants made use of observational tools which included class visits and collaborative subject specific discussions

which were used to elicit discussions that would inform the participants about the learning. The focus of the discussions during the implementation/observation stage was on learner-teacher engagement, conversations on assessment, the engagement of the learner and the teaching materials as well as implementing new practices. The reflection stage of the collaboration took place after the theme was taught which allowed the participants to reflect on and analyse their practices in order to understand which activities promoted learning and which practices and activities learners found challenging. These reflections informed and challenged their knowledge about their teaching practice which in turn informed their planning for their next unit.

Teachers engaging in discussions around structured activities suggest that these activities enabled teachers to think deeply about their existing practices in a more systematic way by observing the learning and the difficulties experienced by learners while they learn. Teachers could use this data as stimuli to discuss and unpack the effectiveness of their own practice in a collaborative, subject focused environment. Similarly, Brodie and Chimhande (2020) suggest that there is a correlation between the different activities that a PLC engages in and the content of its talk. As the activity changes in the PLC, so does the content. Brodie and Borko (2016) argue that "professional learning requires a deliberate, collective focus on issues of teaching, learning and schooling" (p. 155). I will start off with my analysis by discussing how the teachers participated in the SSPLC and the discussions that could support changes to practice in the SSPLC. Then, using data from the observations, I will analyse each of the activities of the SSPLC to highlight the teachers' experiences of participating in the SSPLC. This will include those opportunities that created learning as well as the challenges experienced by the participants.

5.3. Teacher participation in the SSPLC

The analysis of the data from the observations of the SSPLC reflected that the contributions made by the various participants were around content knowledge and pedagogy. Teachers engage with different forms of knowledge during the teaching and learning process. The discussion and interaction among the participants, noted below, reflect the social phenomenon of learning through legitimate peripheral participation in an ongoing social practice. The participants of the SSPLC are involved in a discussion where they are engaging with one

another around the content that should be covered, and in the process, also learning from one another.

> Sarah: *Yes, and they also look at heathy diet and how a healthy diet effects all those systems. So, if we look at the skeletal system from a knowledge point of view, do we just want the children to understand the different parts of the skeleton? Is that what we are saying? And the function of a skeleton from a knowledge point of view?*
>
> Frank: *So, in my mind yes, that would be it, right? For the skeletal, right? Even medical students at university, that's basically what they learn. The functions and the different parts. I didn't do this last year. So, am I incorrect in saying that guys?*
>
> Sarah: *You're right, that is the idea behind it. The functions, the names of the bones and so on.*
>
> Ravi: *How it works together.*
> Dhevan: *I am just looking at the functions of the skeletal system the different parts that make up the skeletal system and obviously the names of the skeletal system and how they work together.*
>
> Frank: *Ja!*

The conversations around content in the SSPLC provided Frank – who was teaching science for the first time – with the SMK that he needed. He acknowledged that "*he did not do this last year*" and asked for confirmation about what content should be taught. He associated the type of content that is taught in Grade 4, with what medical students must learn. This suggests that he may have limited knowledge on the scaffolding of the content that is to be taught and looks to his SSPLC to provide him with guidance. He asked: "*am I correct in saying that guys*?" Both Sarah and Ravi provided him with support. Sarah negotiated her response by first acknowledging what Frank has said by confirming "*you're right, that is the idea behind it*" to instil confidence in him and then narrowed her response by stating that the focus should be on the functions and names of bones and Ravi added that the learners should also cover how the skeletal system works together. As Frank collaborates and listens to the knowledge presented by his colleagues, he is continuously learning and improving his practice. He is acquiring the knowledge and skills of the community with the aim of becoming a full participant in the community.

The evidence from the science lesson that was videotaped revealed Frank engaging with learners in group discussions. A learner asked a question "*Mr Frank, my question is while we are investigating, how will we work*? Instead of providing the answer Frank asked the class, "*would anyone like to answer*?". He also created a safe learning environment for his learners to learn, question and express their ideas and learn from each other. Frank, in his lesson, explained to his class that "*there is no right or wrong answer here*". He urged his learners to contribute towards the lesson "*Come on, if I was not here, what would you do? What would the moderator do?*". A student then responds "*monitor, reflect and adapt*". He provided some encouragement to the student by saying "*fantastic*".

The interaction among the participants in the SSPLC also focused on the sharing of practices where the participants drew from each other's experiences to build their PCK. The following discussion among the participants highlights the sharing of practices:

> Sarah: *With regards to the child who needs remediation we would need to scaffold the activities and we are going to have to group them obviously with somebody who is a little bit stronger and would assist them.*
>
> Frank: *I would give them a structured role in a group.*
> Ravi: *Yeah, so what I was thinking about doing is to group a strong top, middle, and bottom. I think it will just be a better way to collaborate, so everybody is helping everybody.*
>
> Sarah: *I was thinking maybe a weak and a middle child or a top and a middle child, just so one inspires the other, so they learn from each other.*
>
> Dhevan: *So that's the grouping sorted out and my other point, I wanted to find out obviously when the children are working, you're going to be going into the meet sessions and you basically want to observe the learning that is taking place there.*
>
> Frank: *Ya, what sort of discussions are they having and maybe guide them.*

The above discussion centred around the practice of grouping learners for a collaborative task. Frank suggests that he would allocate "*structured roles*" for the learners, whereas Ravi offers a different suggestion to Frank and stated that she was thinking about placing learners in groups of different abilities where the learners all assist one another in the group. Ravi explains "*I think it will just be a better way to collaborate, so everybody is helping everybody.*" The

different suggestions provided by the participants allowed them to develop different perspectives as to how they could group the learners and created an understanding of why one approach is better than the other – which Sarah explained as "*just so one inspires the other, so they learn from each other"*. Discussions that provide various options of instruction and highlight why they work may enhance teachers' individual as well as collective learning.

Frank indicated in his interviews (which I discussed in Chapter 4) that he found it difficult to say, "*I don't understand*". His limited PCK hindered his participation in the SSPLC and he mentioned that he found it difficult to understand "*how one would choose to teach something*" as he was used to using a teacher-led instruction method when he taught. This created tension for him. His lack of sufficient SMK and PCK in teaching science made him feel that he was letting his colleagues and learners down. Furthermore, Frank acknowledged that he was struggling with his identity as a teacher at his new school. Coming from a more traditional school, he had been quite sure of expectations regarding his role in the classroom. He was the source of knowledge in the classroom and the learners listened to what he had to say. At his new school this was different as he was no longer the only source of knowledge. This may have caused stress for him, and this could have affected his performance in the SSPLC. To promote learning in the SSPLC, the focus of the SSPLC can play an important role in managing the tension that participants experience.

During the initial stages of the SSPLC, Ravi and Frank both participated cautiously within the community. However, the discussions in the SSPLC did offer support in the form of SMK as well as PCK. At the onset of participating in the SSPLC, Frank declared that he "*wasn't here last year*" and therefore may have felt that he possessed limited knowledge on the practice of learning that is expected. By stating that he was not there last year could have been his way of asking for assistance. Ravi, initially, always asked for more details about collaborative practices in order to understand the expectations. For instance, "*how will we know that collaboration is taking place?*" or "*will learners be required to walk around with the iPad?*"

The discussion that follows shows how the participants in the SSPLC offered support in developing topic-specific strategies which may have contributed to the development of their PCK.

> Sarah: *We have got two videos for each task. Remember I said that they watch the video, and they do their mind maps before they start their research.* (Sarah shows

examples of activities – building systems using recycled material – to colleagues as an activity).

Dhevan: *Okay, so they have got their videos, and in term of producing models to help with their explanations do you guys do that as well? I know that […], you showed on an A4 piece of paper where the children build something*.

Ravi: *So previously what they had to do is that they had to build the digestive system and then put it on a card and then show it to the class. They had to cut out each individual part of the digestive system or the skeletal system or any one of those and they put it together.*

Frank: (Looking at the examples of possible activities, in the form of building systems that is projected onto the monitor*) That's great Sarah. Sorry I have never seen that. Oh, my gosh! That is fascinating. Wonderful, wonderful. So that's got my, guys, that just tickled my…* (Participant is excited by the examples of activities).

The snippet from the SSPLC shows how the discussion among the participants is spurring conversation and the process is helping the participants build their knowledge of subject and topic-specific strategies as well as contributing towards their learning trajectory. Frank's "surprised" response indicates that he is not familiar with activities other than teacher-led activities, but he shows interest in the student-led practices. Showing interest towards alternative practices is a first step in facilitating a change in practice. As a result of the peer support that he is getting from his colleagues in the SSPLC, the tension and stress that he may have experienced in teaching the subject has changed to excitement. The discussion around the different activities also leads Ravi to reflect and draw from her own prior experience to contribute towards the discussion. She recalls that "*previously what they had to do is that they had to build the digestive system... cut out each individual part… and they put it together*." The recollection allows her to verbalize the process of the sequence of the activities to make sense of what is expected. The collaboration facilitated pedagogical conversations which led to the sharing of practices. Discussions that outline the sequence of activities allow the participants to familiarize themselves with the steps and actions that should be taken when implementing new practices and provides them with the knowledge to develop their PCK.

From here on I will discuss the three collaborative SSPLC sessions: planning, observation, and reflection. The discussion around planning, observation and reflection enabled focused and directed thinking on the artefacts and initiated interesting conversations amongst the participants of the SSPLC as they were informed by the actual examples that were used and were able to get a better sense of the learning that was taking place and of what was possible. Artefacts like samples of learners' work, video recordings of planned lessons and samples of activities were used to initiate, guide, and promote discussions in the SSPLC.

5.3.1. Collaborative planning

In this section I will explore the collaborative discussions in each of the planning meetings as they helped me understand how these activities contributed towards the building of SMK and PCK for the participants as they engaged in the process (see Table 5.2). The exploration of the sessions also sheds light on how the participants explored the various artefacts, and how the discussions that arose from the collaboration were used to improve knowledge.

Table 5.2. Collaborative planning in the SSPLC

Planning stage of SSPLC	
Focus of discussions	Content to be covered
	Activities and resources needed to facilitate learning
	Assessment to evaluate learning
	Support and collegiality

Table 5.2. provides an overview of the focus of discussions that took place among the participants in the planning stages of the SSPLC. Collins and Duguid (1989) suggest that acquiring PCK from the community "entails both changing the user's view of the world and adopting the belief system of the culture in which they are used" (p. 33). Changing the user's view requires the user to engage in focused areas of discussion as indicated in Table 5.2., which aids in the understanding of knowledge among the participants of the PLC. This in turn allows for the learning of PCK. Any new knowledge that is acquired through the process of learning may affect any pre-existing knowledge that the teacher has (Kwakman, 2003).

The data reflected that planning in the SSPLC consisted of conversations that focused on outlining the content that was to be covered [Table 5.2]. The conversations indicated what

needed to be taught, when and how it should be taught, thus ensuring that the participants were able to see the full picture.

For example, in a discussion on the skeletal system, Sarah confirmed in the meeting that the focus of the content that should be covered will be "*healthy diet and how a healthy diet affects the skeletal, digestive and muscular systems. So, if we look at the skeletal system, from a knowledge point of view, we just want the children to have an understanding of the different parts of the skeleton and the functions of the skeleton"*. In Chapter 4, during the analysis of the interviews, Frank stated that he had "*never taught science*" and admitted that he continuously relied on his SSPLC to make sure that his "*content knowledge is where it needs to be*." Due to his engagement in the SSPLC discussions we are able to see a growth in Frank's SMK to a point where he was now contributing towards the discussion. He affirmed Sarah's suggestion when he agreed that "*Yes, that would be right, for the skeletal system they learn the functions and the different parts.*" The conversations among the participants in the SSPLC around SMK were substantial and led to a shift of knowledge with regards to the understanding of the SMK that science teachers should have about those requirements for learning. This type of knowledge involves any prior specific science knowledge that teachers should know before teaching a concept as well as knowledge of any skills or abilities that learners should have to assist them while learning.

The collaborative discussions on different activities that facilitate learning among the participants of the SSPLC assisted the participants in developing their knowledge on scaffolding the activities correctly to promote learning. This, in turn, added to the participants' own PCK. Teachers may develop certain preferences in their practice, and therefore it is important for teachers to develop a deeper knowledge base about the effectiveness of certain practices. For instance, Figure 5.1. represents a collaborative word wall that was the outcome of the discussion that took place in the SSPLC meeting regarding designing activities that assisted in creating meaning around words that learners may come across while completing their research activities.



Figure 5.1. Collaborative word wall

The discussion resulted in teachers planning a word wall activity to scaffold learning before completing their main research task. Ravi suggested that the learners should also complete a "*word wall*" before doing the research task as this would give them "*some sort of knowledge on words that they are going to come across in their research*". Ravi also argued that allowing learners to complete research activities alone, without any prior knowledge, would lead to learners not understanding what they were researching.

Frank, who had come from a very traditional teaching background mentions the following in his SSPLC after participating in a discussion around which activities to use when teaching the skeleton: "*It honestly looks great. I know my children are going to love making these*." This suggests that he sees the benefits that a type of practice where learners are more involved will have on improving learning and has adopted this practice as part of his growing PCK. Consistent with Frank, Sarah appreciated the discussions and contributions made by the participants around the different activities that should be included to teach the section. She stated: "*That's quite interesting. I haven't thought of that*." Her response suggests that the discussions in the SSPLC has made her think about the activities that she would have used and the limitations thereof while the new suggestions have contributed towards the development of her PCK.

The discussions in the planning stages also focused on different kinds of assessments to evaluate learning. Frank suggested that he, "*would give them [learners] a structured role in the group and say, 'Right, this is boy A's role, and these are the questions that come with this role'. If you can answer these questions that is what success looks like*". Ravi suggested that learners should "*teach the class what they have learnt and make a google slide presentation. So, they basically have to understand what they have learnt because they are teaching*

everybody else." Sarah added to the discussion by suggesting that "*once the presentation is done, we will then do a bit of consolidation in our books. We have worksheets that consolidate everything.*" Collaborative planning in the SSPLC meetings informed teachers' understanding of the different strategies that they could use to assess learning. The diversity of suggestions made around assessments by the participants also provided them with knowledge on assessment. If teachers are exposed to a variety of options for assessment, rather than using only one type, the more they will be able to accommodate learners' needs. Using different assessment types will support the teachers in identifying gaps in their learners' knowledge and can be used as an artefact that provides authentic feedback to facilitate further discussions in the SSPLC. Discussions about different assessment types contribute towards knowledge on how teachers assess different teaching approaches in classrooms.

