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Exploring Pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk in the classroom

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DECLARATION

I know and accept that plagiarism is DISHONEST. Therefore, I declare that:

- ✓ This research report is my own work.
- ✓ I have acknowledged all direct quotations and paraphrased ideas.
- ✓ I have provided a complete, alphabetized reference list, as required by the APA method of referencing.
- ✓ I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.
- ✓ I 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 source of the ideas or words in my writing

Signature: N.K. Radebe.

Nomfundo Knowledge Radebe

18 June 2020

ABSTRACT

Perceptions are our own individual conceptual frameworks that we construct from experiences and use to predict and understand phenomenon (Norman, 2014). Therefore, experiences and perceptions are worth studying as they enable us to understand individuals' conceptions of phenomenon such as learner-learner talk, a social interaction with a potential to mediate learning according to Vygotsky (1978) sociocultural theory of learning. Hence, the purpose of this study was to investigate pre-service Physical Sciences teachers' experiences and perceptions of the value of learners talking to their fellow learners in the classroom.

To address the purpose of this study, a qualitative research approach with a case study design of four pre-service Physical Sciences teachers implicitly tutored in learner-learner talk was used drawing on the sociocultural theory of learning as a theoretical framework. Data was collected through individual interviews with these teachers before teaching experience regarding their talk with peers in lectures, tutorial and practical sessions. These teachers were followed to teaching experience where observations were carried out which included audio-recording their talk with learners as well as the talk between their learners. With each lesson observed, post lesson interviews were conducted with the teachers. The data from interviews, post lesson interviews and observations was analysed using categories. The data from audio-recording pre-service Physical Sciences teachers talk and their learners talk was transcribed and analysed using Scott (2008) and Mortimer & Scott (2003) communicative approaches and Mercer's (2008) three types of talk respectively.

The study found that these teachers had a positive experience of learner-learner talk during lectures, tutorial and practical sessions and thus perceive it to be effective in promoting learning and worth encouraging in the classroom. During teaching experience, these teachers extended their positive experience to the learners they were teaching using mostly the interactive/authoritative communicative approach, which is considered to be of low quality.

The implicit tutoring of the pre-service Physical Sciences teachers about learner-learner talk may have been the cause of these teachers being unable to largely employ communicative approaches of high quality. As such, the findings point to the need to explicitly teach pre-service Physical Sciences teachers on how to facilitate learner-learner talk in the classroom. This skill will be translated to the learners they will teach resulting in these learners engaging in high quality talk which, in turn, will improve their understanding of the content taught in Physical Sciences.

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CHAPTER ONE
INTRODUCTION AND BACKGROUND

1.1 BACKGROUND

The 2018 National Senior Certificate (NSC) Examination Diagnostic Report has shown that South Africa is facing a great concern of poor performance in Physical Sciences. Physical Sciences is a subject taught in most South African secondary schools and, according to DBE, (2011), this subject is considered to be playing a significant role in the lives of South Africans because it contains knowledge that is often utilised to deal with issues facing the society. Studies have responded to this great concern by investigating contributing factors to poor performance in this subject. Among those studies is Makgato and Mji (2006); Makgato (2007); Dhurumraj (2013) and Zenda (2016). These studies denoted the use of traditional teaching methods as being prevalent in Physical Sciences classrooms and as a possible contributor to poor performance. According to Hurst, Wallace & Nixon (2013), this teaching method involves the teacher disseminating information meanwhile learners remain passive recipients of that information. As a result, this teaching method is incompatible with Vygotsky's view of learning because it fails to encourage active engagement with the knowledge taught during the lesson.

Vygotsky (1978) postulate that learning is mediated through social interaction and for learning to take place, learners need to actively participate in the meaning-making process. Social interaction, as outlined by Hurst et al (2013), is "meaningful dialogue among learners" (p. 376). From this definition, it is appropriate to consider learner-learner talk as a social interaction since it involves learners externalising their thoughts as they interact with their peers. Learner-learner talk renders learners with an opportunity to actively participate in the lesson by engaging in discussions that promote scrutiny of ideas. This, in turn, enables an understanding of the conceptions that learners have constructed, illuminate misconceptions that learners may have and denotes a starting point for teaching in order to enable conceptual change.

Given this central role that learner-learner talk plays in the learning process, this study aimed to investigate pre-service Physical Sciences teachers' experiences and perceptions of the value of learners talking to their fellow learners in the classroom. According to Brown, Collins & Duguid (1989) perceptions influence how one act and learn. As such, studying pre-service Physical Sciences teachers' perceptions enabled an understanding of the possible teaching methods they will employ in the future when teaching. Since perceptions are linked to experiences, how these

teachers view the value of learner-learner talk may be influenced by their experiences of it, hence it was worth studying these teachers' experiences and perceptions of learner-learner talk.

1.2. PROBLEM STATEMENT

The 2018 National Senior Certificate (NSC) diagnostic report reveal that there is improvement in the Physical Sciences learner performance from 2015, with the number of learners achieving 30% and above increasing from 58.6% to 74.2%, and learners achieving 40% and above increasing from 36.1% to 48.7% (DBE, 2019). The table below shows the trend in the Physical Sciences learner performance from 2014 to 2018.

Table 1: The trend in the Physical Sciences learner performance from 2014 to 2018.

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above	No. achieved at 40% and above	% achieved at 40% and above
2014	167 997	103 348	61,5	62 032	36,9
2015	193 189	113 121	58,6	69 699	36,1
2016	192 710	119 467	62,0	76068	39,5
2017	179 561	116 862	65,1	75 736	42,2
2018	172 319	127 919	74,2	84 002	48,7

NSC Examination 2018 Diagnostic Report (extracted from DBE, 2019)

This is not a pleasant improvement because more than half of the learners who wrote the final Grade 12 Physical Sciences examination achieved less than 40%. This implies that more than 50% of the learners who wrote the final examination failed to meet the university entrance minimum requirement of 50% and above. Furthermore, the number of learners writing final Grade 12 Physical Sciences examination has been decreasing from 2015. Makgato (2007), conducted a study based on trends which showed reduced number of learners as we are seeing now, assert that this decrease is as a result of learners observing failure from their fellow learners and that discourages them to take this subject. This is a serious concern because South Africa has a shortage of doctors, engineers, technologists and many other professionals that are scientifically oriented as Zenda (2016) noted. Pratzner (1994) argues that this shortage has resulted in the country not having the ability to develop economically without having to bring in foreign scientific and technological expertise. Mateus, Allen-lle & Iwu (2014) also argue that this shortage has resulted in "the country's inability to develop, utilize, and retain enough human

capital from its own resources" (p. 64). Rasool & Botha (2011) also argues that "skills shortages are major obstacles to economic growth and job creation in South Africa" (p. 1). In other words, there is a consensus from Pratzner (1994); Rasool & Botha (2011) and Mateus et al (2014) that this shortages has a major effect on the country's economic growth and development.

In a study conducted by Makgato (2007) in South Africa, lack of proper teaching and learning methods was identified to be a contributing factor, among other factors, to poor performance in Physical Sciences. A study conducted by Zenda (2016) in South Africa reiterates that teachers are continuing to use traditional teaching methods. This method of teaching involves the teacher disseminating all the information to the learners. As a result, learners remain passive throughout the lesson taking notes, occasionally answering questions and interacting with their peers (Hurst et al, 2013). In other words, this method of teaching does not encourage learners to actively participate in the classroom. Other than the preference of this teaching method due to large classroom sizes and lack of resources, Zenda (2016) posit that this teaching method enables teachers to complete the syllabus faster, seemingly, incomplete syllabus was identified as another factor which contributes to poor performance by Makgato (2007). This teaching method, according to Devlin (as cited in Makgato, 2007), "discourage learners and cause anxiety about mathematics and Physical Sciences, which could contribute to poor performance" (p. 97).

Using teaching methods that are appropriate significantly contribute to learning and Physical Sciences, as a subject, requires the use of teaching methods that will facilitate active learning. Learner-learner talk can be used as one of the teaching methods that could facilitate active learning because, according to Routman (2005), learning is enhanced when learners talk to their peers and are actively engaged. Learner-learner talk provide learners with an opportunity to be actively engaged in the learning process as required by the social-constructivists i.e. Vygotsky (1978).

Dhurumraj (2013) in his study of determining factors contributing to poor learner performance in Physical Sciences in KwaZulu-Natal Province suggested that further research should focus on pre-service Physical Sciences teachers' education in order to improve performance in this subject. As such, this study focused on pre-service Physical Sciences teachers because I believed that if we can find out what these teachers' experiences and perceptions of learner-learner talk are, we would be able to anticipate the teaching methods they will employ in their classrooms and plan interventions accordingly that may improve the status quo of Physical Sciences in South

Africa. Many studies have directed attention on establishing the importance of learner-learner talk in the learning process including Hurst et al (2013). Other studies have focused on studying high school learners' perceptions of talk including that of Kaya, Erduran & Cetin (2010). However, there is limited understanding of teachers' perceptions of talk as Kaya et al (2010) outlined. Therefore, this study will contribute to this literature by exploring pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk.

1.3. RATIONALE FOR THE STUDY

According to Vygotsky (1978), learning is a social activity and takes place when learners actively create meaning of their world view by interacting with others. Vygotsky's view of learning entail that in a classroom setting, learners should be encouraged to actively participate in the lesson for learning to be enabled. As such, traditional teaching methods are contrary to this philosophy of learning. They are also in direct contrast with the idea proposed by Hurst (1998) that the person who is working the most is the one learning. By work, Hurst (1998) refers to engagement with, and internalization of information through reading, writing, thinking and speaking.

Teachers, in traditional teaching methods, work the most as they prepare and deliver lessons while learners passively receive information. Probst (2007) states that learners should be the ones doing the work thus, doing the learning. This suggests that learners should be the ones doing most of the speaking, writing, thinking and reading in the classroom by actively engaging in meaningful social interactions with other people including the teacher and fellow learners. Research by Hurst et al (2013) outlined the pivotal role that social interactions, particularly learner-learner talk, can play in the learning process. Thus, concurring with Routman (2005) that learning is enhanced when learners talk to their peers and are actively engaged.

Given this significant role of learner-learner talk in the learning process, a study on pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk would assist us to anticipate the possible teaching methods that they will utilise in the future. It will also develop a profound understanding of why traditional teaching methods are still prevalent in the Physical Sciences classrooms while learner-learner talk or alternating different teaching methods can enable learning better as suggested by Makgato (2007). Therefore, the purpose of this study was

to understand pre-service Physical Sciences teachers' experiences and perceptions of the value of learners talking to their fellow learners in the classroom.

1.4. THE PURPOSE OF THE STUDY

The purpose of this study was to investigate pre-service Physical Sciences teachers' experiences and perceptions of the value of learners talking to their fellow learners in the classroom during Physical Science lessons. In order to address the purpose of this study the following research questions were answered:

1. What are pre-service Physical Sciences teachers' experiences of learner-learner talk?
2. How do pre-service Physical Sciences teachers' experiences influence their perceptions of learner-learner talk?
3. How do pre-service Physical Sciences teachers' experiences and perceptions about learner-learner talk influence their teaching practice?

1.5. SIGNIFICANCE OF THE STUDY

This study was worth doing because it will contribute knowledge in the discussions of learner-learner talk which arises from learner-learner interaction during Physical Science lessons. It may also encourage pre-service Physical Sciences teachers to examine their perceptions of teaching and learning and thus, encourage them to challenge the traditional way in which Physical Sciences is currently taught and learned. As such, strive to promote more opportunities for learning in Physical Sciences classrooms by encouraging and facilitating learner-learner talk, consequently, increase learners' performances in this subject. This study also illuminate pre-service Physical Sciences teachers' ideas about the role of a teacher in the classroom as Crow (1987) suggested that students come to teacher-training institutes with well-established images of teachers' roles.

1.6. THE RESEARCHER AND POSITIONALITY

Positionality is a concept used in research to indicate an understanding that whenever one is conducting research, their opinions, beliefs, experiences and values tend to influence how they interact with the data inversely influencing the conclusions reached (Ungvarsky, 2019). Although positionality is almost unavoidable, Ungvarsky (2019) argues that it is possible to minimise its impact through identification and disclosure of personal information that may possibly affect the direction and trustworthiness of the study. Hence in the next paragraphs, I will disclose information that may have affected the direction of this study.