The collaborative planning meeting provided the participants with support and collegiality. Sarah said that "*I think that we will sit and discuss that. We also have some different ideas for this year, so perhaps we will discuss that and make some points*". The data from the four planning meetings highlighted that the SSPLC provided its participants with a context to have collaborative professional discourse around the content and during this process, new ideas grew which added to the teachers' PCK. Sarah wanted to discuss a new activity that she would like to introduce with the participants of the SSPLC and she wanted to hear their thoughts about the activity. She stated, "*I think we will sit and discuss that*." Discussing new ideas in a collaborative space allows the participants to unpack the idea, create understanding of the expectations and contribute towards the building of the activity. This process allowed the teachers to make a vested interest in the teaching of the unit that was being discussed. It created excitement as Frank demonstrated while listening to new ideas in a SSPLC discussion: "*That's great Sarah [Showing examples of models that could be built] Sorry, I have never seen that! Oh my gosh! That is fascinating*!"

Frank was used to teaching using a PowerPoint presentation where he was the source of knowledge. He looked to his peers to provide him with the support, guidance, and knowledge on how to go about teaching in new ways, saying that "*Sarah and Ravi have been helping me with that*". Borko and Putnam (1996) state that the type of learning that the teacher must participate in is "heavily influenced by an individual's existing knowledge and is situated in a particular context" (p. 674). By receiving assistance from his colleagues, Frank was able to reflect on existing knowledge of teaching and learning and use the discussions and support offered in the SSPLC to modify his instruction and continue with experimenting with different

practices and in so doing build his PCK. He felt confident enough to ask his colleagues "*I would really appreciate some ideas to make sure that we can push this through because I think it's a lovely learning opportunity, the whole Jam board idea*." His comment suggested that he saw the benefits in enabling leaners to be actively involved in their own learning process. He thought that the Jam board[2] was a lovely learning opportunity which reflected a shift in his thinking about practice and he used it as a basis for altering his method of instruction.

My analysis of the data on the planning stage of the SSPLC has shown that the discussions around planning activities and unpacking the content have been beneficial in getting the participants to think more deeply about their practices and this has led to the questioning of instruction to improve learning for the learner. However, this process has shown that it can also cause disagreement among the participants. While discussing the progression of activities that needed to be completed Ravi started to feel anxious at the amount of work that needed to be done. Due to the change where the emphasis is on guiding the learners to construct understanding using various activities and methods of instruction, she felt that she could not control the pace at which the learners would work and was concerned that she would not be able to get the learners to complete the activities on time. She stated, "*I'm slightly worried about the time in terms of doing, answering those questions*". She also expressed her concern in allowing learners to conduct their own research: "*I'm just worried because our little ones are little. Researching and finding out and exploring. It's awesome, but I'm just worried that they're going to go off on a tangent trying to find out one thing*." Ravi appears to be disagreeing with the other participants in the SSPLC about allowing learners to conduct research on their own as she is concerned that the learners may go off on a tangent. Differences of opinion among participants in a PLC may create opportunities for new ideas to emerge. As a result of the disagreement, Sarah suggested that they should "*set out the group roles at the beginning*". The difference in opinion enabled the participants to come up with the idea of managing the research task by allocating specific group roles to the learners.

5.3.2. Implementation and observation

The conversations in the implementation and observation stage of the SSPLC focused on discussions about the effectiveness of activities that were planned and whether the teaching

[2] Jamboard is a collaborative online interactive whiteboard that is used for gathering ideas and making thinking visible.

methods used were appropriate. These conversations opened up opportunities for the participants to question their practices and explore different practices to promote learning.

Table 5.3. Collaborative implementation and observation in the SSPLC

Implementation and observation stage of SSPLC	
Focus of discussions	Analysing learning – questioning practice & evaluating the pacing of tasks
	Sharing practice – new ideas
	Assessment conversations
	Reviewing activities
	Reviewing learners' work

Table 5.3. highlights the focus of discussions among the participants that took place online during the observation stages of the SSPLC meetings. The discussions in the SSPLC focused on analysing the learning that was taking place which helped to facilitate a change in teaching strategy where specific teaching strategies that are useful in assisting learners understand specific science concepts, were discussed. Teachers adopted practices where they provided learners with constructive feedback to improve their learning. During one of the implementation and observation sessions, while the teachers where analysing a learner's work, the following contribution by Sarah, highlights a typical example of how the discussions in the SSPLC facilitated change in practice.

During the implementation and observation stage of the SSPLC sessions, Sarah displayed a learner's work who was working online and who did not follow up on her suggestions to add more detail to her answers when she resubmitted her work. Sarah stated that instead of just marking the work as incorrect again, she gave the learner a few questions to answer to better guide her towards completing the activity. As indicated in Figure 5.2 Sarah commented on the learners' work as follows:

1. *What type of nutrients are absorbed into your blood stream?*
2. *Where do the nutrients go to once they are absorbed from the intestines?*
3. *Where does most of the digestive process take place?*

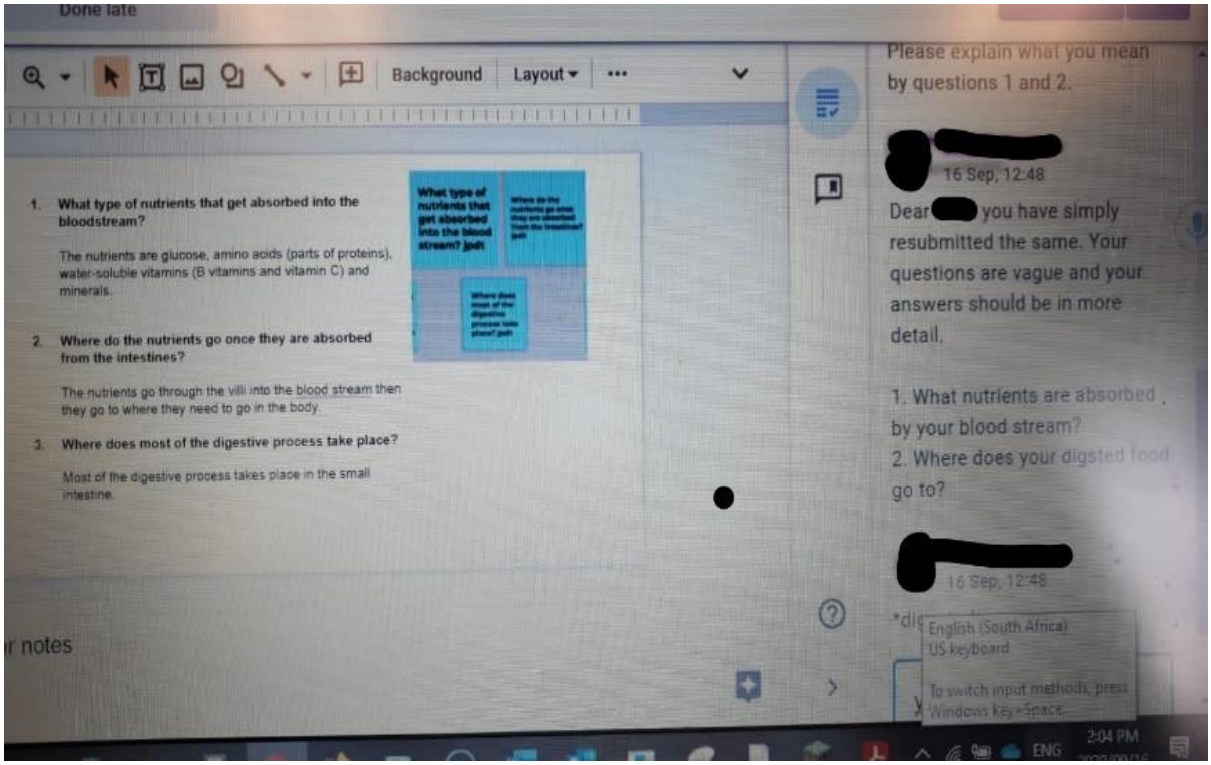


Figure 5.2. Teacher feedback Intervention 1

Seeing that the learner used the additional feedback to complete the questions, Sarah proceeded to follow up with more questions for the learner to complete. This is indicated in Figure 5.3.

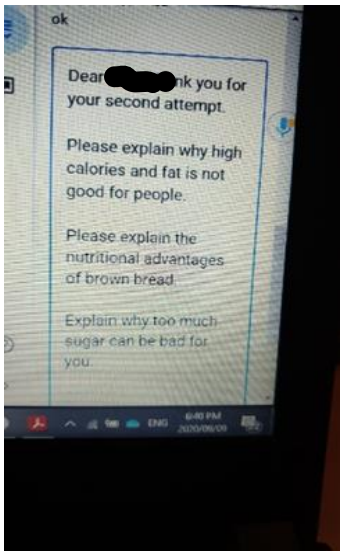


Figure 5.3 Teacher Feedback Intervention 2

As indicated in Figure 5.3. Sarah praised the learner for completing the previous task by stating "*Dear [student name] thank you for your second attempt*" and proceeded to provide the learner

with a few more directed questions to assist the learner in better completing the task. The practices of providing feedback and scaffolding the learning that are indicated in Figures 5.2 and 5.3 show how the teacher had changed her practice and provided a learner with feedback that helped to create an understanding of the concept of food digestion by asking her to do some research on specific questions. Sarah has been teaching for 23 years, but these new strategies of teaching that they were expected to adopt has taken Sarah out of her comfort zone. Sarah explained that changing teaching strategies during the lesson was new to her. She exclaimed: "*Yeah, that's a learning curve*" which reflected that she had learnt something new. Teacher practice should be informed by a deeper knowledge base about the effectiveness of practices and why certain practices yield better results than others.

The discussions in the observation stage of the SSPLC meetings did not only focus on analysing and addressing problems that arose during the teaching phase of the lessons, but also served as an accountability structure to ensure that what was planned, was being implemented in the classroom (Brodie & Shalem, 2011). Sarah acknowledged that she was "*still at the beginning stages, we haven't gone as far as we thought we would have*". Here we see Sarah being accountable to her peers by providing them with feedback on where she was with her lessons. Another form of accountability that was observed during the observation stage was that participants were asked to justify why certain activities were being used. For instance, Ravi asked: "*Uh, the idea with this project is to do group work, how to work together as a group, and that's what we trying to upskill the kids in or is it about being able to research*?" Sarah contributed towards the discussion by explaining that "*it's a combination, so we do want them to learn how to collaborate with each other but then we also want them to learn how to access and use information from different sources*". Ravi seems unclear about what the objectives of the lesson are, as she is familiar with teaching content and her PCK on teaching skills are still developing. She is assisted by her colleague, Sarah, who confirms what the objectives of the lesson are. These collaborative conversations helped teachers to become accountable to one another as well as being sufficiently comfortable in seeking advice from their PLC colleagues. These findings support Feldman and Fataar's (2016) argument that "vigorous 'habitus engagement' and reflexive dialogue are necessary if changes in pedagogical practices are to be achieved" (p. 22).

The sharing of practices among the participants provided the teachers with some guidance on how to navigate learning during the inquiry. Following on from Frank's observation about bigger groups not working, Sarah acknowledged that "*we need smaller groups*". The

conversation around the size of groups and how it impacted the learning process spurred Sarah on to suggest that "*maybe we can insert a self-reflection rubric at the end of every week to assess themselves and the group. That might help give us a clearer understanding of how each one is feeling and how are they finding what they're doing*". Sarah who has more experience in teaching science is also learning from the collaboration. Frank, being a new teacher, and listening to the contributions, begins to think about his knowledge on instructional strategies and muses that "*if we give the child a role of being the reflector, for instance, in the group to evaluate how their peers contribute maybe that could be an avenue*". Frank is adding to Sarah's contribution which shows that his PCK is developing. Sarah supported Frank's idea by stating "*That's a good idea*", which helps to confirm Frank's contribution and contributes towards the development of his confidence in changing his practice. The sharing of practices in the SSPLC contributed towards the building of Ravi, Sarah and Frank's PCK and provided them with the confidence to contribute towards the discussions.

Conversations that related to assessment during the planning stages identified the different kinds of assessments that could be used to evaluate the learning. However, already during the observation stage of the SSPLC the discussions around assessment provided the participants of the SSPLC with the knowledge of when to assess and how the assessment tools would be used to assess that learning. For instance, Ravi enquired: "*What I would like to know, I'm assuming we would give the kids the rubric beforehand so that they know what they are being assessed on and what they should be looking for?*" As Ravi is developing her PCK in science, the SSPLC has provided Ravi with a platform to clarify her knowledge on assessment, specifically when to provide the learners with the assessment tool. Ravi is used to using traditional methods of assessment in the form of tests. She uses tests to assess what content the learners know or do not know. This discussion then provides her with the support she needs on how to assess using a rubric. Sarah responded to Ravi and stated that "*Yes, we do have a rubric, but we are in the process of changing it now because we're trying to adapt it.*" Through this discussion, Ravi is developing her knowledge and shifting her thinking on different assessments and creating an understanding that assessment can be used to enhance learning by informing learners of their expectations as compared to using an assessment at the end of the section to record what the learners know or do not know.

The collaborative discussions during the observation stage of the meeting resulted in teachers reviewing their activities in an effort to promote learning. And, as the activities changed, the teachers made changes to the assessment tools. Sarah also suggested that in order to assess

learning, a change of activities was required. She noted that "*previously we thought we didn't have to look at the three questions and their research because we trusted that they will do it, and not everybody did it [the research]. So, what we have to insist on now, in order to assess their learning, is that every child should submit the three questions and their research*". By using the learners' work as an artefact and analysing it, the teachers were guided as to how to remediate the learning and what work should be assessed. Participants in the SSPLC are being exposed to discussions about the knowledge of the dimensions of science learning. This type of knowledge refers to what teachers perceive as being important to assess in scientific literacy.

Participants, during the observation stage of the SSPLC meeting, also had an opportunity to review learners' work which provided authentic feedback on the progress of learning. As the teachers collaborated and assessed the learners' engagement and learning this led in turn to creating alternative activities and using different approaches. For instance, Sarah observed that upon reviewing a group's task that "*each learner took a turn to type the key points that they could think of in the chat and then the rest of the group copied that into their books to create the bubble map. But there were some learners that did this and there was some that did not*." The participants discussed this concern in the SSPLC, and Ravi suggested that to ensure that learning is taking place they should "*pull them back into it, to say; 'Okay, how is this related to the muscular system? How is this related to a healthy diet?* Sarah offered her suggestion as to how she guided the learning of a particular student who needed extra support and was working online. But upon observing the learner's work in the collaborative environment, she realised how an earlier intervention to her practice might have yielded better results. Furthermore, Sarah recalled what she had observed by reviewing learners' work: *Some of my children […] wrote questions and then they just wrote from the top of their heads. They didn't do any research and I could tell from their answers that it wasn't researched at all*". From reviewing the learners' work the participants came up with suggestions and "*were able to give them [learners] feedback on whether they […] were on the right track or whether they needed to relook at what they had researched*". Participants offered alternative activities as a means to promote learning and this process added to the participants PCK. I will now move on to discussing the reflection stage of the SSPLC sessions.

5.3.3. Reflection

Table 5.4. below highlights an overview of the focus of discussions during the reflection stage of the SSPLC. Reflection among participants in this SSPLC was "*very important*". Reflecting upon one's practice in a collaborative environment where individuals hold different views, facilitates conversations about different methods of instruction and aims at improving existing practice.

Table 5.4. Collaborative reflection in the SSPLC

Reflection stage of SSPLC	
Focus of discussions	Alternative options to structure activities
	Sharing practice – new ideas
	Validity of content
	Talking about the outcomes of the lesson

Sarah acknowledged in her interview that the activities in the SSPLC meeting involved teachers reflecting upon "*what we had planned for the children […] this is what we actually did in the classroom. This is what worked really well with all of the children*". This was confirmed by Frank's remarks during the reflection stage of the SSPLC meeting where he affirmed that *"I felt like I could have explained a couple of things a bit better in terms of irritable bowel syndrome. I even told them how to spell it incorrectly. Also, the children in groups of three got through the work a lot quicker than children within a group of six*." Similarly, after watching the video recording of the lessons that were video recoded when the school was allowed to open, Sarah conceded during the reflection sessions that "*I should've got my desks into groups first because it took us a long time to get them into groups so that was a big thing. I put it down for next year to remember to organize the groups when the kids are out at break*." Creating time to reflect on one's teaching enabled the teachers to discuss the merits of their practices and provided the opportunity for the participants to discuss what their planning actually looked like when it was implemented. Teachers looked for evidence as to whether their practices translated into effective learning during the reflection and used this knowledge to build their PCK. Sarah admitted during her interview that her teaching techniques had changed due to her participation in the SSPLC. She affirmed: "*Yes, I would say it has, because during our subject*

specific […] learning community meetings we discuss each other's teaching methods […] so we learn from each other."

The reflection stage of the SSPLC gave the participants an opportunity to review the structure of the activities that they had used. The review of activities in the reflection stage was an overall reflection on the activities that were planned and the interventions that needed to be implemented to promote learning. The reflections at this stage were used to inform future practices and planning. This was affirmed by Ravi who suggested that she *"almost feels like we have to almost prep them [learners] on how to do research before we give them a task, so if we really want the kids to have the knowledge then that might need to happen towards the end of year topic but at the beginning of year maybe we teach them how to research, how to be a project manager.*" Ravi used the reflection to analyse the overall learning that had taken place. This process made her understand why the learners experienced difficulties with the task and in the process provided her with the knowledge to inform future practice to ensure that the learning is successful for the learners. The process of reflection on the structure and scaffolding of the activities contributed towards the development of the teachers' PCK. Sarah agreed with Ravi and reflected that "*I showed them how to read sentence by sentence and write it in their own words so that is something we should do at the very beginning. But I only realised like when we were already halfway through, I realised maybe we keep saying you've got to write in your own words but what if they don't know how to do that? So that is something we have to start with next time round.*" The reflective practices in the SSPLC helped the teachers understand their learners' strengths and weaknesses as well as their own assumptions. Sarah assumed that her learners knew what it meant to write down their answers in their own words. It was through the review during the reflection stage of the discussions that she was able to make the link as to why the learners were not completing their research successfully. The process of reflection helped Sarah to identify the barriers that her learners were experiencing and, in the process, helped build her PCK.

Ravi mentioned that the validity of the content should be reviewed as she felt that learners should be able to relate to the content. This shows a growth in Ravi's PCK. At the beginning of the planning sessions, Ravi asked a lot of questions around the content that needed to be covered and repeated samples of content that was covered from her previous year. At this stage we see that Ravi is suggesting that the content should be reviewed. Sarah agreed with Ravi's suggestion by affirming "*that is a valid point and definitely something we will look at for the new year*". While a PLC encourages all participants to contribute and learn together, it seems

that Sarah is making the decision to review the content that is to be taught. This could be because Sarah has participated in the SSPLC for a longer period and has more experience in teaching science. She acknowledged the contributions made by the participants towards the development of activities and which supported Ravi in adopting the practices of the learning community. In response to Ravi's suggestion, Sarah explained that "*I quite enjoyed the twist that this project took this year. I liked all the different ideas that we used. We chopped and changed what we initially started off with, and it turned out to be pretty good*". Appreciating the contribution of colleagues helped develop collegial relations among the participants and created an environment where they could share freely. Suggestions were not dismissed but rather implemented. Through this process the participants were able to observe their suggestions being implemented and as they reflected on their practice, they developed their own abilities to solve problems and alter their practices. Reflecting on their own suggestions enabled the participants to come up with solutions as the teaching and learning process unfolded and this process could have resulted in them becoming more flexible in their teaching.

The reflection stage of the SSPLC meeting also allowed the participants to talk about the outcomes of each other's lessons that they observed, and video recorded. The video recordings allowed the participants to view the lessons more than once. This activity also allowed them to reflect on their own practices. Sarah explained that "*I should've got my desks into groups first because it took us a long time to get them into groups.*" Sarah acknowledged that getting learners to organize their desks during the lesson wasted teaching time and she made a mental reminder to make sure that the desks would have to be organized before the lesson in future: "*I should remember to organize the groups when the kids are out at break.*" Sarah also acknowledged that she could have started the lesson differently. She stated that "*Frank asked his class to define advocate, and, in my lesson, I told them what advocate means so it's a good idea for us, you know, going forward, that we let the children actually look up the difficult words.*" The reflections on the lessons helped Sarah to identify what the strengths and weaknesses in her practice were and during this process helped grow her PCK. Through this process she was able to identify the factors that promoted and hindered learning in her class. Frank added that he "*could have explained a couple of things a bit better*". He even acknowledged that he "*even told them how to spell osteoporosis incorrectly*". Upon his reflection he acknowledged that "*perhaps a bit more planning from that point of view is needed*". The reflection on the lessons also provided the participants with opportunities to see which teaching strategies worked well. Sarah added that "*I think that is something that we have*

to continue going forward, we've got to walk around, we got to check what they are doing." which suggests that she is thinking and questioning her existing practices and making changes to her practice.

The process of reflecting on one's lessons was a form of support to each of the participants. Sarah mentioned that because of the reflection that took place, she questioned the validity of her practice which led to her changing her practice. She acknowledged: "*So, yes, I do look at myself and if I find that I am not reaching that child then I try peer teaching.*" Reflection on Practice (ROP) and Reflection in Practice (RIP) helps teachers develop their PCK and their confidence for the purpose of improving the learning experience for the learners. Participants in the study highlighted the importance of changing practices that do not work, and therefore RIP and ROP must happen simultaneously to improve the learning experience for the learner. Participating in collaborative reflections with participants in a SSPLC facilitates change in teachers' practices. Providing support to teachers facilitates growth and enables teachers to make those shifts in their knowledge and practice (Chauraya, 2016). My analysis will now move on to discussing the learning that took place in the GPLC.

5.4. Analysis of GPLC meetings

The generic professional learning community (GPLC) consists of a diverse group of around 9 to 14 staff members who teach in different phases of the school. The GPLC consists of teachers from the early learning centre, junior school, middle school, and from the high school. The participants meet every fortnight and follow a structured curriculum where the discussions centre around theories of teaching and learning. The GPLC discussions are led by a facilitator. The participants use examples of teaching and learning experiences from their classrooms to make sense of the knowledge discussed in the GPLC and in the process develop their GK. Participating in the GPLC places each of the participants in the position of a learner. The aims of the GPLC are to facilitate community, support personal and group pedagogical knowledge, and to improve working relations among staff who teach in the different phases of the school. At the inception of this study in 2019 the participants of the SSPLC attended different GPLCs. However, during the recording of the GPLC sessions in 2021, due to timetable changes, all three participants from the SSPLC, Ravi, Sarah, and Frank, attended the same GPLC. The GPLC that was selected for the analysis of this study consisted of 14 participants including Ravi, Sarah, and Frank, and because this group was bigger, I assigned numbers when referring

to the additional participants. Table 5.5. provides a summary of the focus of conversations in the GPLC.

Table 5.5: A brief description of the focus of GPLC discussions

Activity	Focus of discussions
General discussions	• Sharing experiences of Protea walks • Sharing of classroom experiences • Emotional support
Focused discussions using learning manual	• Discussions on change, diversity, and courage • Discussion on the AGES Model • Discussion on the SCARF Model • Discussions on assessment

Table 5.5. shows that the GPLC was engaged in two distinct activities: general discussions and focused discussions using the content on theories and models of teaching and learning which was located in the learning manuals that each member of staff received. My observations of teachers engaging in general and focused discussions on GK suggest that these activities provided teachers with a cauldron of new knowledge and a focus on teaching and learning to draw upon. The GPLC discussions offered an opportunity for the participants to listen to the experiences of a diverse group of teachers about their understanding of the different models and theories of teaching and learning and how different teachers were implementing these strategies in their classes. Such acquired understanding was then used as stimuli to support teachers in their discussions in their SSPLCs.

Using data from the observations, I will analyse each of the activities in the GPLC to highlight the teachers' experiences of participating in the GPLC. This will include those opportunities that facilitated learning as well as those that hindered learning for the participants. I will start my discussion by analysing the general discussions around the Protea walks that took place in the GPLC and how these discussions facilitated the development of GK.

5.5. General discussions in the GPLC

Table 5.6. represents the focus of the general discussions that took place in the GPLC. Changing teachers' knowledge and practices requires teachers to build on their knowledge in an environment that is conducive to learning. The discussions among participants in the GPLC appeared to help to build stronger relationships between the participants which in turn created a better understanding of the learning expectations among the teachers.

Table 5.6. Focus of general discussions in the GPLC

Activity	**Focus of discussions**
General discussions	• Sharing experiences of Protea walks • Sharing of classroom experiences • Emotional support

In the GPLC meetings, the group reflected on and discussed experiences of their classroom visits which they referred to as Protea walks which took place twice a year. Having the opportunity to view different practices at play can create a wider knowledge base and influence teachers to adopt aspects of activities and practices that they have observed into their own teaching. Sarah explained that "*Protea walks are where teachers voluntarily invite other teachers into their classroom to share their students' learning process and experiences*". In the SSPLC participants had the opportunity to visit each other's classes once for each theme that was planned and that reflected the same grade, same subject and same lesson that was taught. The focus was on teachers observing how the learners experienced the knowledge and activities that were planned, and the participants used the observations as stimuli to modify their instruction to facilitate learning. The Protea walks are different in that they occur in the GPLC, and teachers get to visit classes of different grades and subjects. Having the opportunity to observe different teachers' classes at play allow the participants to view the implementation of practices that have been discussed in the GPLC in different subjects and across grades. This provides the participants with a visual image of the implementation of these practices and may inform their learning about the practice.

Teachers' practices vary depending on the subjects as well as the age group that they teach. Ravi, in the GPLC meeting had the following to say about the Protea walks: "*I think as teachers, especially at School X, we are all very much from different walks of lives. To a certain*

extent we all have quite rich experiences here at School X, so it's always interesting for me to go into other teachers' classrooms and see their approaches to teaching, and you know, the way they approach certain subject matter. So, I think we are quite diverse in our points of view and how we approach teaching." Another participant during the GPLC meeting – teacher 1, affirms Ravi's contribution by acknowledging that "*teachers speak different languages* [referring to different practices]. *Each language equips you with different tools to approach different concepts*". Sarah recalled that her experience of doing the Protea Walks "*was the most worthwhile thing for me because I learned, and I actually wrote this down; do this next time, do this*".

Conversations around sharing teachers' classroom experiences, and being diverse in their planning and teaching methods, helped affirm that all teachers are different and have different teaching styles. This type of conversation among diverse participants also helped to alleviate some anxiety that teachers may have had about colleagues visiting each other's classes. Following on from the discussion from teacher 1 on teachers implementing different practices and equipping one with tools to approach different concepts, Ravi added to the discussion about teachers being diverse and have different languages [practices] and stated that "*we've got quite a growth mindset at School X, and that we are willing to learn*". The concept of the growth mindset (Dweck, 2015) is discussed in the GPLC, and the teachers are encouraged to approach their challenges as opportunities to learn from and to grow their skills. Conversations about having a growth mindset in the GPLC meetings helped to create the context of learning by suggesting that teachers are not the bearers of all knowledge and that their knowledge is not static. By having a growth mindset, it is being suggested that the participants should be open to learning in a meaningful way which includes taking on the challenges that they experience in the classroom and learning from them in order to improve their practices. For instance, Frank demonstrated a growth mindset in the SSPLC where he showed a willingness to learn from his colleagues by asking them for suggestions and adapting his instruction style where he was the bearer of all the knowledge. He stated that "*what we initially planned was they [learners] would present to the other groups and the other groups will have a chance to ask questions but as I say we didn't quite achieve it this week. We need to find a way where we can still have that but hold them accountable in some other way. I would really appreciate some ideas to make sure that we can push this through because I think it's a lovely learning opportunity*".

Spurred on by conversations from Teacher 4 in the GPLC meetings who exclaimed that it was necessary "*to be brave, to be brave about change, to be brave about difficulty and to be brave*

about uncertainty", participants were more willing to share their experiences. Sarah stated that "*I want to share my own personal experience when I first started at School X*". Sharing ones' own personal experience in the GPLC enabled other participants to develop their self-confidence as they were able to identify with each other's experiences, and hence, were more willing to contribute and be vulnerable amidst colleagues. And, as teacher 4 conceded: "*you get more people end up saying I also don't know*", with an understanding that learning is taking place. Sarah acknowledged during the GPLC discussion that she "*now feels so confident to say 'I don't know how to do that please show me' and I think, the way we've been going has actually made me feel more comfortable in being able to say, 'I'm not sure' or 'I'm not familiar. Please can you show me'*". Teacher 1 agreed with Sarah and affirmed with "*Ja, that is true*". Acknowledging that you did not know something opened the discussions among the colleagues in the GPLC meetings as participants were able to identify with each other's experiences and they were more willing to share their practices and experiences with each other and learn from one another.