I was born and raised in Driefontein, a rural area in Mpumalanga, by my grandmother. She joined her ancestors in August 2009 when I was doing Grade 8. I then moved to Gauteng to stay with my mother and proceeded with my studies in a high school at Soweto. I passed my Grade 9 and proceeded to Grade 10. In Grade 10 we were expected to choose subject specialisations and I chose science which had only one class. In this class, we were unfamiliar with each other because we were all coming from different classes from Grade 9. However we knew each other's names and faces because it was a culture of the school to post the list of top ten high performing learners for the entire Grade as well as for each class after each test. This created a competitive environment amongst us as learners and that had its own advantages and disadvantages. It was advantageous because it would push us to study in order to be on the top ten list, at least one of them. It was disadvantageous because we were consumed by the competition, fighting for a spot on the top ten list such that we hardly helped each other. Furthermore, once you get the spot, you had to fight to remain on the list because if you do not make it to that list in the next round, you would become a laughing stock. This culture continued until I graduated for my matric.

I went to a university in Gauteng, University of Witwatersrand, to study towards a teaching degree specialising in the secondary phase. During my first year, I realised that everything was different from high school. For example, almost all my assessments were in essay form which required me to read numerous articles and none of the lecturers spoke IsiZulu, my home language, during lectures or tutorials, they spoke English throughout. In addition to this, I had no friends and that made it difficult to adjust in such an environment. By June, I had made some friends, and towards examinations we would form study groups as part of preparing for the exams. I found the study groups beneficial. However, they were formed for exams only and would stop during the semester. This changed when I was doing fourth year in the Physical

Sciences class. We were relatively few in the Physical Sciences class and every now and then during lectures the lecturer would give us problems to solve and instruct us to talk with the person sitting next to you. This interaction with my classmates did not stop in class nor was it for exams preparation only. It was escalated to online platforms where we created a group that we utilised to engage any time without the need for physical contact.

With this experience, high school and university experience, I realised that instructors/educators influence how we interact with fellow students. This is because I believe that if the Physical Sciences lecturer did not encourage us to talk in class, we would not have engaged with each other beyond preparing for exams. Upon enrolling for postgraduate studies, this experience of working with fellow students was positively enhanced, eliciting my interest in understanding talk between learners/students and positively shaping my current view of working with fellow classmates. Discovering that the science education community has taken interest in this aspect excited me. This excitement may have influenced how I interacted with the participants. It is also possible that since the research participants of this study were from the same school of education as me and possibly taught by the same lecturers as the ones who taught me, I may have overstated positive results with inappropriate bias on negative results. It is for this reason that different techniques have been used to analyse the collected data. Also, it is worth mentioning that the information about the research site is based on my own experience as a student and a laboratory demonstrator for the Physical Sciences and Physical Sciences methodology courses. As such, I may have provided explicit details about the research site and the teaching of Physical Sciences at the site are presented.

1.7. STRUCTURE OF THE RESEARCH REPORT

This research report consists of five chapters. The first chapter introduces the study and includes the research questions the study intends to answer as well as the study's significance. Chapter Two provides the theory this study is based on and the relevant literature reviewed. The third chapter provides a detailed discussion of the approach, methods and analytic framework that were employed in obtaining data that would assist in addressing the purpose of this study. This chapter also provides a justification of the selected sample, the steps that were followed in the validation of the research procedure as well as ethical issues that were taken into consideration.

Chapter four presents findings of the study. The last chapter presents a summary of the findings and conclusion. It also provides recommendations for further research.

CHAPTER TWO
LITERATURE REVIEW

2.1. INTRODUCTION

This chapter starts by discussing the theoretical framework which "is the foundation from which all knowledge is constructed (metaphorically and literally) for a research study" (Grant & Osanloo, 2014, p. 12). Following the theoretical framework are the tools that were used to analyse data and the literature reviewed evaluating the relevant published knowledge relating to this study.

2.2. THEORETICAL FRAMEWORK

This study is based on Vygotsky (1978) socio-cultural theory. This theory was chosen because "it explains not only how individuals learn from interaction with others, but also how collective understanding is created from interactions amongst individuals" (Mercer & Howe, 2012, p. 13). The socio-cultural theory views learning as a social activity where learners actively construct meaning of their own world by interacting with others. This theory asserts that social interaction is pivotal to the meaning-making process. According to Hurst et al (2013), social interaction is meaningful engagement amongst people. Learner-learner talk is a social interaction because it involves learners externalizing their thoughts and sharing ideas with their peers. In other words, it involves two or more learners engaging with each other meaningfully. In this sense, learner-learner talk can also be viewed as pivotal to the meaning-making process.

However, Vygotsky (1978) stipulates that learners cannot passively receive information; they need to be actively engaged in the process of constructing meaning. This stipulation is critical as it entails that simply imparting information to learners in a classroom setting without giving them an opportunity to engage with it will not enable learning. As such, it implies that learners should be given an opportunity to actively engage with the imparted information, through discussions that involve constructive criticism and exploration of ideas for example, in order for them to acquire critical thinking skills necessary in order to apply the acquired information to solve conceptual problems and for learning to be enabled.

Vygotsky (1978), registers that learning is firstly mediated in the inter-psychological plane. In this plane, learning is mediated as learners socially and culturally engage with other people. With

regards to a classroom situation, this is when learners are actively engaging in learner-learner talk, explaining, discussing, constructively criticizing and exploring each other's ideas. After learning has been mediated in the inter-psychological plane, it is then mediated in the intra-psychological plane. In this plane, Vygotsky outlines that learners internalise social activities i.e. the talk with their peers or teacher, enabling their thinking to be shaped. According to Wertsch (1985), internalisation is a process of transforming a social activity into a psychological activity. In other words, the inter-psychological plane occurs outside the mind of the learner while the intra-psychological plane occurs in the mind of the learner.

The interpsychological plane is critical as it is plane where the information that is internalised by learners comes from. Studies have shown that learners do not always have correct conceptions about science, meaning that one peer misconceptions can be passed on to the other peer during learner-learner talk. Therefore, while learner-learner talk as a social interaction may be pivotal to learning, it may also perpetuate misconceptions amongst learners. Thus, it is important that this type of interaction is carefully monitored. In other words, the information shared in the inter-psychological plane needs to be carefully monitored to prevent perpetuation of misconceptions and to enable conceptual change or learning.

Vygotsky (1978), states that individual learners have mental functions that have fully developed and mental functions that are yet to develop. Fully developed mental functions indicate learners' actual development level and are determined by learners' ability to accomplish tasks without assistance. Mental functions that are yet to develop indicate learners' potential development level and are determined by learners' inability to accomplish certain tasks without aid from a more knowledgeable other. According to Vygotsky, by participating actively in social interactions, individual learner's actual development level can be shifted within the zone of proximal development (ZPD). ZPD is "the difference between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance with more capable peer" (Vygotsky, 1978, p. 86).

ZPD is pivotal in teaching and learning because it denotes the starting point for teaching. According to Ohta (2001), earlier work considered the more knowledgeable one to be an adult, researcher, or teacher. However, a learner can assist a less knowledgeable peer during learner-learner talk, enabling the less knowledgeable peer to engage in knowledge-building, thus shifting their actual level of development (Ohta, 2001). This means that during learner-learner

interaction, the role of the learner can shift from being the less knowledgeable peer to a more knowledgeable peer and vice versa depending on the learner's actual development level with regards to the concepts under study. This, thus, signifies the valuable role an interaction amongst learners can play in enabling learning.

As learners actively participate in social interactions with their peers and externalise their ideas, language plays a vital role. This is because language, according to Vygotsky, as cited in Mercer & Howe (2012), is both a psychological tool and a cultural tool. As a psychological tool, language structures an individual's thinking process, enabling them to make meaning of their own experiences. As a cultural tool, language is used to share experiences amongst people in a society or community. These experiences are then analysed collectively to make meaning of them. Therefore, language is a "means for transforming experiences into cultural knowledge and understanding" (Mercer, 1995, p. 4). What this means is that language is not only necessary for people to communicate but it enables people to think about shared experiences and learn with others. Nonetheless, this study did not focus on the language used to facilitate learner-learner talk because it is broad and is a research field on its own. This study focused only on the lived experiences and value of learner-learner talk arising from learner-learner interaction.

2.3. CONCEPTUAL FRAMEWORK

2.3.1. PRE-SERVICE TEACHERS EDUCATION

Pre-service teachers, also called student teachers, are students currently enrolled for a teaching qualification. The education the pre-service Physical Science teachers receive during their enrolment for this teaching degree include an introduction into "more complex forms of thinking about teaching" (Yuan & Lee, 2014, p. 1). This education is aimed at preparing them to cope better with the realities of a classroom in the future. As such, they are not only taught content knowledge about the particular subjects they want to teach but they are also taught teaching practices aimed at helping them to make content knowledge accessible to learners (Yuan & Lee, 2014). In the selected school of education, pre-service teachers are taught how to make content knowledge accessible to learners during methodology classes. These classes are separate from the content classes where they learn about the content knowledge of the subject they intend to teach. These classes are taken from the first year of the teaching degree till the fourth year. Thus, fourth year pre-service Physical Sciences teachers were the suitable candidate for this study as

they are more knowledgeable about Physical Sciences as a subject and how to teach it compared to other pre-service Physical Sciences teachers in the other years of study of the teaching degree.

Yuan & Lee (2014) assert that teaching practicum, also known as teaching experience, is central to teachers' professional training and learning. Hence, pre-service teachers are given an opportunity yearly to go into schools and experience actual teaching and learning. During this period, they are under the supervision of qualified teachers who model to them the role of the teacher so that they can "enhance their teaching knowledge and skills and interrogate and reflect on their deeply held values and beliefs, which can contribute to their cognitive learning and development" (Yuan & Lee, 2014, p. 1).

Yuan & Lee (2014) outlines teaching as an interactive process which is concerned with learning. As such, one of the competences that pre-service teachers have to develop during their training for the teaching degree is learner engagement (Yuan & Lee (2014). Learner engagement refers to learners' "cognitive investment in, active participation with, and emotional commitment to learning particular content" (Bender, 2017, p. 2). Bender (2017) proposes twenty different strategies that may be used to maximise learner engagement. Among the twenty strategies is collaborative instruction which involve learners working in groups to solve problems and make sense of meanings (Bender, 2017). Similar to collaborative instruction, learner-learner talk may be used as one of the strategies to enhance learner engagement. This is because leaner-learner talk is a social interaction as discussed in section 2.2, and allows learners to bring together their intellectual resources to solve problems and understand experiences with or without the guidance of the teacher, thus mediating learning (Wilkinson, Soter & Murphy, 201). In the selected school of education, learner-learner talk, as a teaching strategy that pre-service teachers may use to enhance learner engagement, is not part of the curriculum, particularly in Physical Sciences and Physical Sciences methodology courses. However, pre-service teachers are taught learner-learner talk implicitly during practical sessions and tutorial sessions where they are mostly required to work in small groups under the guidance of a laboratory demonstrator/tutor. Thus, they have some experience of learner-learner talk obtained from working in groups during the above-mentioned sessions.

The above paragraph points out that learner engagement is not entirely about increasing the number of learners participating in the classroom but it is also about the quality of the interaction. In learner-learner talk, quality learner engagement may be understood in terms of the

nature of talk that learners/pre-service Physical Sciences teachers engage in (Mercer, 1995) and/or the communicative approach they employ (Mortimer & Scott, 2003). As such, to understand better pre-service Physical Sciences teachers' value of learner-learner talk, this study looked at the pre-service Physical Sciences teachers' experiences of learner-learner talk during teacher training and the quality of their engagement with their learners in classrooms during teaching practice.

2.3.2. PHYSICAL SCIENCES

Physical Science is a subject offered in most secondary schools in South Africa from Grade 10 to 12. Unlike other subjects, Physical Sciences constitute two subjects, Chemistry and Physics (DBE, 2011). I refer to Chemistry and Physics as subjects because in other countries, such as Zimbabwe, Physics and Chemistry are taught as separate subjects at secondary schools, meaning that learners in these countries have an option to choose to either do both Chemistry and Physics as two different subjects or select one of these subjects (Ncube, 2014). In a South African context, learners do not have that option as Chemistry and Physics are considered to be components making up the Physical Sciences subject (DBE, 2011). This means that if a learner chooses Physical Sciences as a subject at secondary school, that learner will have to do both Chemistry and Physics.

Physical Sciences is focusing on investigating physical and chemical phenomena through "scientific inquiry, application of scientific models, theories and laws in order to explain and predict events in the physical environment. This subject also deals with society's need to understand how the physical environment works in order to benefit from it and responsibly care for it." (DBE, 2011, p. 8). Physical Sciences enable us to understand the world we live in and provide us with knowledge and skills necessary to solve real world problems.

The Physical Sciences offered in schools is different from the Physical Sciences practiced in the world of scientists. This is because this subject is aimed at providing learners with scientific knowledge that is embedded in science education (Okoye, 2002). Science offered in schools provides learners with necessary skills to embark on scientific enquiry. Thus, good performance in this subject is valuable in the society and is seen as an entrance ticket into high profile professions (Okoye, 2002). This means that societies believe that learners who opt for this subject at secondary school have great opportunities into scientific oriented careers awaiting them at the end of Grade 12.

DBE (2011) assert that "Physical Sciences plays an increasingly important role in the lives of all South Africans owing to their influence on scientific and technological development, which are necessary for the country's economic growth and the social wellbeing of its people" (p. 8). This is because the knowledge contained in this subject influence critical issues including economic development, social, political and technological issues. As such, it is important that studies on this subject are conducted in order to improve performance and the number of learners opting for this subject which consequently enhances economic development of this country and the social wellbeing of its people. Hence, this study is focusing on this subject, Physical Sciences.

At the core of this subject, is practical work. Practical work generally refers to any task that involves learners working with materials and making observations. According to DBE (2011), practical work clarifies and reinforce the concepts taught in the classroom and may include simple practical demonstrations, experiments and practical investigations. Leite & Afonso (2000) assert that practical work has a potential to increase performance in Physical Sciences. This is because practical work provides learners with experiences that can possibly influence them to understand and appreciate the value of Physical Sciences according to Parkinson et al (1998). In other words, practical work elicits learners' interest in the subject. It also teaches them about the significance of cooperation, listening skill and respecting other learners' perspectives as part of the curriculum implicit aims. In other words, practical work is an ideal activity for learner-learner talk to be employed. Practical work makes Physical Sciences the most suitable subject in which learner-learner talk may be employed as it provides learners with an insight of how knowledge come to be accepted as true in the science world.

In the selected school of education, pre-service Physical Sciences teachers conduct at least three practical work activities for the Physics component and at least three practical work for the Chemistry component in each year of study. This is because each component is taught for six weeks from the first year of study to the second year of study. From the third to fourth year of study, pre-service Physical Sciences teachers are taught each component for 12 weeks. In the third year of study, though pre-service Physical Sciences teachers are exposed to Physical Sciences for the same amount of weeks, their level of knowledge is lower than that of fourth years. Hence this study is focusing on this subject and on fourth year pre-service Physical Sciences teachers as they are more knowledgeable about teaching and learning Physical Sciences

as a subject. As such, their experience and perceptions of this type of talk will be valuable for this study

2.3.3. INTERACTION

Whenever two or more people actively exchange information, they are said to be interacting. In a classroom setting, Moore (1989) contends that there are three types of interactions possible. The first possible interaction is called learner–content interaction. According to Moore (1989), this is a type of interaction that takes place between the learner and the subject matter and is observable when a learner interacts with the subject matter through reading and/or writing. In this interaction, it is possible to have the different communicative approaches on the content the learner is interacting with. For instance, a reading may be presenting multiple perspectives. That reading could be seen as being dialogic than authoritative which presents only one perspective (Scott, Mortimer & Aguilar, 2006). In that sense, by actively reading that material, the learner will be exposed to multiple perspectives and that makes it possible for the learner to engage in exploratory talk with self or with others.

The second possible interaction is called learner–instructor interaction. This is a type of interaction that takes place between the learner and the teacher and is observable during teaching, for example, when the teacher and learners are actively engaged in a discussion (Moore, 1989). In this type of interaction, an authoritative or dialogic communicative approach may be observed. For instance, the teacher may choose to present or share one point of view with the learners or multiple points of views. In another case, the teacher may allow learners different point of views to be heard and interacted with. In the case where multiple point of views are shared, presented or interacted with, the communicative approach used is dialogic, while in the case of one point of view being presented or shared the communicative approach used is authoritative according to Scott et al (2006). Scott (2008) posits that it is also possible to have both communicative approaches interchanging.

The third possible interaction is called learner–learner interaction. This type of interaction takes place between learners only through written or spoken dialogue (Moore, 1989). In this type of interaction, learners may be in peers or group settings with or without the presence of the teacher (Moore, 1989). This type of interaction is at the core of this study because whenever learners are

talking amongst themselves, they are actually verbalising their thoughts. As such, the resulting talk, learner-learner talk, serves as a reflection of what is in the minds of the learners, informing us about their conceptions. Therefore, this study focused on this type of interaction and its resulting talk.

2.3.4. LEARNER-LEARNER TALK

In 1997, Kasten conducted research in classrooms on peer talk and found that teachers and principals of that era were spending extensive amount of time trying to keep their learners quiet. According to Kasten (1997), the same teachers and principals could not understand why learners were terrified of oral assessments and uncomfortable speaking to a group of people even in their adulthood. Kasten contend that these teachers and principals were unaware of the significance of social interaction in learning, as outlined by Vygotsky (1978) in his socio-cultural theory, that it mediates learning.

Learner-learner interaction is a social interaction that provides learners with an opportunity to verbalize their thoughts. This opportunity, according to Almasi & Gambrell (1997), enables learners to improve their ability to share ideas, consider other learners' perspectives, and to take responsibility for their own learning. Ketch (2005) posit that learner-learner interaction also enable learners to build understanding, empathy, and respect for other learners' opinions. As learners verbalise their thoughts during learner-learner interaction, talk offers them "a means to combine their intellectual resources to collectively make sense of experience and to solve problems" (Wilkinson 2010, p. 143).

Learner-learner talk can be classified into three categories namely: disputational talk, cumulative talk and exploratory talk (Mercer, 1996). According to Mercer (1996), disputational talk is a type of talk that involves disagreement and individualised decision-making, with few attempts to offer constructive criticism and/or suggestions and consists of assertions and counter-assertions exchanges that are not supported with evidence. Mercer posit that disputational talk is characterised by a competitive atmosphere where each learner wants to have their views heard and they tend to be defensive of their ideas and are not willing to take other learners' point of view. Atwood, Turnbull, & Carpendale (2010) consider this type of talk to impede learners from gaining new insight. As such, this type of talk is considered to be least effective in problem solving by Mercer (1995), meaning that is it of low quality. However, this type of talk, when

properly managed, can greatly enhance learning as it can lead to clarification and consensus built on supported claims.

Contrary to disputational talk, Atwood et al. (2010) assert that cumulative talk lacks critical evaluation of ideas, which is central to interactions that are cooperative. Cumulative talk, according to Mercer (1996), takes place when learners positively build on what other learners have said, thus, repetitions, confirmations and elaborations are common in this type of talk. This type of talk is similar to inclusive argumentation, as noted by Scholtz et al. (2008), where learners in a group would rather use the concept of *Ubuntu* and not rebut their peers' assertions. While Barnes (1999) postulate that this type of talk increases confidence and rapport amongst learners in a group, Mercer et al. (2004) deliberates that this type of talk reveals a need to develop learners communicating and thinking skills. For Barnes (1999), this type of talk is a result of learners working on an activity that is not challenging enough. This assertion has a critical implication on the kind of activities given to learners. It implies that learners should be given activities that will promote knowledge construction and shift their actual development level within the ZPD.

Contrary to both disputational talk and cumulative talk, Atwood et al. (2010) postulates that exploratory talk is a cooperative interaction that involve learners critically and constructively engaging with one another's ideas. According to Mercer (1996), in this type of talk learners challenges each other's ideas with justification, they value alternative ideas and make joint decisions through evaluation of different ideas. This entails that consensus, in this type of talk, is built on evidence or justification provided. Thus, Mercer (1995) contend that exploratory talk is the most effective and valuable type of talk in problem solving, meaning that it is of high quality.

According to Scott (2008), exploratory talk has some resonance to the dialogic communicative approach because it encourages sharing and evaluation of ideas. As mentioned above, a dialogic communicative approach is one of the communicative approaches possible in a classroom between a teacher and learners where a teacher invites learners to state their point of views. In this communicative approach, the teacher may request a learner to provide more details of their view or ask other learner whether they agree or disagree with the proposed ideas. This communicative approach can be interactive or non-interactive. According to Scott (2008) an interactive/dialogic communicative approach involves the teacher and learners considering

different points of view while the non-interactive/dialogic approach involves the teacher, alone, reviewing various points of views.

Counter to the dialogic communicative approach is the authoritative communicative approach. This type of communicative approach involves the teacher not considering ideas raised by learners and only one perspective is presented. Just like the dialogic communicative approach, the authoritative communicative approach may be interactive or non-interactive also. In an interactive/authoritative communicative approach, the "teacher focusses on one specific point of view and leads students through a question and answer routine with the aim of establishing and consolidating that point of view" (Scott, 2008, p. 21). The question and answer routine used in this communicative approach is known as the initiation-response-evaluation pattern. This pattern, according to Mercer & Dawes (2008), is commonly used to check learners' understanding, check if learners are paying attention, encourages learners to participate in the lesson and to give them feedback.

Scott (2008) postulate that in a non-interactive/authoritative communicative approach, only one point of view is presented by the teacher alone without involving learners. This means that the non-interactive/authoritative communicative approach denies learners the opportunity to interrelate or reinterpret new ideas and experiences in order to restructure their existing knowledge. Vygotsky (1978) and Barnes (2008) clearly argued that for one to learn, they need to be actively engaged in the learning process. In light of these authors' postulates, it is clear that this communicative approach renders learners passive in the learning process. As such, this communicative approach can be considered to be ineffective in enabling learners to actively construct or reconstruct knowledge.

The interactive/dialogic communicative approach, on the other hand, is most valuable as it involves different views being explored by both the teacher and learners and it may lead to a collective understanding being reached. Thus, it corresponds to the way of learning proposed by Vygotsky in his sociocultural theory. Therefore, this communicative approach should be promoted in classrooms. In order to promote it, Howe and Mercer (2007) suggest that teachers should refrain from using closed questions and use open questions. Open questions will encourage learners to express their thoughts and that may also reveal any misunderstandings they may have. They also encourage learners to explore their peers' ideas. When such questions are used, Howe and Mercer (2007) stipulate that it is important to give learners sufficient time to

think answers through and also encourage them to justify their claims and elaborate more on their answers. They also suggest that teachers should "encourage learners to put knowledge into their own words (while also offering them new vocabulary to accommodate new ideas)" (Mercer & Howe, 2012, p. 17).

Nonetheless, all these communicative approaches are useful in analysing the manner in which a teacher works with learners in a classroom to develop ideas. In other words, "the communication system that a teacher sets up in a lesson shapes the roles that the pupils can play, and goes some distance in determining the kind of learning that they engage in" (Barnes, 2008, p. 2). What this mean is that these communicative approaches reveal the roles that each teacher renders to their learners during the learning process, whether they should be active or passive participants.

While social interactions have been considered valuable in the learning process, several factors have been identified as influencing the level of exchanges possible during learner-learner interactions. Amongst those factors are ground rules, the design of collaborative tasks and the relationship learners have with each other. Ground rules are guidelines outlining how learners should engage during learner-learner interaction. According to Mercer (1996), teaching learners ground rules for interacting yields more effective exchanges. This is because these rules establishes the purpose of the collaborative task by preventing the domination of decision-making by certain learners in the task and also ensuring that all group members' perspectives are respected, considered and sought. Thus, minimizing disputes and enabling cooperative interactions.

In a literature review carried out by Howe and Mercer (2007), they found that certain features in the design of collaborative tasks promoted effective learner-learner interactions. These features include the design of collaborative tasks in a manner that will require learners to explore different views; the design of collaborative tasks in such a way that all collaborating learners have to share their views for the task to be completed successfully; and how collaborative tasks are designed to ensure that they present challenges that are appropriate for learners in that particular age. As such, Howe and Mercer (2007) concluded that how tasks are designed for collaborative interactions influence the effectiveness of the learner-learner interaction. These factors influencing learner-learner interaction are significant to this study as they enabled me to understand better pre-service Physical Sciences teachers' experiences of learner-learner talk and their perceptions of the value of learners talking to their peers in the classroom.

Another factor that Howe and Mercer (2007) found to influence the successful completion of the task is the relationship that learners who are supposed to work together have with each other. They found that learners who are friends tend to interact with each other i.e. they share ideas and also challenge each other's ideas. This is contrary to learners who are not friends as they tend not to share nor challenge each other's ideas. As such, Howe and Mercer (2007) postulate that friends are more likely to successfully complete the task as compared to learners who are not friends. This factor is significant as it gave me a better insight into understanding the type of talk learners in the pre-service Physical Sciences teachers' classes engage in. Consequently, they gave me a better understanding of pre-service Physical Sciences teachers' experiences of learner-learner talk and their perceptions of the value of learners talking to their peers in the classroom.