Alongside developing participants' GK the GPLC, discussions provided its participants with emotional support. Teacher 2 conceded that "*it's been a long and difficult year you know. A lot of things have changed just in our curriculum because of the way we structured our program to accommodate online learning*." Teacher 11 affirmed this with an "*Absolutely!*". Teacher 12 acknowledged that "*I never thought in a million years I would be teaching 10-year-old children with their parents sitting next to them and the fear that comes with that, you know. Talk about courage and vulnerability*". Teacher 3 added that she had left her planning documents in her classroom and due to the Covid-19 restrictions she was unable to access this material as she was quarantined at home. She noted that *"when I was beginning my lesson, I had no book at all, so everything was just like coming from my head – I was dying*". The participants shared their experiences of the changes that they had had to make. They used words like long, difficult, fear, and even "dying" to express how they felt while implementing the changes. This indicates that implementing change is not easy and that the teachers experienced a lot of difficulty along the way. At the end of that GPLC session the group, altogether, started clapping. The group clapping can be seen as a sign of approval and admiration for what they had achieved. This may have contributed towards their comfort and emotional support and promoted collegiality within the group.

5.6. Focused discussions using a learning manual

Table 5.7. reflects the focused discussions that took place in the GPLC where participants' discussions were guided by the content from the learning manual. The discussions around theories and models of teaching and learning in the GPLC sessions created intersections where different types of generic knowledge came together to create new outcomes of thinking around teaching and learning and challenged the teachers to reflect critically on their practice. As the participants were reading and discussing more about their practices, they were able to bring something new into their SSPLC discussions. This resulted in the teachers being able to share what they had found so they could learn collectively. These shifts in learning helped teachers develop their GK as well as their PCK. Reflection in an environment like the GPLC that does not necessarily focus on subject matter and content taught in classrooms, can be a meaning-making process where, through the process of sharing one's experiences of teaching techniques in a collaborative environment, teachers are able to make shifts in their own practice with a deeper understanding.

Table 5.7. Focused discussions in the GPLC

Focused discussions using learning manual	• Discussions on change, diversity, and courage • Discussion on the AGES Model • Discussion on the SCARF Model • Discussions on assessment

During a discussion on change in the GPLC, Teacher 2 remarked that even in the Early Learning Centre (ELC) "*you get everything from the learners*" and that it is so much better than "*when you dictate to everybody*". The teacher from the ELC is affirming the benefits of using practices that allow learners to be active in their own learning and she admitted that she was using these strategies in the ELC to promote learning. Teacher 3, who teaches in the junior school, supported Teacher 2's observation by acknowledging the benefits that she had observed by implementing practices where learners are active in their learning. She claimed that "*the kids love to be in charge, hey*". Consistent with the other two participants, Teacher 11 supported their remarks by acknowledging that "*they love it when they have to be the teacher*." A participant in the GPLC who teaches high school mathematics shared her experience of using mini whiteboards which enabled learners to work out problems in groups. She said "*I have got one, finally got little white boards and it is the first time that I've used them, and the kids are*

loving them. It is really cool for maths – to do the working out, to show, and to rub out". Another participant stated "*that is nice to hear. Generally, when kids go up into high school it becomes a paper and pen kind of lesson*". Discussions in the GPLC allowed the participants to see how practices where learners are more engaged with their learning are being used throughout the different grades. Others were encouraged to do the same.

The discussions in the GPLC highlighted and acknowledged that teachers are diverse and use different types of instruction in their lessons in order to meet the needs of their learners. Teacher 14 acknowledged that "*we are quite diverse in how we approach teaching*". Acknowledging that teachers use various means of instruction in their teaching can help to normalize the practice. This is very different to when teachers were all expected to stand in front of the class and dispense knowledge. Teacher 1 agreed with teacher 14 by noting that "*there are different ways of preparing lessons*". By teacher 1 acknowledging that there are different ways of structuring lessons may also inform the other participants that there are different ways that learners can learn. This discussion could lead to participants being more open to learning new practices. Teacher 14 affirmed that "*we are willing to learn*".

Engaging in conversations around courage can help support teachers make the necessary changes to their practice and can develop a culture of learning. In the GPLC Sarah asked: "*What does it mean to show courage at school X*". Teacher 4 responded by suggesting "*the first thing that sort of came to mind with courage was bravery… to have the courage to speak up and the courage to communicate sort of boldly and say if you don't understand, or if you say you don't agree, maybe*". Teacher 3 added that courage was being "*willing to take risks that come your way*". Conversations around courage may help teachers address their fears of making changes to their own practice or, as teacher 4 stated, developing the courage to ask for help when you don't understand, or engaging in complex and sensitive conversations when you have to disagree with another participant's suggestion. The discussions on courage in the GPLC assisted Frank in developing courage who had, in the SSPLC, admitted that he did not know what to do as he was not here last year and was obliged to ask for assistance from his colleagues.

The GPLC sessions also dealt with building of generic knowledge (GK) which included knowledge on the AGES model of learning that the participants watched on video. Davis, Maite, Rock, McGinniss, & Davachi (2014) feel that there are essential components that should be taken into consideration to facilitate learning in a region of the brain called the hippocampus. Davis et. Al. (2014) state that "the hippocampus runs along the innermost lip of the brain's

cortex. It registers those experiences that are to be remembered when they occur, and then can later re-activate the relevant brain regions, in appropriate synchrony, across the whole cortex, facilitating recall of those memories" (p. 5). They suggest that "attention, generation, emotion, and spacing" (AGES) can be used to leverage the hippocampus to perform optimally (p. 5).

The facilitator in the GPLC suggested that the AGES model helps learners to fully engage in activities and improves performance. The facilitator asked for suggestions that would show how a teacher could heighten learner' attention in his/her classroom. Teacher 9 suggested that for her "*to gain attention, I have to tell stories, that's how they[learners] learn biology and that is when they are most engaged*". Teacher 6 conceded that in her class she has "*a lot of kids that have an excellent general knowledge and they come up with something and then I take that and run with it and then I realize, 'Oops! we were doing maths!' So, for me, I have to be cognizant of the fact that I need to focus and stay focused on the lesson*". Teacher 8 noted that "*you can't keep attention for the entire lesson, but you can have periods of focus and I think that you need to identify those important areas in your lesson where the kids have to focus. So at least if you've got the attention for those focus points, I think that you will have more chance of getting through to them*." Teachers used examples from their own classes to make sense of the learning around how gaining learners' attention during the learning process can be used to promote learning. Teacher 8 shared that she started asking her learners a series of questions at the end of her lessons as an exit slip which she calls "*rapid five*" to determine which concepts the learners have grasped, and which require further consolidation. Sarah added to the discussion thread by suggesting that she started using an electronic platform "Kahoot"[3] to assess her learners' understanding at the end of her lessons and she claims that that her learners "*love it*". Teacher 10 added that she started to get her learners to explain their methods to the class and they "*learn from each other*" which she acknowledged "*works well for the little ones*". As the participants shared their examples of how they gain their learners' attention, the participants were also learning and adding to their growing PCK. Sarah used the concept of attention in her discussions in the SSPLC to support her learners. She explained "*so they [the learners] require individual attention. We just have to support them with how they must improve, conduct their research, where they read, [how] they repeat it to themselves and then write it in their own words*". The collaborative discussion allowed the participants to link the

[3] Kahoot is a game-based educational learning platform that is used by educational institutions to promote learning.

theory to their practice and during this process they could clarify their own understanding of how theory informs their practice.

Another focus of discussion in the GPLC was around the SCARF model (Status, Certainty, Autonomy, Relatedness and Fairness). In the video shown in the GPLC, the SCARF model is explained:

> Status is about relative importance to others. Certainty concerns being able to predict the future. Autonomy provides a sense of control over events. Relatedness is a sense of safety with others, of friend or foe. And fairness is a sense of perception of fair exchange between people. (Rock, 2008)

These five domains, it has been suggested, influence learners' behaviour in social settings and are used to explain why learners can experience strong emotional reactions when working with others in a group setting. Using the SCARF model, it is suggested, assists learners in collaborating and working effectively with other learners by understanding behaviours and reducing conflict. The participants in the GPLC offered examples encountered in their own classrooms of the elements from the SCARF model. For example, participant 8 suggested for the status element that "*I like to let my kids know how I am feeling so if I'm having a bad day"*. She suggested that informing the learners about how she is feeling allows the learners to understand her state of mind and they are then more receptive to learning. Participant 4 added to the discussions and suggested for the element of certainty that: "*I find that especially with Grade 10s, especially with certainty, what I plan to cover in this lesson so something like the learning outcomes for the lesson, so they know what is expected from them in the lesson*." Ravi took this concept of certainty into the SSPLC to provide a solution to help her learners work more effectively during group tasks. She recalled that in her SSPLC for "*each of those groups, call them aside, talk to them and say, this is your responsibility, this is what you're going to be doing in your group, this is their responsibility, this is how it's going to be working*". The discussions around the different models that facilitate learning informed teachers' knowledge about different methods and practices of teaching and how they are being used by the teachers to promote learning. The knowledge that is communicated is not only theoretical, but the collaborative nature of the GPLC allows its participants to use actual examples from their classes to support the theory and in the process make the learning relevant.

The discussions around assessment in the GPLC and the SSPLC were different. The talk around assessment in the GPLC was on different types of assessments and the participants recalled

different examples of how assessments were being used in their subjects and grades to promote learning. The discussions around assessment in the SSPLC were about selecting the most suitable kind of assessment to assess the learning. The feedback that was provided by the assessment discussions was ongoing and used as stimuli in the SSPLC sessions to assess the learning and adjust the instruction accordingly.

The following discussion among the participants in the GPLC highlights the diversity in assessments that are being used.

> Teacher 7: *I enjoy the idea of regular testing.*
>
> Teacher 8: *They don't have to be huge tests; they can be little 5 minute or ten-minute tests during your lesson.*
>
> Teacher 7: *Mmmm.*
>
> Teacher 8: *I mean, I do that with my class I always do rapid five.*
>
> Teacher 9: *So, things like Kahoot.*
>
> Sarah: *I was just going to say that we use Kahoot in our Maths lessons.*
>
> Teacher 10: *The little ones – we don't do testing. We don't have formal assessments although we have continuous assessments.*

The diversity of participants in the GPLC offered an opportunity for a variety of examples of assessments to be discussed. These discussions in the GPLC informed the participants of the different forms of assessment and how they could be used to assess and promote learning. For example, Teacher 10 explained that they don't do formal testing in her grade. She stated that she writes a problem on the board and asks the learners to find a solution. She noted that "*some children come up with three different ways, so they will share their three different strategies. So while it's also an assessment, they are learning not just from the teacher but from each other*". Teacher 5 also noted that she was very excited to get portable whiteboards in her class. She stated: "*I have got them, finally got little white boards and it is the first time that I've used them, and the kids are loving them. I am really enjoying them. The kids show their work and then rub out*". The move to using alternative forms of assessment may lead to teachers exploring different practices to promote learning. This was evident in the discussions that took place in the SSPLC around assessment.

The SSPLC discussions on assessment focused on deliberating what activities would be most successful in assessing learning and when these activities should be completed. For example,

Frank suggested that the learners could "*complete a diagram*" and conduct some "*research*". Sarah suggested that they should also include a "*word wall*". Sarah suggested that the learners should first complete an activity that provides the learners with instructions and tips on how to do research. She stated there should also be some "*pre-learning activities that should be completed before the learners complete their research*". Ravi suggested that the learners should "*teach the class what they have learned… they should make a google slide presentation and they should also build the digestive system and show it to the class*". The learners' progress in these activities provided the participants of the SSPLC with ongoing data about the learning that was taking place and this knowledge was used as stimuli to facilitate further discussions in the SSPLC which in turn informed the participants to adjust their practice accordingly to promote learning. For example, Sarah explained that the word wall activity was a "*little bit of a disaster because we had children who did what they were expected to do and were waiting to share with the others and the other learners did nothing. So, what I think we must do is that when we get to this research task, we must allocate beforehand what each child must do*".

5.7. Knowledge building in the SSPLC and GPLC meetings

The aim of teachers participating in the two professional learning communities, SSPLC and GPLC, was to bring these two dimensions of knowledge-building (which includes PCK and GK) into a productive relationship where teachers would be able to use the opportunities afforded through collaboration and knowledge-building. In so doing the participants would develop their knowledge of alternative forms of instruction in the GPLC and create a deeper understanding of teaching and learning. In the process, this would help shift and support their own thinking in their SSPLC as they planned and worked towards improving their practice. Having multiple opportunities for collaboration allowed participants to engage in continuous learning that was diverse as well as focused. The dialogical process among the participants in the GPLC provided teachers with GK which was used to support each one of them in making the necessary changes to their own teaching practice during the planning, observation, and reflection stages that took place in their SSPLC.

The generic discussions in the GPLC provided the participants with knowledge on how to use assessments to promote learning. Frank noted that what he took out of watching the video on the AGES model was to provide learners with ongoing feedback on their assessments. He reflected "*one of the things that really stuck with me is giving constructive feedback*". The

discussion in the GPLC motivated Frank to modify his thinking around assessment and how he could use assessments to provide his learners with constructive feedback to promote their learning. During his SSPLC discussions Frank explained how he used the practice of providing feedback to assist his learners: "*they were going off on different tangents, I had to pull them back into it. Okay, how is this related to the muscular system? How is this related to a healthy diet? You are not really answering what a healthy diet is*". The discussion around feedback in the GPLC provided Frank with knowledge on how to use feedback as part of his instruction method which in turn supported the development of his PCK.