2.3.5. EXPERIENCES AND PERCEPTIONS

Experience is often understood as knowledge or skills that one acquired through practical contact with a situation or observation of an event. It is based on this understanding that Boud, Cohen & Walker (1993) considers experience as being fundamental in the learning process. This means that for learning to take place, one's experience should be taken into consideration and engaged with. This is because negative experiences, if not engaged with, may impede learning while positive experiences may stimulate and enhance learning if engaged with (Boud et al., 1993). In other words, by engaging with one's experience, their ideas about that experience may be reformed, ultimately changing their world view (Kolb, 1984). This may be understood to mean that how we respond to events is dependent on our observations or practical contact with such events.

The above paraghraph suggest that perceptions, generally known as ideas/views that one has with regards to a phenomenon, are linked to one's experiences and form internal mental models as stated in Norman (2014). According to Norman (2014), internal mental models are conceptual frameworks that one constructs and uses to predict and understand an interaction/event. In other words, these conceptual frameworks are constructed based on our experiences with the phenomenon in question. As such, they serve as guiding mental images from which all new information is being filtered. Norman posit that these internal mental models provide individuals with a belief system, observability and predictability. Norman (2014) notes that the belief systems enable individuals to reflect on their own beliefs that they have acquired. Norman

(2014) highlights that observability help individuals to make links between the physical world and the mental model while predictability enables one to understand and anticipate responses from a system.

Barnes (1992), noted that students come into classrooms with a set of interconnected expectations, suggesting that internal mental models are organized as cluster sets of expectations. Barnes further explained that these internal mental models are derived individually and socially, meaning that they are shaped by ones' experiences as well as expectations and values from inside and outside social settings. In teacher-training institutions this entails that pre-service teachers have vivid images of teaching before they are even taught how to teach (Calderhead and Robson, 1991). This is possible because pre-service teachers spend at least twelve years in schools observing their teachers modelling teaching. What Calderhead and Robson (1991) mean is that pre-service teachers internalise the modelled view of teaching and that forms their perception of teaching.

Brown et al (1989) posit that what one perceive, contributes to how one will act and learn. This means that perceptions, similar to experiences, are influential in learning and achievement as Kaya et al (2010) asserted. Hence, the vivid images of teaching that pre-service teachers possess, whether good or bad, influence how they will interpret the experiences offered by the teaching degree and how they will translate and apply the knowledge and projected practices as teachers during teaching experience and/or when qualified. In another sense, this means that experiences are a seed for perceptions.

In that regard, institutions offering teaching degrees should acknowledge that pre-service teachers are not clean slates from which new and desired images of teaching may be formed. They should attempt to reshape the already constructed images of teaching by engaging with their experiences. However, how can one reshape one's mental models without knowing what they are? This study therefore, attempted to answer this question by finding out what are pre-service Physical Sciences experiences of teaching and learning with regards to learner-learner talk, how are their perceptions influenced by their experiences and how their perceptions influence how they teach. Perceptions, in this study, are considered to be views of pre-service Physical Sciences teachers' with regards to learner-learner talk while experiences are considered to be knowledge acquired through practical contact with a situation. As such, exploring pre-service teachers' experiences and perceptions of teaching with regards to learner-learner talk

may denote a starting point where reshaping of pre-service Physical Sciences teachers mental models may begin or how we can reinforce their internal mental models.

2.4. CHAPTER SUMMARY

In this study, learning is viewed as a social activity mediated though social interactions as proposed by Vygotsky in his sociocultural theory. Therefore, in this chapter, I have discussed the sociocultural theory of learning by Vygotsky (1978) from which this study is based on. I have also reviewed literature related to this study based on the following concepts: pre-service teachers' education, Physical Sciences, interactions, learner-learner-talk and experiences and perceptions. In the next chapter, I will discuss the methodology that was followed in order to conduct this study

CHAPTER THREE
RESEARCH METHODOLOGY

3.1. INTRODUCTION

The purpose of this study was to investigate pre-service Physical Sciences teachers' experiences and perceptions of the value of learners talking to their fellow learners in the classroom. In order to address the purpose of this study, this study sought to determine pre-service Physical Sciences teachers' experiences of learner-learner talk, how their experiences influence their perceptions of learner-learner talk as well as how their experiences and perceptions about learner-learner talk influence their teaching practice. As such, a case of four pre-service Physical Sciences teachers currently doing fourth year in a tertiary institute of education in Gauteng was studied. Therefore, the aim of this chapter is to outline the research design which details the procedure that was followed in addressing the purpose of the study. In the next section, I will discuss the paradigm that served as a guide in terms of how the collected data was interpreted in relation to the purpose of this study.

3.2. RESEARCH PARADIGM

According to Creswell (2003), a research paradigm refers to underlying assumptions that researchers have "about how they will learn and what they will learn during their inquiry" (p. 6). In this study, I adopted the interpretivism paradigm because it is based on the belief that people create meaning as they engage with others (Creswell, 2003). Thus, it concurs with this study's foregrounding theory, Vygotsky's socio-cultural theory, where learning is viewed as taking place through active interaction with other people. Hence Creswell (2003) argues that any research that has interpretivism as an underlying knowledge claim depends mostly on the views of the participants being studied and the cultural settings where participants live.

This study is consistent with this knowledge claim because I believe that people make meaning from their experiences and what they perceive is a reflection of the meanings they have constructed. Thus, this study was focusing on pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk. Pre-service Physical Sciences teachers may be implicitly tutored on group work but if their experiences of this type of social interaction have not been productive, they are unlikely to find its value and may not employ it in their teaching. Hence, I believed that if we can focus on their experiences of this type of social interaction and

also how they perceive it we can develop a deeper understanding and be able to predict whether they are likely to employ it in the classroom in future or not.

In that regard, interviewing pre-service Physical Sciences teachers and observing them in classrooms when teaching, provided this study with the insight it needs. Thus, this study adopted the qualitative research approach and used a case study design in order to develop a comprehensive understanding of these pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk.

3.3. RESEARCH APPROACH: QUALITATIVE

This study adopted a qualitative approach because it is an "interactive, face to face research, which requires relatively extensive amount of time to systematically observe, interview, and record processes as they occur naturally" (McMillan & Schumacher, 2010, p. 340). It also "provides an in-depth, intricate and detailed understanding of meanings, actions, non-observable as well as observable phenomena, attitudes, intentions and behaviours" (Cohen et al, 2011, p. 219). Furthermore, this research approach "probes issues that lie beneath the surface of presenting behaviours and actions" (Cohen et al, 2011, p. 219). Thus, it enabled me to understand the teaching practices of pre-service Physical Sciences teachers beyond the surface as to how do their perceptions and experiences influence the way they teach.

Merriam & Tisdell (2016) posit that this research approach is grounded on the belief that people create meanings by actively engaging in an interpretative process of experiences, phenomena and/or activities, as such, it is in parallel with the theoretical framework of this study as discussed in the previous chapter. Qualitative research approach is concerned with quality rather than quantity. Hence, it is utilised to interpret and understand people's actions, thoughts, beliefs and perceptions (Macmillan & Schumacher, 2010). Since this research approach involve analysing people's actions, beliefs, perceptions and thoughts, it enabled me to acquire a comprehensive understanding of pre-service Physical Sciences teachers' experiences and perceptions of the value of learners talking to their fellow learners in the classroom.

3.4. CASE STUDY

In order to know more about a phenomenon, one needs a research design. A research design "specifies a plan for generating the evidence that will be used to answer research questions" (McMillan and Schumacher, 2010, p.20). It also outlines the type of research to be undertaken in line with the adopted approach. In order to know more about pre-service Physical Sciences teachers' experiences and perceptions of the value of learner-learner talk in the classroom, a case study design was adopted. According to Merriam & Tisdell (2016, p. 37) "a case study is an in-depth description and analysis of a bounded system". Cohen, Manion, & Morrison (2011) argue that this research design can establish the cause and effect in real context of any phenomenon under study. Thus, it was suitable in understanding the experiences and perceptions of the value of learners talking to their fellow learners in the classrooms of the selected groups of pre-service Physical Sciences teachers' and how those experiences and perceptions influence their teaching practice, if at all.

3.5. SAMPLING PROCEDURE AND SAMPLE SIZE

Cohen, et al. (2007) postulates that probability and non-probability sampling are the only sampling methods that one can use to select a sample from the larger population. Probability sampling, as stated by Cohen, et al. (2007), is a sampling method that selects a sample randomly from the larger population with an aim of making generalizations. As a result, the sample becomes the representative of the wider population. Non-probability sampling, as stipulated by Cohen, et al. (2007), is a sampling method in which the sample is selected deliberately with an aim of targeting a particular group. With this sampling method, the sample may or may not represent the larger population. In this study, I used a non-probability sampling because this study followed a case study design, thus, targeting a group of four pre-service Physical Sciences teachers doing their fourth year of study when this study was conducted.

Non-probability sampling methods include convenience sampling as well as purposive sampling. Convenience sampling, according to Cohen et al. (2007), is a sampling method whereby "researchers simply choose the sample from those to whom they have easy access" (p. 114). Easy access could be thought of in terms of time, effort and finances. In this study, convenience sampling was used to select the sample. Hence, data for this study was collected in one of the schools of education in Gauteng which was selected due to easiness to recruit. The school of

education was convenient to recruit because it is where I am currently enrolled as a student and also employed as a laboratory demonstrator.

Purposive sampling, according to Creswell (2007), is a type of sampling method in which the sample of the study is selected based on the information that the participants can bring in understanding the central phenomenon and research problem of the study. This sampling method is deliberately subjective and bias in nature. However, it is useful in recruiting participants that are in possession of particular characteristics that may be useful in addressing the purpose of the study. In addition to the convenience sampling method, this study used purposive sampling because firstly, the study was targeting pre-service teachers that are specialising in the Physical Sciences subject since this is one of the subjects that learners are struggling with as outlined in the previous chapters. Secondly, the individuals specialising in the Physical Sciences subject had to be in their fourth year of study because at this year of study they would have had much exposure to different teaching strategies and have much teaching experience compared to other pre-service Physical Sciences teachers in different years of study.

The 2019 fourth year Physical Sciences class of pre-service teachers had a total of 41 students and only four out of these students were selected to participate in this study. Four participants were selected because teaching experience has a limited period, which is approximately 6 weeks, not sufficient for observing quite a number of research participants repeatedly and adequately. Furthermore, this was to allow the participants to choose days and times convenient for observations during teaching experience based on their own schedule without exerting pressure on them. The four research participants were chosen with an assistant of a fellow laboratory demonstrator coordinating the participants' laboratory, who suggested that they would be suitable for this study as they were one of the few groups in the laboratory who discussed a lot during practical sessions. These pre-service teachers' rich experiences and perceptions of learner-learner talk informed how this study could be extended to other subjects and also the kind of intervention that could take place in developing the concept of learner-learner talk in teachers. This means the results of this study cannot be generalized to the whole population of pre-service Physical Sciences teachers as they are specific to the targeted group. However, they may be relatable to entire population of fourth year pre-service Physical Sciences teachers at that particular school of education.

3.6. SUMMARY OF THE PARTICIPANTS

As I have mentioned above that the participants for this study were four pre-service Physical Sciences teachers that were doing their fourth year of study in Physical Sciences when this study was conducted. As part of guaranteeing anonymity, pseudonyms in place of the pre-service Physical Sciences teachers' real names have been used. The pseudonyms given to the four pre-service Physical Sciences teachers in this study are: Dlomo; Hlophe; Nkosi and Zuma. From here, the pre-service Physical Sciences teachers will be referred to using their pseudonyms. The following sections provide a detailed account of the techniques used to collect data for this study.

3.7. DATA COLLECTION TECHNIQUES

In order to respond to the three research questions and address the purpose of this study, individual interviews with the four pre-service Physical Sciences teachers as well as observations and audio recordings were carried out. In the next subsections, I will provide a detail account of how each technique was used to collect data for this study.

3.7.1. INTERVIEWS

An interview, as stated in Cohen et al. (2011), is an technique of collecting data that enables the interviewees to "discuss their interpretations of the world in which they live, and to express how they regard situations from their own point of view" (Cohen et al., 2011, p. 409). There are different types of interviews and this study adopted the standardized open-ended type of interview. This is because this type of interview, according to Cohen et al (2011), has fixed set of questions pre-determined and all interviewees are asked the same set of questions in the same sequence so that the interviewer may compare interviewees' responses. The interview schedule used for this study with pre-determined questions can be found in Appendix F. The interviews lasted for about 20 to 35 minutes, depending on the interviewee, and were held at an office in the selected school of education by me, the researcher, alone. These interviews were held individually with each pre-service Physical Sciences teacher to ensure confidentiality before heading for teaching experience. Furthermore, the interviews were audio-recorded for the purpose of accurately capturing the interviewees' responses.