The conversations that took place in both PLCs enabled the teachers to question and reimagine the type of instructional practice that was needed at the school. Teacher 4 explained during the GPLC discussions that she used positive feedback to help build her learners' confidence. She explained, as an example, that "*I have got a little boy in my class that thinks he is so bad at school, and he internalizes it all and he stomped out of the classroom the other day. He said, 'I couldn't do it'*". Teacher 4 went on to say that she had used positive feedback to boost his confidence. She noted that "*I have been writing these little notes into his books and it has just boosted him up*". Frank also explained in the GPLC that one of the issues that he had had to deal with was the "anxiety" that learners feel while completing assessments and the emotional impact that it had on them. After listening to teacher 4's contribution, he suggested that he "*should stop using the word 'wrong'*" as a form of feedback to his learners but rather look at alternative means to motivate his learners. In his SSPLC discussions, Frank reflected "*I had [learner's name] who didn't want to know anything about a human stomach but wanted to know about a bird's stomach. So instead of saying no, I let him explain how a bird stomach fills and empties and he had to go through the same process and find diagrams on the bird, he had to think about how he is going to relate that to his group's work*". The conversations in the GPLC, according to Frank, re-emphasized the fact that every child is different and that if you want to perform to the best of your ability, you need to take that into consideration to enable best practice.

Frank's practice, when he started teaching at the school, was very traditional and mainly centred around using a PowerPoint presentation to transmit knowledge and thereafter asking his learners a few questions. He stated in his interview that "*I would come into the classroom for instance, I would present a PowerPoint presentation and ask questions and I'd expect my children to have a far better understanding or perhaps grasp of what I'm trying to teach them than was actually the case".* Listening to discussions in the GPLC that focused on alternative

teaching practices added to Frank's growing PCK. Examples of these conversations include: "*I am really trying to push the autonomy in my own classroom. My grade 9's, I gave them a choice of nine different projects. They want to write a song or create a podcast or some of them are doing moving music – they are really taking ownership of their project*" or, "*So what we have done in grade 3 is that we have done a grid. So, if there are five-word blocks, there are five who write a story, there are five reading to a buddy, there are five reading to self, and once they have finished that activity, they can colour in the block, but they will have to complete the whole grid once before they can get a new grid*". These conversations from the GPLC provided Frank with an understanding of alternative examples of teaching practices as well as opportunities where he was able to view these practices being implemented during the class visits. Participating in the GPLC influenced him in changing his practice and he now designs activities where learners can engage with the material and use the skills that they need to acquire when dealing with the concept. During a discussion in the SSPLC Frank suggested ideas like: "*they [learners] would present their findings to the other groups and other groups would have a chance to ask questions*" and, "*so for next week we are introducing the research cards. We give them the opportunity to find the information as opposed to us giving them the information*". These suggestions show that Frank is using the knowledge that he has acquired from listening to the conversations in his GPLC. This reflects a development and growth in his PCK from using more teacher-centred approaches to more learner-centred approaches. He further stated that he learnt these methods of teaching in his GPLC.

Changing teachers' practices requires teachers to build on their knowledge in an environment that is conducive to learning. The collaboration among participants in the GPLC and SSPLC built stronger relationships between the participants which in turn created a better understanding of the learning expectations among the teachers. These conversations informed discussions in the SSPLC and helped the participants to understand their learners better. The participants were able to observe how learners learn differently which in turn informed their practice by creating alternative approaches to teaching. Changing the teachers' knowledge about learning enabled the teachers to be more open to trying new practices. The relationship that developed between the two PLCs enabled the teachers to link theory and practice. This collaboration allowed the teachers to understand how theory informs practice. By using data from the various artefacts, the teachers were now able to understand the theory.

5.8. Conclusion

In this chapter, I have attempted to understand the complementary roles that GPLCs and SSPLCs can have in growing teacher knowledge and shifting teacher practice to inform their PCK. The analysis reflected that each PLC played a specified and complementary role in the development of the teachers' knowledge and that this contributed towards their PCK. The GPLC provided its participants with generic knowledge that helped them understand: how children learn; a supportive and non-threatening environment; and an opportunity to collaborate in a safe space. These factors created a context for participants to question their own practice. The analysis also reflected on the importance of teams where members are diverse in respect of their expertise, SMK, and experience. These aspects supported teachers in changing their practices. The analysis also highlighted that the discussions in the GPLC were supported and enhanced by relevant artefacts of teaching and learning that teachers brought from their SSPLC conversations, planning meetings, as well as from what they observed in their own classrooms. The dialogical process among the participants in the GPLC provided teachers with a common language of learning, confidence, and a positive pedagogical disposition that was used to support teachers in making the necessary changes to their teaching practices during the planning, observation, and reflection stages that took place in their SSPLC. Time, teacher workloads, teacher attitudes, as well as the on-going nature of the PLCs contributed to how teachers participated in the PLCs.

The SSPLC sessions focused on developing PCK by engaging in structured conversations that promoted collaboration and were centred around having discussions and debates regarding teaching aids, student collaboration, learners' work, misconceptions, instructional processes, and subject matter that is specific to their grades and subjects to meet the needs of the learners. The analysis reflected that through the process of engaging in focused and systematic collaborative discussions that concentrated on planning, observation and reflection of teaching and learning in science, teachers developed open and critical minds as they engaged with the reasoning of others in their PLCs. They learnt to question and debate the effectiveness of activities and practices used. This presented them with the opportunity to alter and shift their practices and learn and grow as professionals. The data from the study reflected that having teachers participate in the SSPLC as a timetabled event was important in realizing the goals of improving teacher practice. Not providing teachers with sufficient time caused them to

experience stress and anxiety. The data also revealed that having trust was associated with being able to rely and depend on one another and that such a trust was built over time.

Participating in the GPLC and SSPLC discussions allowed teachers to explore conversations and experiences in context. The dialogical conversations that occurred in the GPLC and SSPLC brought the two dimensions of knowledge-building that included PCK and GK, into a productive relationship where teachers were able to use the opportunities afforded through ongoing collaboration and knowledge-building and in so doing create a deeper understanding of teaching and learning which contributed towards developing their PCK. While the focus of the PLCs involved different learning activities and types of support, the different conversations influenced each other and helped teachers develop a better understanding of the learning expectations among the teachers.

It was evident from the remarks of the participants that the PLCs influenced each other in a cyclical manner. The GPLC informed their practice with GK which gave them the confidence to collaborate more effectively. The GPLC setting, which consisted of a diverse group of participants who each taught different grades and subjects, supported participants in terms of building their confidence in their PCK, which in turn enabled them to become more confident at participating and contributing in their SSPLC.

Chapter 6: Understanding the relationship between GPLCs and SSPLCs

6.1. Introduction

In my rationale in Chapter 1 I discussed the fact that teachers influence much of what happens in the classroom, as their practices and dispositions around teaching and learning have an impact and can influence how they teach and what they teach. Much of the research that has been conducted emphasizes that PLCs support ongoing interactions among teachers. During my investigations around PLCs, I found that a great deal of existing research focused on teachers participating in only one PLC so I was intrigued to find out how they would engage in two different PLCs. I was motivated to understand how and what teachers learn in their PLCs, and whether different PD offerings in the form of GPLCs and SSPLCs work together or in isolation from one another, and the extent to which they both offer professional learning opportunities in the form of development.

The purpose of this chapter is to conclude my research and discuss the findings that have been uncovered during the analysis process. The findings that have emerged from the study will be used to answer the main question: How do generic and subject specific professional learning communities co-produce knowledge, including generic and pedagogical content knowledge, with the aim of informing teacher learning in natural science teaching? I used two questions to answer my main question: first, how reflection through collective inquiry fosters the development of pedagogical content knowledge and second, what do teachers bring from each PLC in the form of artefacts and tools, to inform the other.

To address the question: how reflection through collective inquiry fosters the development of pedagogical content knowledge, I will first focus on how deliberate and focused discussions in the two PLCs contributed towards the development of new knowledge and how this appeared to lead teachers to think more deeply about their practices and contribute towards the process of developing their PCK. To address my second question: what teachers bring from each PLC in the form of artefacts and tools to inform the other, I will highlight the tools and artefacts that each community produced and how these tools and artefacts could have contributed towards the development and building of new knowledge for the teacher and ultimately the development of their PCK.

6.2. How reflection through collective inquiry fosters the development of pedagogical content knowledge?

I showed in Chapters 4 and 5 that participating in the GPLC and SSPLC discussions enabled teachers to evaluate their current practices and explore alternative approaches to teaching in context. I found that the dialogical conversations that occurred in the GPLC and SSPLC brought the two dimensions of knowledge-building: GK and PCK into a productive relationship where teachers were able to use the opportunities afforded through collaboration and knowledge-building to improve on their quality of instruction. Figure 6.1. depicts the relationship that the two PLCs share.

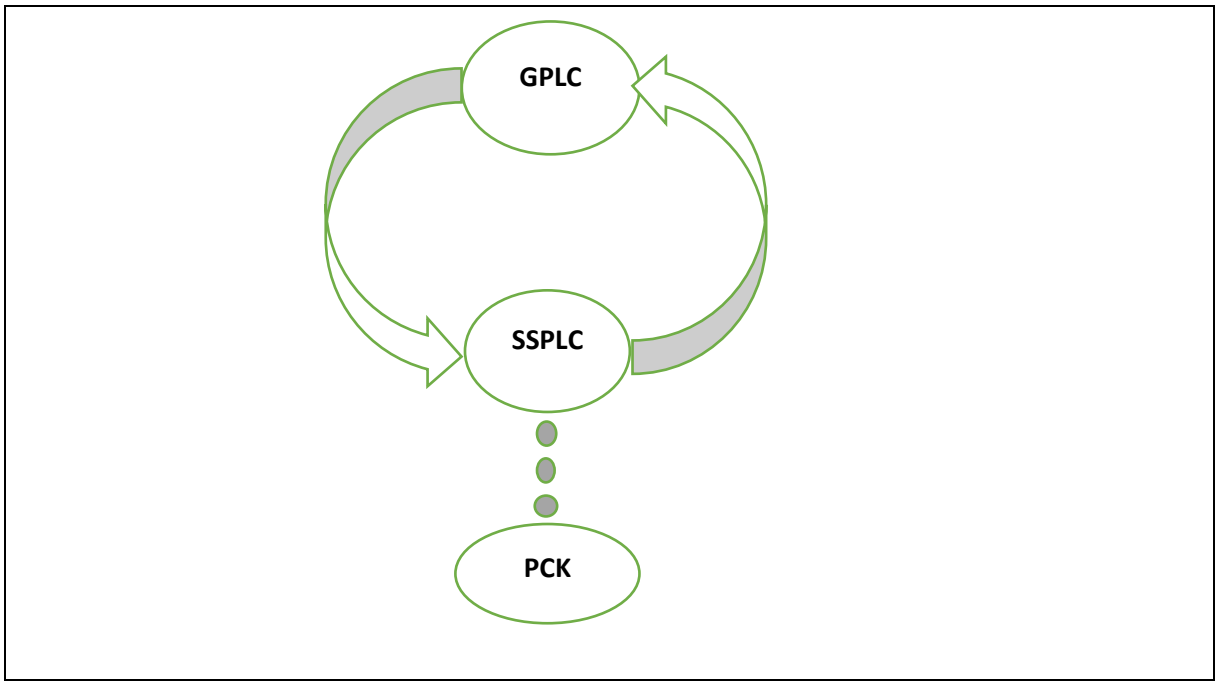


Figure 6.1. Relationship between GPLC and SSPLC

Figure 6.1. shows that having multiple opportunities for collaboration – in the form of participants engaging in GPLCs and SSPLCs – allowed the participants to engage in continuous discussions that were diverse as well as focused. The diversity of participants in the GPLC included teachers that teach different subjects, different grades, and have been in the teaching profession for a varied number of years. This diversity allowed teachers to be exposed to different colleagues' experiences of teaching and learning where ideas about new practices were discussed, interpreted, negotiated, and in the process, teachers had the opportunity to add

to their knowledge about alternative teaching practices. The GPLC created intersections where different types of generic knowledge came together to create new outcomes of thinking around teaching and learning. The intersections offered spaces of possibilities for the participants where they could make connections between their own knowledge and their learning experiences in the GPLC. I found that the dialogical nature of the GPLC introduced the participants to new knowledge and provided teachers with a cauldron of new knowledge on teaching and learning from which to draw upon when planning and discussing approaches to teaching in the SSPLC. I showed that the social features of learning, which included learning with and from others, constructing shared meaning, and interacting and building on each other's experiences, that characterized the GPLC, were emphasized by the participants using examples of their own lessons to make links to the theory that was being discussed. The use of artefacts in the form of a teacher learning manual, samples of learners' work and Protea walks provided the stimuli and focus for the discussions in the GPLC and transformed how the participants collaborated and what they collaborated on.

The findings from this study highlighted that the dialogue that the participants were involved in, within the GPLC, served as a tool to unpack learning and provide a new language and new knowledge which empowered the participants to engage in and contribute towards the development of activities, as well as gaining the confidence to question practices in the SSPLC. Ravi, during the SSPLC meeting, questioned the effectiveness of allowing learners to conduct research and suggested that there is a need to teach the learners how to do research first. This finding indicated that the discussions in the GPLC not only challenged the teachers' existing practices but also created an understanding of the effectiveness of different practices. Ravi stated for instance, that the conversations in her GPLC contributed to her questioning the effectiveness of her practice and provided her with knowledge on alternative approaches to learning. Frank felt that the GPLC conversations helped him understand why he had to use alternative forms of instruction in his practice and assisted in making him believe in what he was doing.

Feldman and Fataar conducted a study (2016) on five teachers' participation in a PLC where the dialogical characteristic of the PLC was used as a tool to elicit communication about their teaching and pedagogical dispositions. The initial engagement with the teachers highlighted an "absence of both a didactic language and a pedagogic reflexivity" (p. 18) which resulted in conversations that did not challenge teachers' practices but rather focused on discussions relating to learner behaviour and class sizes (Feldman & Fataar, 2016). Moving beyond

Feldman and Fataar's study I found that once the GPLC equipped its participants with the pedagogical language and new knowledge of teaching approaches as well as building confidence in their ability as teachers, the participants felt sufficiently enabled to engage in constructive debates around alternative forms of instruction and contribute to conversations which in turn created opportunities for learning. The findings from the study indicated that the ongoing conversations that took place in the GPLC and the SSPLC influenced the participants to re-think their knowledge and helped to deconstruct new knowledge and institutionalize learning for the participants.