3.7.2. OBSERVATIONS

Observation, according to Cohen et al. (2011), is a method of collecting data that allows the researcher to gather data from naturally occurring social situations. There are different types of observation including non-participant observer where the observer remains detached from the environment during observation (Cohen et al., 2011). I adopted this type of observation for this study because it enabled me to describe all the classroom interactions, particularly non-verbal interactions/behaviours, in each pre-service Physical Sciences teacher's lessons. Three observations of each pre-service Physical Sciences teachers' lessons during teaching experience were carried out using the observation schedule in Appendix H. The observations were carried out by me alone on days and times chosen by the pre-service Physical Sciences teachers.

3.7.3. AUDIO-RECORDING TEACHER LESSON TALK

While making observations of the whole class interactions, the talk between pre-service Physical Sciences teachers and their learners was audio-recorded. The aim of the audio-recordings was to capture pre-service Physical Sciences teachers' verbal interaction with their learners. The data yielded by these audio recordings was used along with the data obtained from observations to understand how these pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk influenced their teaching practice. To capture this verbal interaction, the pre-service Physical Sciences teachers were given audio-recorders to hold with one hand while teaching. They carried the audio-recorders around even when they moved to different locations within the classroom.

3.7.4. AUDIO-RECORDING LEARNER-LEARNER TALK

Apart from audio-recording the verbal interaction between the pre-service Physical Sciences teachers and their learners while observing the classroom interactions, the talk between learners as they work in small groups was also audio-recorded. These audio-recordings were used to determine the type of talk and quality of learner-learner talk prevalent in the classroom as facilitated by the pre-service Physical Sciences teachers. However, only one small group of learners per pre-service Physical Sciences teacher had their talk audio-recorded. I chose to audio-record one small group because the main focus of this study was on how pre-service Physical Sciences teachers facilitate learner-learner talk in their classrooms, not necessarily on the learners. However, to understand better the pre-service Physical Sciences teacher's contribution to each group of learners during the lesson, it was necessary to audio-record the learners' talk.

These groups were selected with the pre-service Physical Sciences teachers' assistance, from the consenting group of learners, and their interaction was followed throughout the observed lessons.

3.7.5. POST LESSON INTERVIEWS

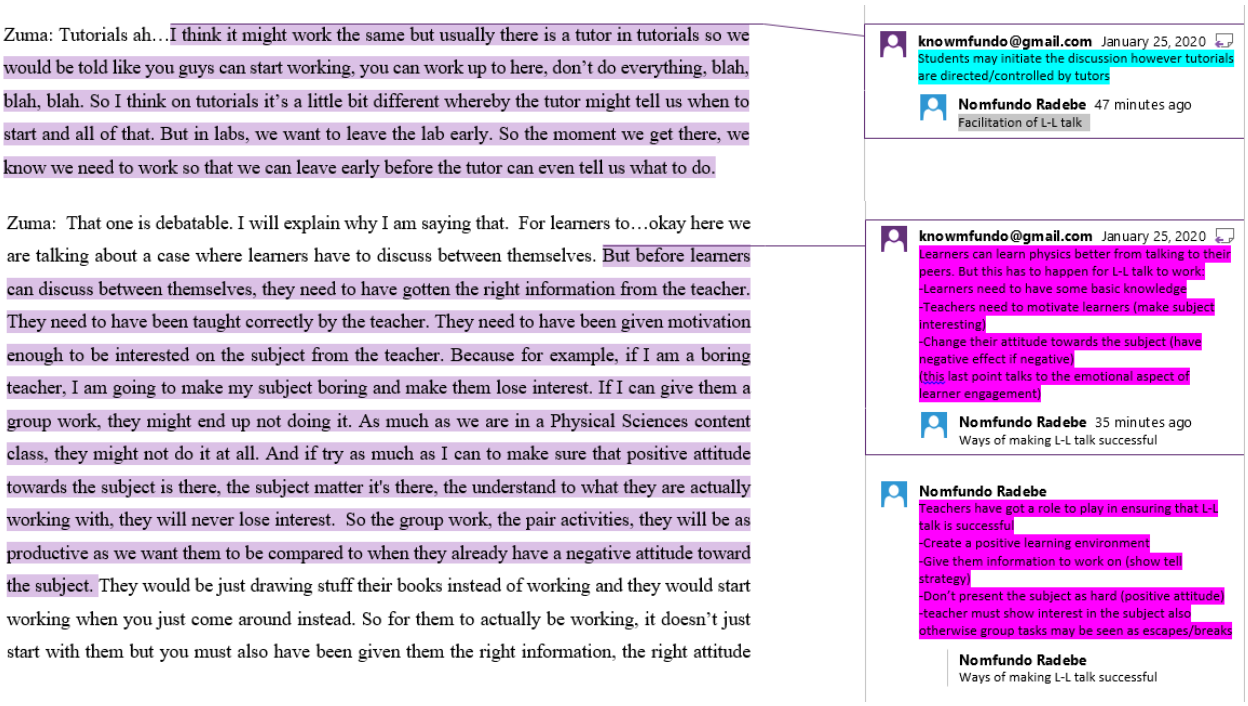
After each observed lesson, brief interviews were conducted with the pre-service Physical Sciences teachers based on the observations made. These interviews were used to clarifying some of the observations, such as understanding the purpose of the lesson and the nature of tasks given to learners. The questions were determined from the lesson events which seemed to be interesting or unclear from observations. In other words, there was no interview schedule prepared for these interviews as they were considered to be follow up on what transpired during the lesson. These interviews were brief, about 2 minutes long and were also audio-recorded. They were conducted in the pre-service teachers sitting area and we were excused by fellow pre-service teachers allocated at that school as they assumed that my visits were for assessment purposes *(my opinion here)*. Data from these interviews was used along with the data from observations.

3.8. DATA ANALYSIS

This section outlines how each of the data collected using the techniques above was prepared, organised and analysed.

3.8.1. INTERVIEWS

Data collected from the pre-service Physical Sciences teachers using the interview schedule which is in Appendix F was first transcribed before it could be analysed. From here, their responses to each question were read while making comments. The comments made on all pre-service Physical Sciences teachers' transcripts were compared. Comments showing views of pre-service Physical Sciences teachers were identified and coded with a purple colour and those showing knowledge acquired through physical contact were also identified and coded with a blue colour forming two groups of comments. The comments in each group were compared to identify similarities and differences. Thereafter, meaning from the identified similar comments was sought and categories emerged. Photograph A illustrate the process undertaken to analyse the data from interviews.



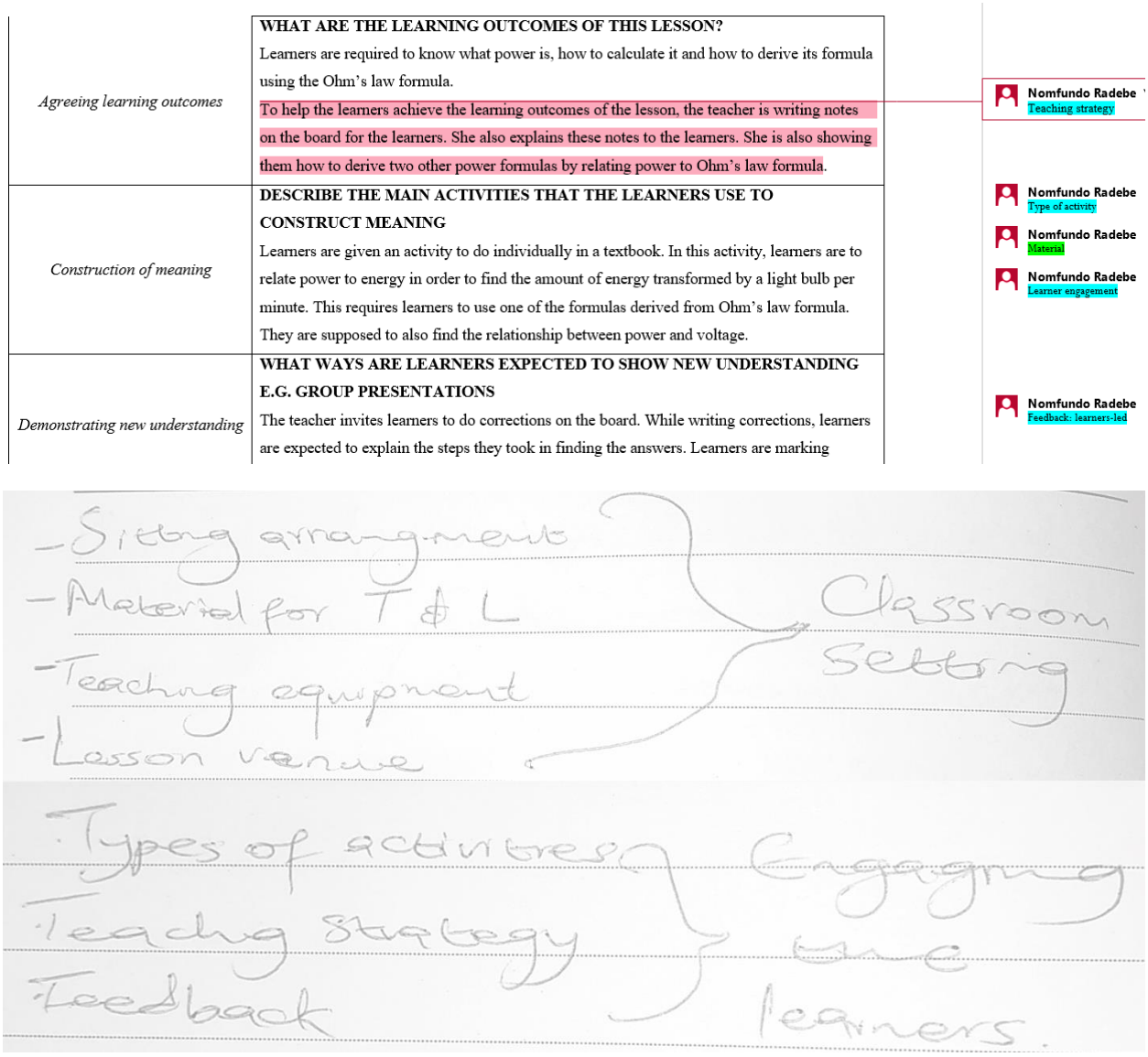
Photograph A: Analysis of interviews data

From here, meanings identified under experiences were compared with those of perceptions to determine how experiences may have influenced these pre-service Physical Sciences teachers' perceptions of learner-learner talk thereby answering the second research question of this study.

3.8.2. OBSERVATIONS

The observation schedule was adapted from Scott (1987) framework and used to collect and organise observations. The framework consists of five elements. The first element, *preparation for learning*, provides a description of the physical environment and the preparations made by the teacher to ensure effective learning conditions. The second element, *agreeing learning outcomes*, provides a description of the ways in which the teacher helps the learners achieve the learning outcomes of the lesson. The third element, *construction of meaning*, provides a description of the main activities that learners use to construct meaning. The fourth element, *demonstrating new understanding*, describes ways in which learners show their new understanding e.g. group presentations. The last element, *reviewing new learning*, involves learners reflecting on their learning.

After this set of data was collected and organised using the above mentioned framework by Scott (1987), I read the observations of each pre-service Physical Sciences teacher per lesson and made comments. The next step was to make sense of the comments made on the observations of all pre-services Physical Sciences teachers. To do this, I identified key issues addressed by each comment. The emerging key issues were then grouped together according to similarity, refined and then colour coded. Photograph B show how the data from observations was analysed.



Agreeing learning outcomes	**WHAT ARE THE LEARNING OUTCOMES OF THIS LESSON?** Learners are required to know what power is, how to calculate it and how to derive its formula using the Ohm's law formula. To help the learners achieve the learning outcomes of the lesson, the teacher is writing notes on the board for the learners. She also explains these notes to the learners. She is also showing them how to derive two other power formulas by relating power to Ohm's law formula.
Construction of meaning	**DESCRIBE THE MAIN ACTIVITIES THAT THE LEARNERS USE TO CONSTRUCT MEANING** Learners are given an activity to do individually in a textbook. In this activity, learners are to relate power to energy in order to find the amount of energy transformed by a light bulb per minute. This requires learners to use one of the formulas derived from Ohm's law formula. They are supposed to also find the relationship between power and voltage.
Demonstrating new understanding	**WHAT WAYS ARE LEARNERS EXPECTED TO SHOW NEW UNDERSTANDING E.G. GROUP PRESENTATIONS** The teacher invites learners to do corrections on the board. While writing corrections, learners are expected to explain the steps they took in finding the answers. Learners are marking

Photograph B: Organization and analysis of observation data

This analysis process was useful in providing context necessary to understand the verbal interaction audio-recorded between pre-service Physical Sciences teachers and their learners as well as between the learners only.

3.8.3. AUDIO-RECORDING TEACHER LESSON TALK

This set of data was first transcribed before it could be analysed. From the transcribed data, I identified episodes and used them to categorise this data. According to Creswell (2018), episodes are moments where learners are solving a problem or engaging with a particular concept. In this set of data episodes were considered to be instances where two or more elements of each communicative approach, as identified by Scott and Mortimer (2003), were observed. Table 2 below shows characteristics of the four different communicative approaches as used to identify episodes from the transcribed data.

Table 2: Characteristics of each communicative approach (adapted from Scott & Mortimer, 2003; Scott, 2008)

Interactive/dialogic	**Non-interactive/dialogic**
The teacher and learners consider a range of ideas The teacher invites learners to state their point of views The teacher may request a learner to provide more details of their view The teacher may ask other learners whether they agree or disagree with the proposed ideas	The teacher, alone, reviews different points of views including those raised by the learners
Interactive/authoritative	**Non-interactive/authoritative**
The teacher focusses on one specific point of view and leads students through a question and answer routine with the aim of establishing and consolidating that point of view This can be compared to closed questions where one right answer exists in an Initiate-Response-Evaluation pattern (Sinclair & Coulthard, 1975). Learners are involved in the lesson and may ask questions but only point is pursued.	The teacher presents a specific point of view This is comparable with a formal lecture where the students or pupils are listening and not involved in classroom talk.

Below is excerpt A from Appendix K illustrating how this set of data was analysed as described above:

Nkosi: …what is an EMF? Learner A? You don't know what's an EMF? You did circuits but you don't know what EMF is. Learner C?

Learner C: Electromagnetic force

Nkosi: EMF?

Learner C: It's an electromagnetic force

Nkosi: EMF is the total voltage of the battery. Do you understand? It's the total voltage of the battery…

This excerpt represents an episode identified to be representing an interactive/authoritative communicative approach. This episode was identified as being interactive/authoritative because the teacher uses a closed question to initiate a discussion with the learners. Learner C, gives a response which is not the one required by the teacher hence he gives a new definition of what an EMF is. In this sense, this episode uses the Initiate-Response-Evaluate/Feedback mechanism commonly used in interactive/authoritative communicative approach according to Scott (2008).

This manner of analysis was used for all this set of transcribed data. After all data was categorised into episodes representing different communicative approaches, the frequency of each episode was determined to identify the type of communicative approach prevalent in each pre-service Physical Sciences teacher's lessons and across all four pre-service Physical Sciences teachers' lessons.

From the identified categories of frequency of communicative approaches, the quality of interaction engaged in by each pre-service Physical Sciences teacher and by all four pre-service Physical Sciences teachers was determined. In this study, the authoritative communicative approaches represent low quality interaction as only one perspective is pursued (Scott, 2008). The dialogic communicative approaches, on the other hand, represent high quality interaction as multiple perspectives are pursued (Scott, 2008). This analysis enabled me to compare their perceptions and experiences of the value of learners talking to their fellow learners in the classroom against their teaching practices during teaching experience as Cohen et al (2011) stated that what they say may actually differ from what they do. In the end, this analysis enabled me to understand how pre-service Physical Sciences teachers' experiences and perceptions of learners talking to their fellow learners influence their teaching practice.

3.8.4. AUDIO-RECORDING LEARNER-LEARNER TALK

Similar to data from audio-recording teacher lesson talk, data collected from audio-recording learner-learner talk was transcribed and episodes were identified to categorise this data. However, in this set of data episodes were considered to be instances where two or more elements of each talk type, as identified by Mercer (2008), are observed. Table 3 below shows characteristics of each talk type as used to identify episodes from the transcribed data.

Table 3: Characteristics of each talk type (adapted from Mercer, 2008)

Disputational talk	There is a lot of disagreement and everyone just makes their own decisions. There are few attempts to pool resources, or to offer constructive criticism. There are often a lot of interactions of the 'Yes it is! - No it's not!' kind. The atmosphere is competitive rather than co-operative.
Cumulative talk	Everyone simply accepts and agrees with what other people say. Children do use talk to share knowledge, but they do so in an uncritical way. Children repeat and elaborate each other's ideas, but they don't evaluate them carefully
Exploratory talk	Everyone listens actively People ask questions People share relevant information Ideas may be challenged Reasons are given for challenges Contributions build on what has gone before Everyone is encouraged to contribute Ideas and opinions treated with respect There is an atmosphere of trust There is a sense of shared purpose The group seeks agreement for joint decisions

Below is excerpt B from Appendix L illustrating how data from pre-service Physical Sciences teachers' learners was analysed:

Learner B: Power its work done over what?

Learner D: Time

Learner B: What is our power?

Learner D: Its 100

Learner C: We have power and voltage, we are looking for resistance, its cross multiplication.

Learner A: We don't have I, V won't allow us to do what you guys are saying

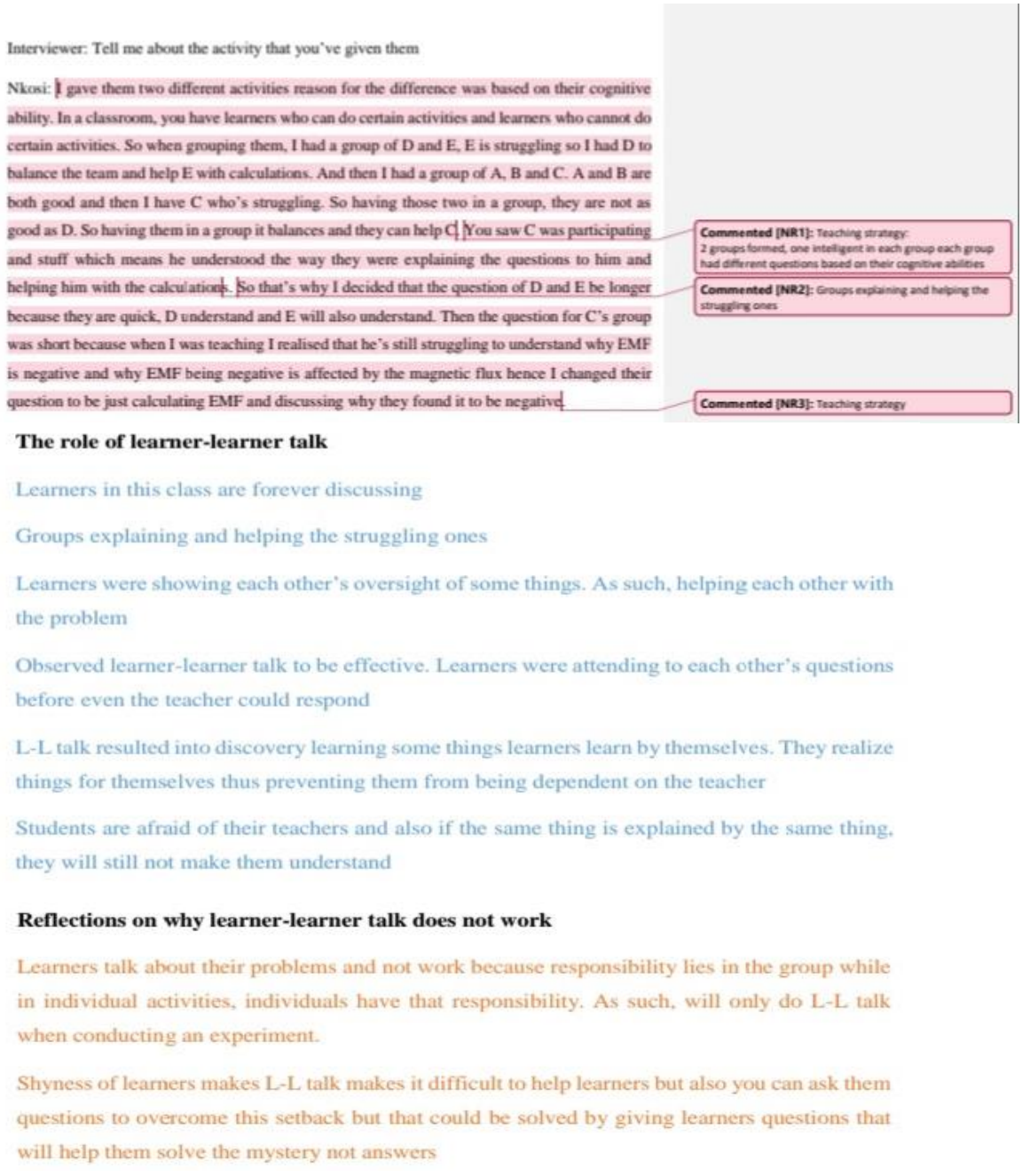
Learner B: What are we saying? We don't have I.

Excerpt B above represents an exploratory talk episode from one of the pre-service Physical Sciences teachers' learners, Hlophe, during her first lesson observation. From this episode, learners are sharing relevant information, such as data required to solve the given problem, equations and methods that can be used to solve the problem. However, learner A challenges the proposed method of solving the problem and state the reason why such a method cannot be used, that the proposed method needs I (current) and they do not have it. After all data from pre-service Physical Sciences teachers' learners was categorised in this manner, into episodes representing types of talk, the frequency of each episode was determined.

All the transcripts from set of data were analysed in this manner. Thereafter, the frequency of each talk type from the identified episodes was counted to determine the type of talk prevalent during learner-learner talk in each pre-service Physical Sciences teacher's lessons and across all four pre-service Physical Sciences teachers' lessons. From the identified categories of frequency of talk types, the quality of talk engaged in by learners in each pre-service Physical Sciences teacher and across all four pre-service Physical Sciences teachers was determined. In this study, disputational talk represents low quality talk as it is deemed least effective in problem solving by Mercer (1995). Exploratory talk, on the other hand, represents high quality talk as it is deemed by Mercer (1995) as most effective in problem solving. This analysis supplemented the analysis of pre-service Physical Sciences teachers teaching and gave me a better insight into understanding how pre-service Physical Sciences teachers' experiences and perceptions of learners talking to their fellow learners influence their teaching practice.

3.8.5. POST LESSON INTERVIEWS

This set of data was first transcribed before it could be analysed. Thereafter, the transcripts for each pre-service teacher were read and comments were made. These comments were combined together and grouped according to similarities. From here, meaning of each group of comment was sought. The process is shown in photograph C below.



Photograph C: Organising and analysing post lesson interviews

After this, the meaning of these comments was read and merged with the findings from observations data. Merging these two sets of data was beneficial in understanding how the pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk influence their teaching practice.

3.7. RELIABILITY AND VALIDITY

In this study, observations and structured interviews were used to collect data that assisted in addressing the purpose of this study. Cohen et al. (2007), outlined that instruments used to collect data have to be examined to strengthen the reliability and validity of the research findings. Reliability, according to Cohen et al. (2007), refers to the extent in which different researchers could obtain the same results when using the same research instrument under the same conditions. One of the factors that normally affect reliability during observations is that the research participants tend to behave in a different way that is either going to bring light or withhold certain information unto the study. In order to ensure reliability when making observations for this study, I spent some time with the research participants in their classrooms during teaching experience before beginning to collect data. This helped the participants to get used to my presence and that also allayed their fears. In addition, three observations per pre-service Physical Sciences teacher were carried out, with an exception of one pre-service Physical Sciences teacher where only two observations were carried out.

According to Brink (1993), validity is about examining the contents of a research instrument if they measure what they are intended to measure. In qualitative research, Cohen et al (2007) posit that validity involves the notion of truth, a description of what actually happened. To ensure validity in this study, all contents of the research instruments were cross-checked by my supervisors to ensure that they are appropriate. Also, the collected data was transcribed in a manner that denotes the perspectives of the participants.

Another factor that threatens to temper with the validity of this study during interviews is honesty from the research participants. During interviews, participants normally feel the need to please the interviewer by responding in a way that they believe they are expected to. As a result, they may withhold or alter certain information. To eliminate this threat and ensure validity, I spent time explaining to the research participants the nature of this study, in terms of its purpose,

how data was to be collected, analysed and used. This ensured that the research participants understood the nature of this study, thus, they did not feel the need to be dishonest.