In Chapters 4 and 5 I showed that in the PLCs the development of a shared meaning and a focus in helping the learners supported the teachers in modifying their thinking. The design of the SSPLC offered the participants an opportunity to plan collaboratively, implement models of instruction, observe learning, reflect on that learning, and address any concerns around their practices in a collaborative environment. I argued that these discussions served as a tool to highlight areas of improvement in their practice and offered the participants with a learning experience that allowed them to gain a deeper understanding as to how their learners actually engaged with the learning material and what changes needed to be made to their practices to make learning more successful for the learners.

I found that the context of the SSPLC offered the participants with ongoing feedback about the learning that was taking place. I showed, through analysing teacher interviews and observations of GPLC and SSPLC sessions, that when this knowledge was deliberated upon and probed in a subject specific collaborative environment, the participants first got to think deeply and reflected on their practices, and secondly, deliberated upon the artefacts that the learners had produced and discussed the outcomes of their lessons with the participants of their PLC to promote learning. This resulted in new dimensions of knowledge being created that contributed towards the development of each participant's PCK. There is a positive connection between the activities of the GPLC and the knowledge that participants use to support their discussions in the SSPLC. In the GPLC, the participants had the opportunity to develop their GK by learning about different models of teaching and learning which they used to support their decisions and discussions about what practices to implement in the SSPLC to promote learning.

The GPLC produces tools in the form of knowledge on different methods that may enhance learning, e.g. Vygotsky and Piaget's theory of learning, the AGES, and the SCARF models that may be used to facilitate instruction, and the discussions that take place among the

participants help to facilitate an understanding of how to use the tools. The SSPLC serves as a platform where decisions are made as to when these tools should be used and evaluates how these tools are being used by reflecting on the artefacts that are produced by the learners. I found that the SSPLC provided a structured platform to receive ongoing feedback on the progress of learning which was then used by the participants to evaluate the effectiveness of their own practices and which provided an opportunity for the participants to use the knowledge gained from the GPLC to suggest new ideas to improve learning.

The SSPLC provided its participants with data in the form of context specific examples which they could use to create meaning of the content being discussed in the GPLC. This meant that the dialogue in the GPLC, around the concepts of learning, was guided by the examples that the participants brought from their SSPLC. This allowed the participants to exchange ideas and also to respond to suggestions and thoughts of the other participants in the GPLC. I found that the content of the GPLC was informed by the needs of the participants in the SSPLC. As an example, Frank was familiar with teacher-led principles of learning where he was responsible for providing the knowledge while the learners were expected to listen and take down the information that he presented. The AGES model was included as content in the GPLC to provide the participants with knowledge on how to better engage with learners who are actively involved in the learning process. The on-the-job learning provided an ideal context for the participants to make sense of their learning as they could identify with the examples and in the process make the connections to the learning.

I found that teachers who were new at teaching science felt more vulnerable and fearful of the expectation of collaborating with a teacher who had a lot more experience. Frank stated in his interview that he felt "*anxious and worried*" during his SSPLC discussions as he was concerned as to whether he was on the right track. Displaying one's subject specific practices in a collaborative space could expose the extent of teachers' knowledge. My research found that this process was intimidating for some teachers and affected their participation. Sarah, for example, who has been teaching at the school for longer than the other participants, became the dominant voice in the discussions. Her views and suggestions around practices dominated the SSPLC discussions. In contrast, Frank and Ravi who were new at the school and who were still building their skills in teaching science, indicated that they felt insecure. As a result of their insecurity, they did not critique or disagree much with Sarah's suggestions out of fear of being exposed as lacking the necessary PCK. Accordingly, Sarah's contributions dominated the conversations.

6.3. What do teachers bring from each PLC, in the form of artefacts and tools, to inform the other?

In Chapters 4 and 5 I showed that the focus of the two PLCs involved different knowledge, learning activities, and support. I showed that the GPLCs' focus was more on the development of GK while the SSPLC focussed on the development of SMK and PCK. The artefacts that were used in each of the PLCs played an integral role in developing the teachers' knowledge in that they provided the stimuli that focused, promoted, and guided the discussions. The focus of a PLC is important in determining the type of knowledge that needs to be acquired (Brodie, 2019).

I found that the artefacts that were used in the GPLC served to provide the participants with knowledge on how to approach teaching and learning. The examples around models of teaching and learning in the GPLC enabled the participants to develop their thinking around assessment and how they could use assessments to provide their learners with constructive feedback to promote their learning. This in turn informed participants' discussions around assessment in the SSPLC and how they should engage with learners' work. I found that these discussions about the different forms of assessment that could be used also sparked teachers' interest. Instead of marking the answers wrong, Frank explained that he had adopted the practice of providing more feedback to assist his learners in promoting their learning. The learners had produced artefacts by using the Jamboards that reflected their thinking and knowledge around the concepts and provided the stimulus to elicit discussion among the participants in the SSPLC. Table 6.1 indicates those artefacts developed and used in each of the PLCs.

Table 6.1. GPLC and SSPLC artefacts

Artefacts	
GPLC	**SSPLC**
1. Teacher learning manual	1.Samples of learners' work
2. Samples of learners' work	2.Video recordings of lessons
3. Videos on models of learning	3.Samples of teaching and learning materials
4. Protea walks	4.Classroom visits

6.3.1 GPLC artefacts

In the GPLC, I found that the learning manual introduced the science teachers to different theories of learning which provided them with a deeper understanding of learning. The content in the learning manual focused on providing the teachers with the knowledge that informed them on how to engage in classrooms where learners are actively involved in the learning process. The content in the learning manual was not static and changed depending on the needs of the teachers. The learning manual provided a focus for the learning and during his interview Frank stated that the activities of the GPLC made him feel like he was *"moving to a clear objective".*

In Chapter 4, I explained that teachers brought samples of learners' work to the GPLC sessions to show how the theory that had been discussed in previous GPLC sessions was being implemented to facilitate learning. Sarah noted in her interview that "*we use their work to show where there were misconceptions and how we bridged that gap or how we scaffolded the activities for that child to actually understand*". I argue that having these ongoing conversations and using examples of learners' work to elicit discussions, appears to have helped teachers gain a deeper understanding of their practice and enabled them to think more systematically about the changes that should or could be made to their practice.

The video recordings that were used in the GPLC provided a visual representation of the new knowledge. It served as an extra resource for the participants to access and make sense of the learning material as compared to only using the learning manual. In Chapter 5, I argued that using video recordings as stimuli to present the new knowledge allowed the participants to view the practice at play. After watching the video on the AGES model, the discussion that followed in the GPLC motivated Frank to modify his thinking around assessment and how he could use assessments to provide his learners with constructive feedback to promote their learning.

The Protea walks served as a tool and offered the participants in the GPLC the opportunity to view different practices at play. I argued in Chapter 5 that these walks created a wider knowledge base and influenced teachers to adopt aspects of activities and practices that they had observed into their own teaching and in the process build their own PCK. The Protea walks offered the participants of the GPLC authentic stimuli to reflect on and discuss. I argued in

Chapter 5 that the diversity of subjects and practices in the GPLC confirmed the understanding that all teachers are different and have different teaching styles.

6.3.2 SSPLC artefacts

In the SSPLC the participants used samples of learners' work as ongoing stimuli to focus and direct their discussions. I found that using learners' work served as evidence to evaluate the teachers' practices by providing authentic feedback on the progress of learning. I argued in Chapter 5 that as the teachers collaborated and assessed the learners' engagement and learning using their learners' work, the evidence provided by this was used to elicit and focus discussions in the SSPLC on instructional problems and successes and provided opportunities for teachers to implement alternative modes of instruction which they drew from their GPLC discussions. Furthermore, the findings revealed that the discussions and the inquiry into more innovative practices served as tools to expose the learning and helped the teachers understand why certain practices may not have worked optimally. Gordon, Petocz and Reid (2007) state that "human transformations lead to the need for further mental tools that again give rise to new ways of conceptualising and acting in the world" (p. 2). They further argue that the mental tools "are created and passed on to others through social processes and socially structured practices" (Gordon, Petocz and Reid, 2007, p. 2).

I found that analyzing video recordings of each other's lessons in the SSPLC allowed the participants to reflect on those lessons that they observed and, in the process, allowed them to reflect on their own practices. In Chapter 5 I showed how Sarah, after watching the video of Frank's lesson, acknowledged that getting learners to organize their desks during the lesson wasted teaching time and she made a mental reminder to make sure that the desks would need to be organized before the lesson in future. She also admitted that she could have started the lesson a bit differently. I found that the reflections on the lessons using video recordings of each other's lessons helped teachers to identify the strengths and weaknesses in their practices.

The use of examples of different teaching and learning materials in the SSPLC provided an opportunity for teachers to view alternative materials that could be used to promote learning e.g., Jamboard, Google Meets and model building. I found that the discussions around these tools assisted the participants in developing their knowledge on scaffolding in order to promote learning. I also argued in Chapter 5 that teachers may develop certain preferences in their practice, and therefore it is important for teachers to develop a deeper knowledge base about

the effectiveness of teaching aids. The SSPLC provided an opportunity for the participants to deepen their knowledge on using different teaching aids to support learning. I also found that the ongoing feedback on learning provided by the activities in the SSPLC meant that the participants had to repeatedly probe and think about new ways of delivering lessons in an effort to make learning more successful. This meant that the participants had to continually inquire about those different methods of instruction which had spurred the discussions in the GPLC as they progressively inquired about different practices that in turn highlighted the potential in the social dimension of learning. The work that the learners produced developed and grew over time and teachers were able to see the outcomes of their interventions which in turn, allowed for further discussions among participants in the PLCs. Mellroth, Bergwall and Nilsson (2021) suggest that teachers are influenced by artefacts where they "react and act" upon them "in order to develop, understand, and accomplish their objectives" (p. 82).

Classroom visits in the SSPLC occurred once for each theme that was taught in science. The focus was on teachers observing how the learners experienced the knowledge and activities that were planned, and the participants used these observations as stimuli to modify their own instruction to facilitate learning and in the process add to their PCK. I found that the SSPLC meeting allowed the participants to reflect on lessons that they had observed and in turn this activity allowed the participants to reflect on their own practices.

The findings have indicated that the PLCs exposed the participants to different tools and artefacts that informed their learning as well as artefacts that they could use to reflect upon their practices and in so doing promote learning. By engaging with artefacts like learning manuals, videos on models of learning and classroom visits, the GPLC provided its participants with a knowledge of the language of learning – which they obtained from discussing theories of learning and best teaching practices with a diverse group of teachers. The participants were able to use this knowledge to understand how learners in their classes learn in particular ways. Participants used this knowledge and language to promote discussions in the SSPLC around best practice in teaching a lesson or engaging with learner misconceptions.

6.4. Limitations of the study

This study reflected data that was collected from three science teachers' participation in a GPLC and a SSPLC. First, the school where the study was conducted is an independent school

with more resources in the form of funding, additional staff, and flexible timetables than the average state school. The findings from this study could be difficult to implement across schools that have limited resources as these schools may not have the luxury of freeing up teachers to attend PD sessions during school time and to participate in two forms of professional development. Participating in two different learning communities is time consuming as teachers have additional school commitments to complete e.g., marking of books, coaching sporting teams, generating reports to name just a few.

Second, the sample size was small and consisted of teachers who teach at one school and is not representative of all teachers who teach science. A broader group of participants would have provided more data to analyse.

Third, not observing classrooms was a limitation. This could not be done, given the scope of a my Masters and I have been careful not to make claims about changes in practice through the dissertation. Had I observed the teachers' practices I would have gained more insight into their learning.

Fourth, my role as HoD and as a participant in the study could be viewed as a limitation. During the initial stages of the interviews the participants were not particularly forthcoming about the problems that they faced during their PLC collaborations. They provided me with generalized, safe answers and it took some probing for me to get them to highlight some of their problems. This could have been because they did not trust me or felt nervous at being interviewed and being part of a study as this process would mean that their practices would be put under a spotlight. My prolonged participation in the SSPLC helped to mitigate some of the anxiety that the participants may have felt. I also tried to mitigate the threat of myself, as a HoD, being present in the meetings by informing the participants that they could withdraw from the study at any point should they feel uncomfortable. The principal of the school also spoke to the participants to ensure their well-being during the study.

Finally, conducting this research during the Covid-19 pandemic meant that there were times when the Department of Education and Training closed all schools for safety reasons. This meant that there were time constraints as the study had to be halted for a period of time until the schools reopened, and the data collection process could resume. This was apparent more in terms of collecting data on the teachers' participation in the GPLC. As a result of school closures and social distancing protocols only three sessions of the GPLC could be observed. A longer observation period of teachers participating in their GPLC would have been beneficial

to the study. However, Covid-19 did present some opportunities. It forced teachers out of their comfort zones and enabled them to collaborate online using Google Meets. In using this technology, the participants were more willing to meet as they were safe in the comfort of their homes. I was able to collect and record the SSPLC meetings using this platform. The recording of these sessions was also made easier as Google Meets has a function that allowed the sessions to be recorded. Covid-19 presented problems with teachers accessing the learners as the learners were at home and could not come to school. However, the discussions in the SSPLC platform supported the participants in identifying electronic tools like Jamboard, Google Classroom and Google Docs to facilitate instruction and guide the learning and this enabled me to collect some of my data.

6.5. Implications for research and practice

6.5.1 Implications for research

My research adds to the growing body of knowledge on PLCs. This study contributed to the understanding of different types of PLCs – GPLC and SSPLC – that teachers engage in and the knowledge that teachers engage with in these PLCs – GK and PCK. I have found that the dialogical conversations that occurred in the GPLC and SSPLC brought the two dimensions of knowledge-building, GK and PCK, into a productive relationship where teachers were able to use the opportunities afforded through collaboration and knowledge-building to improve on their own teaching quality.

This study also contributes to the understanding of the different artefacts that PLCs produce and how different PLCs use these artefacts to elicit and inform discussions to create a better understanding of teaching and learning. Furthermore, this study contributes to understanding how the teachers' engagement with the artefacts plays a central role in the type of knowledge that is produced in the PLCs and how the discussions served as a means to pass on knowledge. The use of artefacts in the GPLC transformed how the participants collaborated and what they collaborated on, and the use of classroom experiences facilitated understanding of why learners do not understand a concept or why they learn the way they do.

The findings from this study confirmed the results of existing studies of factors that hinder and promote participation in PLCs e.g., time, collaborative culture of PLCs, ongoing nature of PLCs and trust.

6.5.2 Implications for practice

Even in schools where there is already a strong knowledge and meaning making ethos, there remain increasing levels of academic expectations. The findings from this study will recommend to the participating school how and when the PLCs should run and will hopefully cement PLCs as part of the PD programme. The findings will inform the school's management team that both PLCs should form part of the teachers' timetable as teachers were more receptive to learning if PD opportunities formed part of their school day. With an understanding of the important role that artefacts and tools play in developing and shaping knowledge, these will become regular partners to facilitate and guide learning in the PLCs where different subjects will be asked to host days where learners' work will be displayed to reflect their progression of learning. It is hoped that the use of technology to host SSPLC meetings will be implemented as the norm in order to use the time afforded more efficiently.

For schools that do not have the resources to implement both PLCs, the findings from the study could inform them of the value that PLCs have in developing teachers' practices and may convince school managers to start up PLCs at their own schools in a form that works for their particular context. The findings could also inform teachers of the types of knowledge that teachers require in order to improve their practice and the role that artefacts possess in alerting teachers of problems that arise during learning and how collaboration among teachers could assist in improving the learning experience for the learner.

6.6. Recommendations for future research

The focus of this research was first, to establish the extent to which the learning from GPLCs and from SSPLCs either work together or in isolation from one another, and secondly, the extent to which they both offer professional learning opportunities in the form of developing PCK that supports instructional reform in science classrooms. For future research, there exists a depth of research that focuses on PLCs' impact on teacher learning. However, there is a lack

of research on the relationship that exists between the interaction of two learning communities on developing teacher knowledge, and it is worth recommending that a researcher explores this relationship further to ensure that the insights are developed even more. The existing research can be used as a foundation that other researchers can build on.

The second recommendation focuses on the need to conduct this research over a longer period of time to systematically focus on the development of teachers' practices using a bigger sample size and schools from different teaching and learning environments to understand the consistency of the findings in different contexts. My third recommendation would be to focus the study on how teachers' participation in different PLCs translates into new practices that are taking place inside the science classroom. If I had the opportunity to conduct this study over again, I would invest more time to ensure that the findings are developed and further improved in an effort to help teachers on the journey of developing their practices.

The final recommendation addresses the need to conduct research with teachers who teach other subjects to understand the consistency of the research findings. If this research study was completed in other subject areas, teachers would be more informed of the role that artefacts and tools play in developing new knowledge that they could use to promote teaching and learning. The collaborative platform in the SSPLC allows for teachers to have focussed discussions with particular reference to planning, implementation/observation, and reflection. This is important in all subject areas to promote learning. If I had to repeat this research study in the senior phase science classes, this would allow for the continuation of improved methods of practice across grades and would give the researcher the opportunity to monitor whether the learners are able to transfer the skills that they have acquired across the different grades.

6.7. Closing remarks

Undertaking this study was driven by the need for me to understand the extent to which the learning from GPLCs and that from SSPLCs work together or in isolation to one another, and the extent to which they both offer professional learning opportunities in the form of developing PCK that supports instructional reform in science classrooms. I found that the dialogical conversations that occurred in the GPLC and SSPLC brought the two dimensions of knowledge-building, which included PCK and GK, into a productive relationship where teachers were able to use the opportunities afforded through collaboration and knowledge-building and in so doing create a deeper understanding of teaching and learning which

contributed towards developing their PCK. The findings from this study revealed the importance of simultaneously developing GK and PCK when working towards modifying teachers' practice.

In order for teachers to be successful in their classroom, they must remain current in their expertise on teaching and learning and develop creative ways to create meaning for an increasingly diverse group of learners. Improvements in instruction in such schools are still needed to enable teachers to explore their strengths and weaknesses, and to reconsider and redesign their teaching and learning environments to benefit all learners as there are still many learners who are not reaching their full learning potential. I found that each PLC developed their own artefacts. I found that the artefacts that were used in the GPLC served to provide the participants with knowledge on how to approach teaching and learning. The use of examples of different teaching and learning materials in the SSPLC provided an opportunity for teachers to view alternative material that could be used to promote learning. I found that the discussions around these artefacts assisted the participants in developing their knowledge on scaffolding in order to promote learning. The knowledge that was generated from engaging with the artefacts placed the role of the teacher as that of facilitator with a focus on the instruction and activities that were designed and in so doing, enabling a focus on how the learners were engaging with the tools and artefacts that they were producing.

I have argued that teachers need different types of knowledge to modify their practice. The findings in the research have shown that participating in GPLCs helps teachers develop their generic knowledge and that participating in the SSPLCs develops SMK and PCK. I have argued that the dialogical nature of the PLCs enabled teachers with new knowledge and provided them with a common language of learning as well as a positive pedagogical disposition to critically reflect on their practices using artefacts and tools drawn from the PLCs. It also enabled them to think deeply about their practices. There exists a mutually beneficial relationship around the development of knowledge between the GPLC and SSPLC. Discussions in each of the communities were fuelled by knowledge and experiences drawn from each of the PLCs to support the learning and emphasising the social dimension of learning that forms part of the PLCs.

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Appendix A

SEMI-STRUCTURED FACE-TO-FACE INDIVIDUAL INTERVIEWS

<table>
<tr><td colspan="2">Dhevan Marimandi
Interview questions</td></tr>
<tr><td colspan="2">a. Please tell me about yourself
b. How long have you been teaching?
c. How long have you been teaching natural science specifically?
d. What is your preferred method of teaching?
e. What do you love most about teaching science?
f. What do you not like so much about teaching science?</td></tr>
<tr><td>Subject Specific Learning Community</td><td>Generic Professional Learning Community</td></tr>
<tr><td>1. What types of activities do you participate in, in the school’s subject specific professional learning community?

a. How have these activities informed your learning?</td><td>1.What types of activities do you participate in, in the school’s generic professional learning community?

a. How have these activities informed your learning?</td></tr>
<tr><td>2. Do your discussions centre around specific topics in your SSPLC?

a. If yes, what are these?

b. Are these discussions relevant to meeting your specific teaching needs? Always/sometimes/never. Please explain.</td><td>2. Do your discussions centre around specific topics in your GPLC?

a. If yes, what are these?

b. Are these discussions relevant to meeting your specific teaching needs? Always/sometimes/never. Please explain.</td></tr>
<tr><td>3. Do the activities that you engage in, in your SSPLC help create new knowledge?

a. Give an example of the type of new knowledge that is produced?

b. How do you use this new knowledge?</td><td>3. Do the activities that you engage in, in your GPLC help create new knowledge?

a. Give an example of the type of new knowledge that is produced?

b. How do you use this new knowledge?</td></tr>
<tr><td>4. In relation to the previous question, do you use students’ work to elicit discussion in your SSPLC?</td><td>4. In relation to the previous question, do you use students’ work to elicit discussion in your GPLC?</td></tr>
</table>

a. If YES provide an example of a resource that you used that assisted you. b. If NO, why do you think you cannot use this information? c. How did this resource assist you?	a. If YES provide an example of a resource that you used that assisted you. b. If NO, why do you think you cannot use this information? c. How did this resource assist you?
5. What benefits do you see in participating in a SSPLC? What challenges are there?	5. What benefits do you see in participating in a GPLC What challenges are there?
6. Do you collaborate with other members in a SSPLC? a. If YES what form does this collaboration take? If NO, why not? b. Do you see any benefits from collaborating with the participants in your SSPLC that assisted your learning? c. Has this collaboration in a SSPLC influenced you in any way as to how you collaborate with your colleagues in your GPLC?	6. Do you collaborate with other members in a GPLC? a. If YES what form does this collaboration take? b. Do you see any benefits from collaborating with the participants in your GPLC that assisted your learning? c. Has this collaboration in a GPLC influenced you in any way as to how you collaborate with your colleagues in your SSPLC?
7. How have what you learned in a SSPLC informed your discussions or decisions in a GPLC with regards to teaching and learning?	7. How have what you learned in a GPLC informed your discussions or decisions in a SSPLC with regards to teaching and learning?
8. What do you understand by the concept of reflection in a SSPLC? a. How do you reflect in your SSPLC?	8. What do you understand by the concept of reflection in a GPLC? a. How do you reflect in your GPLC?
9. During your SSPLC sessions what do you reflect on? a. Do you see any value in this reflection? b. After your discussions in your SSPLC do you experience any doubts about how you teach?	9. During your GPLC sessions what do you reflect on? a. Do you see any value in this reflection? b. After your discussions in your GPLC do you experience any doubts about how you teach?
10. Does reflection help your teaching?	10. Does reflection help your teaching?

a. What other reflections do you participate in with your colleagues in your SSPLC? b. Does your SSPLC use students' work to inform inquiry? b. What is the purpose of these reflections?	a. What other reflections do you participate in with your colleagues in your GPLC? b. Does your GPLC use students' work to inform inquiry? b. What is the purpose of these reflections?
11. Is there enough time for reflection? a. If the answer to the previous question is yes. Why does the community take the time to discuss the reflections? How has this process contributed towards your learning? b. If the answer is no, is there a reason as to why the community does not reflect?	11. Is there enough time for reflection? a. If the answer to the previous question is yes. Why does the community take the time to discuss the reflections? How has this process contributed towards your learning? b. If the answer is no, is there a reason as to why the community does not reflect?
12. How is the reflection that takes place in a SSPLC different to the type of reflection that takes place in a GPLC?	12. How is the reflection that takes place in a GPLC different to the type of reflection that takes place in a SSPLC?
13. What makes your SSPLC collaborative? a. Provide an example of a collaborative experience in your SSPLC. b. Do all members of your SSPLC collaborate? If Yes what enabled the collaborative culture? If No, why do members experience difficulty collaborating with each other?	13. What makes your GPLC collaborative? a. Provide an example of a collaborative experience in your GPLC. b. Do all members of your GPLC collaborate? If Yes what enabled the collaborative culture? c. If No, why do members experience difficulty collaborating with each other?
14. Are their instances when you collaborate with members of your SSPLC outside of the meetings? a. If YES, what does the discussion centre around? If NO, is there a reason why not? b. Is the collaboration related to a specific issue that needs to be resolved?	14. Are their instances when you collaborate with members of your GPLC outside of the meetings? a. If YES, what does the discussion centre around? If NO, is there a reason why not? b. Is the collaboration related to a specific issue that needs to be resolved?
15. How do you feel when your ideas and existing understanding of practices are challenged by your colleagues?	15. How do you feel when your ideas and existing understanding of practices are challenged by your colleagues?

a. Do you promote a discussion around the issue being challenged? b. How has this affected the way you engage with your colleagues?	a. Do you promote a discussion around the issue being challenged? b. How has this effected the way you engage with your colleagues?
16. Has your practice been changed by participating in a subject specific learning community?	16. Has your practice been changed by participating in GPLC community?
17. Did you teach differently before? Please describe the style and how participating in a SSPLC has informed the way you teach?	17. Did you teach differently before? Please describe the style and how participating in a GPLC has informed the way you teach?
18. Is there a sense of trust reflected in your SSPLC a. Provide an example of where trust was reflected in your PLC. b. Did your PLC always trust each other?	18. Is there a sense of trust reflected in your GPLC a. Provide an example of where trust was reflected in your PLC. b. Did your PLC always trust each other?

Appendix B:

TEACHER INTERVIEW: ACCESSING TEACHER PEDAGOGIC CONTENT KNOWLEDGE

Categories	**Questions**
Orientations towards Science teaching	1.Do you have a preferred type of instruction to teach science? • With reference to your answer to the previous question, why do you prefer using this type of instruction and where did you learn this? 2. How do you describe your role as a science teacher? 3. How do you maximise student learning in your class?
Knowledge and beliefs about science curriculum	**Knowledge of goals and objectives:** 1. What informs your goals and objectives when planning a science lesson? 2. How did you experience science when you were at school? 3. Do you read any science related articles when planning your lessons? **Knowledge of specific curricular programmes:** 1. Are you aware of any science related programs/workshops that could assist with your understanding of the science curriculum? • If YES, do you make an effort to attend • If NO, *move on…*
Knowledge and beliefs about students understanding of specific science concepts	**Knowledge of requirements for learning:** 1. How do you think your students learn best. • Based on the answer to the previous question, how did you determine this? 2. How do you determine when to move on to the next topic? 3. How do you cater for variations in your students' approaches? 4. How do you determine your students prior understanding of the concepts that you are teaching?

	Knowledge of areas of student difficulty: 1. Do your students find science difficult? • If YES, why do you think they find science difficult? • If NO, what makes science easy for them? 2. How do you introduce new concepts to your students? 3. How do you identify student misconceptions in your teaching? 4. What are some of the common difficulties which your students experience in science? 5. What could the possible reasons be for their lack of understanding?
Knowledge and beliefs about assessment in science	**Knowledge of the dimensions of science learning that are important to assess:** 1. How do you determine what to assess your students on? 2. What do you determine to be the important dimensions / skills of science learning? 3. What are the different forms of assessment that you use in your teaching? 4. What informs your decision as to which type of assessment you use when assessing your students? 5. How often do you assess your students? 6. What do you use these assessments for?
Knowledge of instructional strategies	**Knowledge of subject-specific strategies:** 1. What informs the type of instruction that you use in your science lessons? 2. Describe a type of instruction that you use when teaching science. • Based on your response to the previous question, what are the different phases of this type of instruction? 3. What different approaches do you use when teaching science? 4. What informs these approaches? **Knowledge of topic-specific strategies: Topic-specific representations** 1.What types of teaching aids do you use to facilitate learning? 2. What informs the use of these teaching aids?

	3. Where do you get these teaching aids from? 4. Why do you choose these types of teaching aids in your teaching?

Influence of PLCs on teachers' PCK	
Subject specific Professional learning community	**Generic Professional learning community**
1. Has your participation in the SSPLC informed the ways you teach a particular topic? a. If YES explain how. b. If NO move on.	1. Has your participation in the GPLC informed the ways you teach a particular topic? a. If YES explain how. b. If NO move on.
2. Has your participation in the SSPLC influenced the knowledge of concepts that you teach? a. If YES, please explain. b. If NO, move on.	2. Has your participation in the GPLC influenced the knowledge of concepts that you teach? a. If YES, please explain. b. If NO, move on.
3. Has your participation in the SSPLC influenced the areas of subject matter that is taught in your grade? a. If YES, please explain. b. If NO, move on.	3. Has your participation in the GPLC influenced the areas of subject matter that is taught in your grade? a. If YES, please explain. b. If NO, move on.
4. Do you discuss student's pre-conceptions and misconceptions about the topic in your SSPLC	4. Do you discuss student's pre-conceptions and misconceptions about the topic in your GPLC
5. Do you discuss what students find easy/difficult to learn about a topic in your SSPLC?	5. Do you discuss what students find easy/difficult to learn about a topic in your GPLC?