3.8. ETHICAL CONSIDERATION

I requested permission from the deputy registrar of the university, the head of the school and the head of the division to conduct the study in the selected school of education. As this study uses human beings as participants, permission to conduct the study was requested from the ethics committee of the University of the Witwatersrand. I also requested permission from the Gauteng department of education as I was following this study's participants in their respective Physical Sciences classrooms during teaching experience in order to answer the third research question of this study. Furthermore, I requested permission from the schools' principals where this study's participants were allocated during teaching experience.

Consent to participate in the study was requested from the pre-service Physical Sciences teachers by kindly inviting them to participate and clearly outlining the purpose and procedure of this study. I also explained to them that participation was voluntarily and they could withdraw their consent to participate in the study at any time and that will not yield negative consequences. As I was also going to observe the pre-service Physical Sciences teachers in their respective classrooms during teaching experience, the learners they were going to teach became participants. As such, I also requested their consent as well as their parents' consent to participate in the study as they are minors. All consents to participants in this study were written down and the pre-service teachers, the learners and their parents had to sign that they give me permission. The signed consent forms were kept safe and they served as proof of consent given in the study.

As the research participants were interviewed individually, confidentiallity was gauranted. As such, participants were assured that all the data collected for this study was to be used only for the purposes of this study and will not be shared with anyone else except my supervisors. I informed them that the collected data will be kept on password protected computers at the University of the Witwatersrand, and my supervisors and I will be the only individuals with access to view it. In addition, the participants were informed that the collected data will be destroyed after three years upon completion of the study. The participants were also informed

that pseudonyms in place of their names will be used and any features that may results in their identity being revealed will not be used in the study to ensure anonymity. The same confidentiality was also placed on audio-recordings of the learners which were captured during teaching practice and this was also explained to the learners and their parents on the consent forms.

Risks associated with this study for pre-service Physical Sceinces teachers were low and psychological and included the participants feeling anxious to be interviewed, observed and audio-recorded when teaching. They may also feel inconvenienced as they will have to invest their time in working with me. To mitigate these risks, I tried to allay their fears by assuring them and ensuring that I do not interfere in their teaching in any way and remaining inconspicuous during the lessons. I also spent some time with them during teaching experience so that they can get used to my presence before collecting data. Furthermore, they were given the option to decide on the days and times they wished to be observed. The consent forms had the protocol number incase they wanted to verify that the project was indeed genuine and it had the permission of all relevant authorities.

Risks associated with this study for learners to be taught by the pre-service Physical Sciences teachers during teaching experience were also low and psychological and included learners being disturbed by my presence, as a stranger, in their classroom and feeling anxious about being audio-recorded. To mitigate this risk, I arrived before the lessons began and remained conspicuous. I also spent some time with them during teaching experience so that they could get used to my presence before collecting data. Furthermore, I allayed their fears by informing them that anything that they may say during the audio-recordings will be kept confidential and I will only focus on all the task-related talks and ignore anything else that will not be related to the task. The consent forms had the protocol number from the department of education incase their parents wanted to verify that the project was indeed genuine and it had the prmission of all relevant authorities.

3.11. CHAPTER SUMMARY

This chapter has provided a detailed discussion and reasons for selecting the interpretivist paradigm guiding this study, qualitative research approach and case study design. It has also provided reasons for selecting the standardized open-ended type of interview and observations which include audio-recording pre-service Physical Sciences teachers and their learners' talk. This chapter has also provided an explanation of how data was collected and analysed to answer the three research questions and address the purpose of this study. Furthermore, this chapter explained how reliability and validity was ensured as well as how ethical issues necessary for this study were addressed.

CHAPTER FOUR
RESEARCH FINDINGS

4.1. INTRODUCTION

This study aimed to investigate pre-service Physical Sciences teachers' experiences and perceptions of the value of learners talking to their fellow learners in the classroom. In order to address the purpose of this study, the following research questions needed to be answered:

1. What are pre-service Physical Sciences teachers' experiences of learner-learner talk?
2. How do pre-service Physical Sciences teachers' experiences influence their perceptions of learner-learner talk?
3. How do pre-service Physical Sciences teachers' experiences and perceptions about learner-learner talk influence their teaching practice?

The learning view proposed in the socio-cultural theory by Vygotsky (1978) that meaning or knowledge is constructed whenever one interacts with others informed this study. This is because learner-learner talk is also a social interaction taking place between learners from which the roles of the learners shift from being a more knowledgeable other to a less knowledgeable other and vice versa during the interaction. Due to the significance of this type of social interaction in learning, it is essential that the pre-service Physical Sciences teachers' experiences and perceptions of this type of social interaction be known as they may provide a starting point from which the issue of poor performance in Physical Sciences, known to be partly caused by the use of traditional teaching methods, can be remedied. As such, this chapter presents findings on pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk.

4.2. SUMMARY OF THE OBSERVED LESSONS

The following sections provides a detailed description of the schools the pre-service Physical Sciences teachers were allocated to as well as the topics and Grade of learners they taught during observations.

4.2.1. SCHOOLS DESCRIPTIONS

All four pre-service Physical Sciences teachers were allocated in different schools for teaching experience. These schools were of different type with varying number of learners. Furthermore, they were teaching different Grades. Table 4 provides a description of the schools.

Table 4: Description of the schools the pre-service Physical Sciences teachers were allocated to

Pre-service Physical Sciences Teachers	School type	Total number of learners	Total number of learners consented	Grade Taught
Dlomo	Public	41	33	10
Hlophe	Public	29	26	11
Nkosi	Independent	5	5	11
Zuma	Independent	30	17	11

The table shows that two pre-service Physical Sciences teachers, Nkosi and Zuma, were placed in independent schools while the other two, Dlomo and Hlophe, were in public schools. In their respective schools, Hlophe; Nkosi and Zuma, were teaching Grade 11 while Dlomo, was teaching Grade 10. The table also shows that about 81% of the learners consented to participate in the study in Dlomo's class. The other percentage include learners who did not bring back the consent forms, learners who did not consent to participate in the study and also learners who consented to being observed but not to being audio-recorded. In Hlophe's class, about 90% of the learners consented to participate in the study. The table shows that all learners from Nkosi's class consented to participate in the study. On the other hand, only 57% of the learners in Zuma's class did consent to participate in the study. This was mainly because the other learners did not bring back the consent forms. In cases where they did bring back the consent forms and consented to participate in the study, their parents' consent forms were missing.

4.2.2. TOPICS TAUGHT

The following table shows the topics taught by each pre-service Physical Sciences teacher per observation. The days and times of observations were decided by the pre-service Physical Sciences teachers and this was done so to reduce the inconvenience of having to spend time working with me. This was to also ensure that they do not end up seeing my visits for observation as being similar to teaching assessment visits. What they would be teaching on the

selected observation day was determined by the CAPS document and what they have done already with the learners. Lastly, the pre-service Physical Sciences teachers were teaching one class of learners for Physical Sciences. In a case of Hlophe, Zuma and Nkosi this was because the schools they were placed at had one Grade 11 Physical Sciences class. In a case of Dlomo, there were two Grade 10 Physical Sciences classes, however he was teaching only one class and the other was given to his fellow pre-service teacher.

Table 5: Topics taught per lesson observed

	Lesson one	Date of observation	Lesson two	Date of observation	Lesson three	Date of observation
Dlomo	Introduction to vectors and scalars	7-Aug-19	Vectors: Finding resultant vector graphically	15-Aug-19	Motion in one dimension	22-Aug-19
Hlophe	Electric circuits: Power	7-Aug-19	Exothermic and endothermic reactions	15-Aug-19	Exothermic and endothermic reactions (Practical)	22-Aug-19
Nkosi	Faraday's law of induction	16-Aug-19	Electric circuits	26-Aug-19		
Zuma	Electric circuits: Power	5-Aug-19	Redox rections	28-Aug-19	Redox reactions	29-Aug-19

The table above shows that three pre-service Physical Sciences teachers were observed three times while one pre-service Physical Sciences teacher, Nkosi, was observed twice. This was because the school Nkosi was allocated at was having many activities which most of the time clashed with the observation times/days. Also, the table shows that the last two lessons for Zuma were observed in a contiguous period. This was mainly because after the first observation, he was swapped with his fellow student and taken to teach Grade 10 which he was uncomfortable being observed and audio-recorded with partly because it was a huge class as compared to the Grade 11 class. As such, I had to wait for him to come back to his Grade 11 class, which he did during the last two days of teaching experience.

4.2.3. A DESCRIPTION OF DLOMO'S LESSONS

During the first observation, table 5 shows that Dlomo was introducing his learners to scalars and vectors where he taught them what scalar and vector quantities are, the difference between the two quantities and how to graphically represent vector quantities. During the second observation, he taught them how to add and subtract vectors and how to find a resultant vector graphically

using the tail-to-head method. In the third observation, he was teaching motion in one dimension and he taught learners about the concept of a frame of reference; position relative to a reference point; distance as a scalar quantity and displacement as a vector quantity and illustrated the difference between displacement and distance; and how to determine the distance and displacement in one dimensional motion.

4.2.4. A DESCRIPTION OF HLOPE'S LESSONS

Table 5 above also shows that Hlophe, during her first observation was teaching the concept of power in electric circuits where she taught learners what power is in electric circuits, how power is related to current, resistance and voltage and how to determine the cost of electricity usage given the power specifications of the appliances used. In the second observation, she was teaching exothermic and endothermic reactions. In this topic, she showed learners graphs of exothermic and endothermic reactions and taught them what these reactions are and what the value of a change in enthalpy in these reactions is. The last observation was a practical session where learners were investigating exothermic and endothermic reactions. To conduct this investigation, they formed solutions by reacting five different chemicals with water and measured the temperature of the water and of the solutions. The difference in the temperature before and water temperature after the chemicals were added was used to classify each reaction as either endothermic or exothermic. During this session, learners were working in small groups which they selected for themselves.

4.2.5. A DESCRIPTION OF NKOSI'S LESSONS

For Nkosi, table 5 above shows that he was teaching Faraday's law of induction during the first observation. In this topic, he taught learners what Faraday's law of induction state, the relationship between magnetic flux and magnetic field and how to calculate the induced EMF and induced current. In the second observation, the table above, table 5, shows that he was teaching electric circuits. In this lesson, he taught learners what happens to current, voltage and resistance in series and parallel circuits and how to solve conceptual problems involving a combination of these circuits.

4.2.6. A DESCRIPTION OF ZUMA'S LESSONS

Similar to Hlophe, the table above, table 5, shows that Zuma was teaching the concept of power in electric circuits during his first observation. However, Zuma had a demonstration to teach this

topic while Hlophe did not have any representations to teach this topic. During the second observation, Zuma was introducing learners to redox reactions. In this lesson, Zuma taught learners how to determine oxidation numbers from the elements valence numbers; describe and identify oxidation-reduction reactions by identifying oxidising and reducing agents and how to balance redox reaction equations. During the third observation, he continued teaching learners how to balance redox reaction equations and how to write the overall redox reaction equations by combining oxidation-reduction half reactions.

4.3. FINDINGS

In this section of this chapter, I will present my findings in the manner that will provide answers to each of the research questions of this study after having coded and analysed the collected data. The findings from the collected data are presented below according to this study's research questions. The following findings addresses the first research question outlined above.

4.3.1. What are pre-service Physical Sciences teachers' experiences of learner-learner talk?

In order to address this research question, data was collected using an interview schedule (see Appendix F). This data set was analysed using the process outlined in section 3.8.1 in the previous chapter from which three categories about pre-service Physical Sciences teachers experiences emerged. These categories are used as subheadings and can be seen below. The first category reveals opportunities given to pre-service Physical Sciences teachers to talk with their peers. The second category reveals how this talk with their peers was facilitated. The last category show the effects of learner-learner talk in the learning process as experienced by the pre-service Physical Sciences teachers. I will now present findings of each category.

Opportunities of learner-learner talk

The analysed data reveal that the pre-service Physical Sciences teachers are given an opportunity to talk with their peers during practical sessions, tutorial sessions and lectures. However, the opportunities granted in each of these sessions vary. The data show that they talk more with their peers during practical sessions followed by tutorial sessions and lectures respectively. The reason

for these varied opportunities are due to the control exercised by the lecturer/tutor which will be discussed in detail in the next subheading/category.

During practical sessions, the pre-service Physical Sciences teachers normally talk about the resources they would use for the experiment, the procedure they will be following in conducting the experiment, the requirements of the experiment, obtained results and how they would use the experiment for teaching and learning purposes. These talks are guided by what is given on the practical manual as well as the data obtained from the practical.