Appendix C

Coding Interviews

Themes	Colour
Challenges	Blue
Collaboration	Green
Trust	Red
Developing practice	Brown
Collegial relations	Beige

6. Do you collaborate with other members in a SSPLC?	16:43. Absolutely, you mean the other grade 4 teachers, science teachers?
a. If YES what form does this collaboration take? If NO, why not?	14:55. ahh well we discuss our prep together we get ideas from each other and also if there is something that we have planned does not seem to go as we planned hasn't worked out well or a child has struggled with this and I am not sure how to get through to that child, i would discuss it with my colleagues and get ideas on how they uhm have dealt with it or if they have experienced the same or just ideas from more experienced teachers on how to handle the situation.
b. Do you see any benefits from collaborating with the participants in your SSPLC that assisted your learning?	17:34. P1: Ya absolutely helped me to keep open minded to learn different things, new techniques absolutely of benefit.
c. During PLC conversations, do you always agree / disagree with the suggestions of your colleagues in the SSPLC?	18:05. I must be honest my colleagues have had amazing suggestions we agree we usually agree on most of the creative ideas but we sometimes disagree on maybe our teaching methods we, not disagree, we suggest different teaching methods so if someone says that I am going to do this so I will say okay I did that previously and this is what happened maybe try it this way but there is no shooting down of ideas or anything like that we respect and tolerate within.
d. What informs your decision to agree / disagree with the suggestions of your colleagues in the SSPLC?	18:58. So that, in my experience in my 21 years of teaching if there is something that I have experienced you know tried out and hasn't worked for me then I will share it with a colleague on the other hand if something you are now I might have just done it on the spur of the moment and it was hugely successful I would also share that with a colleague.
e. Has this collaboration in a SSPLC influenced you in any way as to how you collaborate with your colleagues in your GPLC?	19:55. uhm ya I have found it very useful because uhm during our TATT sessions we are able to discuss the children you know we are able to discuss how this particular child may have grasped a concept or this child has missed it completely uhm during our TATT session we can actually discuss actual children and what we see and all of that. **Interviewer**: So, in your SSPLC you discuss, you collaborate in a particular way so what do you take from there from that learning community into your GPLC. **P1**: uhm so it would be ideas on how we would for example um uh what's the word i am looking for Scaffold activities so we would take actual teaching experiences, and this is what we experimented with, and this is what the child misunderstood, and this is what we did to help them get to where we want them, so we use real life examples.

7. How have what you learned in a SSPLC informed your discussions or decisions in a GPLC with regards to teaching and learning?	
8. What do you understand by the concept of reflection in a SSPLC?	21:38. so reflection is exactly, I mean, what we have been chatting about right now it's looking at your teaching and what were the positives and the negatives no not negatives those things that didn't go so well and um how to improve or change things for the next time round.
a. How do you reflect in your SSPLC?	21:58. uhm sometimes uh so we obviously look at what we have planned what we had prepped together we look at **Interviewer:** so, you look at work 22.15. **P1**: Yes, yes so this is what we had planned for the children uhm this is what we actually did in the classroom this is what worked really well with all of the children this is what they loved this is what they did not enjoy and how can we change things for the next time round so that's the kind of reflection we would do. **Interviewer:** Is it specific on learners work how children learn? **P1**: It is on learners work it is also on teaching techniques because sometimes we've approached it this way and it didn't work well maybe try it this way next time round and we discuss that quite a bit during our SSPLC meetings and we also have a group so if something worked really well right now i will send a message to my colleague on watts app on this is what I did and worked really well.
9. During your SSPLC sessions what do you reflect on?	23:10. We reflect on according to our plan how far we have gone with it uhm whether we've uh covered what was meant to be covered on the day that we, are we on track with our workload uhm we also you know like so if a child has come up with something really interesting or if a child struggled to understand something that we thought was really easy to understand. Those are the kinds of things that we will look at because it will help us understand what we might have said or done incorrectly.
a. Do you see any value in this reflection?	23:50. Absolutely there is so much value in this reflection because uhm we are learning from each other we are learning from each other's experiences and we; I feel that we slightly better prepared that way. **Interviewer:** So, when you say that we are learning from each other's experiences do you mean just colleagues experiences or the children's experiences or both? **P1**: It's a combination of both. II must say because I learn a lot from the children, ya.
a. Provide an example of where trust was reflected in your PLC.	36:24. uhm, so you talking about we working together right, so for example if I, we know we got each other's back for example just say if I after the 15th of every month it is very difficult for me to get onto my Wi-Fi at home or to do anything because it takes forever then I would just message Frank and say I can't post my work for today and he will reuse the post and post for me.that kind of thing so uhm or previously i am stuck outside the school I can't get in the school that kind of thing, so it hasn't been specifically science related uhm but ya definitely there is a sense of trust or a sense if I can rely on you or I can depend on you. Ya.
b. Did your PLC always trust each other?	37:33. uhm this is confidential right **Interviewer:** ya **P1**: I feel that this is to be honest this year has been the year that I really sensed the trust in my SSPLC. Ya, I don't know maybe it is a different year the fact that we've gone through you know covid-19. but I really felt like our group is tight you know. So ya.
b. How has this affected the way you engage with your colleagues?	33:28. We've uhm, there's a, we trust each other we are comfortable saying, I don't understand this please explain it to me or how did you do this I did not get I wasn't able to explain this to the children properly what did you do. We've got that comfortable warm relationship amongst my colleagues where we are not shy to say I don't know I don't know.

Appendix: D

SSPLC sessions coding

Coding	Colour
Support	Pink
Questioning practice	Green
Sharing practice	Brown
Activities	Yellow
Content	Blue

So [redacted] what happens when they finished all their research they then teach the class what they have learnt so they make a whole google slide presentation so they basically have to understand what they have learnt because they are teaching every body else. they reteaching it to the class so if one grou has the digestive system they need to understand how the digestive system works and they have to show it via Google slides and then at the end of their presentation the spectators can ask them questions.

One thing that I want to uh

Sorry [redacted] just to add so once the presentation is done we then do a bit of consolidation in our books so we have worksheets that consolidate everything that they have said so for just that child who might have not listened carefully or who might have not heard it is still in their books if they need to refer to it so we try to cover all the basis

I was just thinking along the lines of um you guys need to you guys are the experts from the grade 4 point of view. Okay uhmm In addition to just using the research part of it looking at certain videos that we can expose the children to in a sense as as a form of resource that will help them develop their understanding of these particular concepts

[redacted] we have got two videos for each task. Remember I said that they watch the video and they do their mind maps before they actually start their research

Ya okay So they have got their videos and in term of producing like models to help with their explainations do you guys do that as well I know that [redacted] you showed that on an A4 piece of paper where the children build something

SO previously what they had to do is that they had to build the digestive system and then put it on a card and then show it to the class they had to they cut out each individual part of the digestive system or the skeletal system or any one of those they put it together.

That's great [redacted] (Showing examples of models that could be built sourced from the internet) Sorry I have never seen that oh my gosh. That is fascinating

[redacted]: Can I just add one thing there In terms of uhhh mmm You know processing that information What we did was the grade 6's I did a Jam board You know the jam board

Skeletal system, We have got one for digestive system and for muscular system and then with the healthy diet the tasks there is to create a food pyramid. I will quickly show you um the healthy diet research card here it is. Okay so these are the things that they had to do (refering to the work card) for the healthy diet. So we are on the right path right

Appendix: E

GPLC sessions coding

Coding	Colours
Sharing practice of protea walks	Blue
Sharing classroom experiences	Brown
Emotional support	Yellow
Change	Grey
Courage	Red
Knowledge	Green

That was ours P1 I can't really read your, your, ya so first of all what we said is uhm as teachers and we specifically talking about the protea walks, visiting other teachers classrooms I think as teachers we all have uhm especially at [...], we are all very much from different walks of lives in a certain extent and we all have quite rich experiences experience uhm here at […] so it's always interesting to me to go to other teachers classrooms and see their approaches to teaching and also you know the way they will uhm approach a certain subject matter so I think ya, we are quite diverse in our points of view almost of how we approach teaching, uhm.
P4: 23:21. It's nice to hear from your colleagues that you did something well because I always found with the Google classroom, like I will make an activity for all of us and I kind of like I'm putting myself out there because […] is just like a pro with all that stuff, she's just so tech savvy and all that so then I come along and make something a bit like, like not so great and they end up saying that's awesome. So, so it is so nice to get that affirmation from your direct colleagues.
P2: 19:59. So we spoke more about the change since Covid-19 that has affected our lives and what I was saying is that we going to look back on that and think g-wiz we learnt all these skills and they will benefit us in so many areas so from that point of view I think it's going to be wonderful eventually and we might be feeling about sort of strained at the moment, and it's been a long year and it's been a difficult year and I think eventually we will look back and see that you know lot of things have changed just in our curriculum because of that or the way we structure our program because of that and so I think they're going to be so many good things that come out of it.
P11: 20:45. Absolutely
P12: 20:46. And our transparency like I never thought in a million years I would be teaching 10-year old's with their parents sitting next to them and the fear that comes with that you know because talk about courage and vulnerability if you don't know, so if you said how do you spell questionnaire? […] knows, […] knows. […] definitely knows but (group laughing together) there's a certain vulnerability you have to be to be willing to make mistakes and I mean this year has just made that so that growth so much, it's accelerated everything.

P1: 16:43: So, do you mind sending this to me and I will pass it on. Okay so is everyone happy with attention for us to move on to next one so I mean I'm just I'm going to skip ahead just I mean in terms of what you would say in terms of those stories if we get her to emotions and feels I have skipped out generation but I think that connection that he makes with our kids is so important in telling the stories in having that conversation so yeah any thoughts on emotion so in that video I mentioned this idea of the scarf model which also kind of comes out of a corporate training idea but I think it's so applicable in our classes this idea of giving them a little bit of **status** you know this acknowledgement that you have done something right. The **certainty** knowing that you know you're not going to you know just kind of I always feel like even if I'm having a bad day I need to put that out of my mind and I need to be a constant for my kids you know the certainty that if you behave in a certain way I'm going to behave in a certain way your **autonomy** I think that's so lovely the day five I mean they can you know the freedom to choose **relatedness** you know being part of the community and then obviously **fairness**. Uhm, you have got a star, I got 10 out of 10 and I did not get a star. You got to be consistent and then obviously all the time and you know that little amygdala which is part of your prehistoric limbic brain that's kind of saying you know Yes or No to what what's going in. If you are feeling completely stressed or anxious and unsafe you are not going to learn up to me so any thoughts, there

P5: 23:05: I think that that is what [...] does well for teachers and to open up that choice.

P1: 23:17: How does you daily five work?

P5: 23:21: So, what we have done in grade three is that we have done a grid. So, if there are five-word words blocks there are five write a story there are five read to a buddy there are five read to self and then they can go and choose and once they finished that activity, they can colour in the block but they will have to complete the whole grid once they can get a new grid. so they must love writing stories so they write stories first five lessons and then that's now done so now you actually have to do the ones that you don't enjoy and then so what I have also said to them is you know depending on how you feeling today, Monday boring one maybe just not feeling so much energy skip one of those mundane boring ones if you feel mundane boring to you done today or if you are feeling creative today write a story or if you just put up chilling read to a buddy so then he can read to you, so uhm making choices but at the end of the day everything has to get done but you got a choice as to when you get them done.

P12: 16:48: I have latched onto something different there, the perfect condition no the condition hampering learning what was it [P10 and P12 say these together] boredom, anxiety] and one of the things that really struck me was positive feedback, giving positive feedback but agh all I do is give positive feedback.
P9: 17:13: Ya
P12: 17:13: I stopped using wrong in the classroom but wrong is a word in the dictionary [group laughs] it is you can be wrong and that is okay right or is there a balance there that I am not seeing?
P10: 17:26. You are right you would say let's see where you went wrong
P12: 17:29: Guys why I am for example what are the chemical compounds that make up water? HWO. Wrong

Appendix: F

Videotaped lessons coding

Coding	Colour
Lesson structure	Green
Learner engagement	Yellow
Teacher role	Blue

Teacher: 9:18: Okay right! So, you are going to choose. The cards have information that explain the roles to you, so you are going to choose. I am only going to give you two minutes to decide who is going to do what in your groups.

12:23: Okay guys just an idea, if you have already been a project manager then maybe don't choose yourself as a project manager for this time round. Let someone else have a turn.

Teacher: 19:49: Fantastic. OK the project managers however have all been given their roles am I right. Project managers please stand up. so [redacted] you guys know you're the project managers you make the big decisions you're going to have to divide the work up in your group

Student: 7:28: Okay you can have different resources for example a metal resources could be an idea.

Student[redacted]: 10:48: So, it what it means to advocate something is to recommend to give it say or say uh this is good you should definitely use this for osteoporosis.

Student: 14:36: they want us to record our information on our google presentation.

Student: 16:49: Mr[redacted] my question is while we are investigating. How will we work?

Student: 18:44: So, in this lesson so we keep the information that we found in this lesson should we should the scribe create the Google slide now.

Student: 19:21: When I go on, I don't have internet on my computer?

Teacher: Fantastic, I am going to display the questions with you guys but before I do that, I am going to hand out your cards for your group role allocations.

Teacher: 10:09: Thank you very much a round of applause again. We all understand that question? This is not just for skeletal guys do we all understand the words in the question?

Teacher: 16:11: The digestive system is going to look at irritable bowel syndrome again: What is it? How is it caused? What treatment is advocated? or suggested and any other interesting information. The muscular system you are going to look at muscular dystrophy: What is it? How is it caused? What treatment is advocated and again any other interesting information. And finally, the Healthy diet you are going to look at Anorexia: What is it? How is it caused? What treatment is advocated any other interesting information. OK guys so those are your questions for this week but now, this is a little bit different from what you did previously everybody close their iPads. You don't need it now.

Teacher: 19:202: Right of course it's a disease of some kind if you're in the skeletal system group what kind of disease do you think this might be?