In tutorial sessions, the pre-service Physical Sciences teachers are normally given questions prior to the tutorial session to attempt at home and then come up with questions they found challenging to do together along with their laboratory demonstrator during the tutorial sessions. Therefore, the talk between pre-service Physical Sciences teachers during tutorial sessions is based on the questions that they raised as challenging.

During lectures, pre-service Physical Sciences teachers are hardly given an opportunity to talk to their peers. As such, they normally hold discussions amongst themselves without the knowledge of the lecturer. Whenever the opportunity to talk with peers is granted, the talk is normally based on a question/quiz posted by the lecturer. Other than that, such opportunities for discussions are opened up if they say they do not understand something. However, if they do understand everything that has been said, the lecturer proceeds with the lecture. As a result, pre-service Physical Sciences teachers find lectures to be about passing content across not necessarily about engaging them with the content.

Facilitation of learner-learner talk

The data shows that the pre-service Physical Sciences teachers initiate and lead the discussions with their peers. At times, the discussions amongst the pre-service Physical Sciences teachers may be guided by the laboratory demonstrator and/or lecturer because they move around during practical sessions, checking their progress with the practical or sit in for their discussions and also intervene whenever they see that they are confused or need assistance.

As mentioned above that talk during tutorial sessions is based on what the pre-service Physical Sciences teachers raised as questions they found challenging. As such, the laboratory demonstrator initiates and guides the discussions between the pre-service Physical Sciences teachers. This is often done by asking questions that will lead into the method one used to find a

solution to an answer being questioned. At times, a demonstration is used to guide the discussions.

During lectures, discussions between pre-service Physical Sciences teachers are guided by questions asked or information provided by the lecturer. The data shows that whenever lecturers give pre-service Physical Sciences teachers the opportunity to talk with their peers, they only take feedback from one pre-service Physical Sciences teacher/pair. The feedback from the rest of the peers/groups in the lecture is not sought.

Effects of learner-learner talk in the learning process

The data reveals that these four pre-service Physical Sciences teachers have had a positive experience of verbally interacting with their peers. Talking with peers has played a positive role in their understanding of Physical Sciences concepts. This is attributed to peers using a simpler language and also code-switching during talk enabling them to understand. In addition, peers uses simpler methods when modelling how a conceptual problem could be solved making it easy to follow and understand the concept being studied unlike lecturers who uses abstract methods making it difficult for them to follow.

When talking to peers, the data shows that the pre-service Physical Sciences teachers' participation in content related activities improved. This is because when these teachers talk with their peers, their confidence in the subject in general and topic in particular is maximised since they get to understand the knowledge offered in the subject better. As a result, they start taking part in activities related to the subject, asking questions and also making contributions to posted conceptual problems when necessary.

Also revealed by the data is that the four pre-service Physical Sciences teachers found talking with their peers really helpful in promoting motivation about their academic work and the subject. This is because as much as talk is about helping each other understand the content, it also creates a healthy competition amongst the pre-service Physical Sciences teachers. This competition is healthy because when the pre-service Physical Sciences teachers engage in talk, they also challenge each other's understanding, thereby encouraging each other to go and study and put more effort into their studies.

The data also shows that through talk with peers, the pre-service Physical Sciences teachers' negative attitude about Physical Sciences changed into a positive attitude. Their attitude has

changed from considering this subject as being difficult and undoable to thinking positively about it as being doable. This is because they get encouraged when they see their peers managing to understand and solve conceptual problems posted by the lecturers as well as performing well in the subject. Thus they assimilate the same attitude, changing theirs from negative to positive attitude.

Lastly, the data shows that the pre-service Physical Sciences teachers are noticing an improvement in their academic performance due to increased verbal interaction with their peers. It is revealed that during early years of study in pursuit of the teaching degree, they were working as individuals and their marks in the subject were low. Due to increased interaction with peers during practical and tutorial sessions, they have been able to manage the demands of the teaching degree and also their marks in the subject have improved.

4.3.2. How do pre-service Physical Sciences teachers' experiences influence their perceptions of learner-learner talk?

In the previous question, I have presented findings of pre-service Physical Sciences teachers' experiences of learner-learner talk. In this question, I will present the findings regarding the pre-service Physical Sciences teachers' perceptions of learner-learner talk. When analysing the data collected using the interview schedule in Appendix F, three categories regarding perceptions emerged and are used as subheadings below.

Benefits of learner-learner talk

The data collected by interviewing the four pre-service Physical Sciences teachers show that they think allowing learners to talk with their peers will enable them to learn Physical Sciences, meaning that their understanding of Physical Sciences concepts can be improved. This is because when learners talk to their peers they explain things in a way that is easy to follow. They also use a simple language that each member in a group understands. As such, their understanding of the concepts is enriched.

The pre-service Physical Sciences teachers think that when learners engage with their peers, they discover their strengths. This strength includes knowing that they can discover things by themselves without being informed by the teacher. This may change the attitude of the learners about this subject. Furthermore, observing their peers having a better understanding of the content covered by this subject may encourage them to change their attitude towards it. As such,

these pre-service Physical Sciences teachers think that learner-learner talk may change learners' attitude about Physical Sciences from negative to positive.

Also revealed by the data is that the pre-service Physical Sciences teachers think that providing learners with an opportunity to talk with their peers may motivate them about their school work. This is because observing their peers having a better understanding of the content covered in Physical Sciences will not only encourage them to change their attitude towards it. It will also motivate them to put effort in their studies, thereby attaining the same knowledge level as their peers thus maximising their participation in the classroom.

All four pre-service Physical Sciences teachers think that when learners engage with their peers, they help each other with the content of the subject being talked about. That is, they help each other understand the content of the subject, address any possible misunderstandings and also assist one another in solving conceptual problems. This interaction between the learners results into all learners involved benefitting, meaning that the one who is explaining obtains a better understanding of content he/she is explaining, likewise for the ones listening. This, in turn, improves the academic performance of the learners.

Drawbacks of learner-learner talk

While the experience of the pre-service Physical Sciences teachers with regards to learner-learner talk has been positive, they have pointed out drawbacks of this type of talk. The first drawback identified was that while learner-learner talk may have changed their negative attitude about Physical Sciences, it may also change one's attitude from positive to negative. As such, attention needs to be paid when learners are given the opportunity to verbally interact with their peers.

Although pre-service Physical Sciences teachers' motivation about the subject has been promoted through talking with peers, the data revealed that talking with peers may also demotivate peers. This is because it is found to be discouraging to see a fellow pre-service Physical Sciences teacher normally engaged with during learner-learner talk not performing well, particularly the one who is known to be more knowledgeable about the subject. As such, fellow pre-service Physical Sciences may be demotivated as they seem to look up to that individual for motivation.

The data shows that the pre-service Physical Sciences teachers think that learner-learner talk will not work all the time. This is because they think that not all concepts are ideal for learner-learner talk. However, they did not reveal nor give examples of concepts they think are not ideal for learner-learner talk with an exception of one pre-service Physical Sciences teacher, Hlophe. Hlophe thinks that concepts in the Chemistry component, not Physics, are ideal for learner-learner talk. This is because she believes that Chemistry concepts are abstract while the Physics component is based on things that may be observed in everyday life.

In addition, learner-learner talk will not always work because even though learners may be in groups, they may not necessarily be talking about the content. This then results into noise being sparked resulting into all efforts made in managing the classroom ineffective. Hence, some pre-service Physical Sciences teachers have preferences as so when can learners talk with their peers. For example, Hlophe prefers to give learners the opportunity to talk during practical sessions only rather than when she is teaching.

Ways of making learner-learner talk successful

During the interview, pre-service Physical Sciences teachers were asked if they would encourage learners to talk in their classrooms. Their responses to this question are tabled below.

Table 6: Pre-service Physical Sciences teachers' responses to encouraging learner-learner talk when teaching

	In your classroom, would you encourage learners to talk amongst themselves?	Give examples of concepts that may need learners to discuss	Physical Sciences component
Dlomo	Yes	Kinematics	Physics
Hlophe	Yes	Chemical change	Chemistry
Nkosi	Yes	Doppler effect	Physics
Zuma	Yes	Organic chemistry	Chemistry

The table above shows that all four pre-service Physical Sciences teachers would encourage learners to talk to their peers in their classroom. They also gave out examples of concepts that they think are ideal for learner-learner talk. Two of the pre-service Physical Sciences choose concepts from the Physics component while the other two chose concepts from the Chemistry component. Their choices to selecting these concepts from the selected Physical Sciences components remain unknown. However, as already pointed out above, the pre-service Physical

Sciences teachers are aware that learner-learner talk will not always be as effective as they want it to be. As such, insights showing how it could be made effective have been proposed and identified from the data.

The first insight identified has to do with the attitude of the teacher towards the subject. It is found that if the teacher possesses negative attitude towards the subject, this negativity may be 'brushed off' (*term used by the pre-services Physical Sciences teachers*) to the learners. As such, the learners may even lose interest in the subject. Therefore, teachers need to show a positive attitude towards the subject and that positivity will be 'brushed off' to the learners.

The second insight identified pointed to the role played by teachers' motivation towards the subject. It is found that the motivation of the teacher about the subject or topic may influence the learners they teach. This is because if they are motivated, they will present/teach the topic well such that it elicit interest in the learners. This then results into the learners being motivated to know more about the topic and subject and put more effort into it, consequently improving their performance.

Since it is already revealed that during learner-learner talk, learners may talk about things not related to the content, these teachers propose that these talks between learners needs to be monitored and the groups/peers need to be structured carefully. Monitoring the discussions means moving around the classroom to check whether the learners are making progress and talking about the relevant content. It also means listening to their talk and addressing any surfacing misconceptions or misunderstandings. Lastly, it means guiding their talk by asking them questions that will probe their understanding and direct them to the answers but not necessarily give them the answers.

In terms of structuring the groups, the teachers proposed that learners who are performing well on the subject be paired or placed in the same group with learners who are not performing well. In this case, the learner who is performing well is considered to be more knowledgeable than the others who are not performing well. As such, the knowledgeable learner will help the other learners understand any concept being studied at that particular moment. This is considered to be beneficial to both the knowledgeable learner and the ones not performing well because they all get to understand the content better.

The data also revealed that these teachers believe that before the opportunity to talk with peers may be granted to learners, it is important to ensure that the learners have the necessary background information about the content to be discussed. This means that teachers need to have taught the learners about the content they want them to discuss. If not, the talk between learners will not yield the expected results. As such, it will not be effective and will be a waste of time.

4.3.3. How do pre-service Physical Sciences teachers' experiences and perceptions about learner-learner talk influence their teaching practice?

Above I have presented what the data revealed about pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk as a means of addressing the first two research questions of this study. Now I will present what the data revealed about the teaching practice of pre-service Physical Sciences teachers as a means of addressing the third research question of this study.

Findings from audio-recording of pre-service Physical Sciences teachers talk

The table below shows the frequency of each communicative approach during the three observed lessons per pre-service Physical Sciences teacher.

Table 7: Frequency of each communicative approach during the observed lessons

Communicative Approaches	Dlomo			Hlophe			Nkosi			Zuma		
	Lesson 1	Lesson 2	Lesson 3	Lesson 1	Lesson 2	Lesson 3	Lesson 1	Lesson 2	Lesson 3	Lesson 1	Lesson 2	Lesson 3
Interactive/authoritative	39	22	16	21	22	20	38	24	0	29	23	25
Non-interactive/authoritative	13	12	20	10	4	4	9	1	0	10	21	9
Interactive/dialogic	5	5	1	6	2	0	1	2	0	15	4	14
Non-interactive/dialogic	5	3	2	1	0	0	0	2	0	8	0	4

During the first observed lesson, table 7 shows that Dlomo mostly employed the interactive/authoritative communicative approach followed by the non-interactive/authoritative communicative approach. Although he least employed the dialogic communicative approaches, both the interactive and non-interactive/dialogic communicative approaches were equally employed. Hlophe also frequently employed the interactive/authoritative communicative approach followed by the non-interactive/authoritative, interactive/dialogic and non-interactive/dialogic communicative approaches, respectively. Nkosi, on the other hand, did not employ the non-interactive/dialogic communicative approach but used mostly the interactive/authoritative, non-interactive/authoritative and interactive/dialogic communicative

approaches respectively. Contrary to all three pre-service Physical Sciences teachers, Zuma had the interactive/dialogic communicative approach being the second most used communicative approach after the interactive/authoritative communicative approach. The non-interactive/authoritative communicative approach followed by the non-interactive/dialogic communicative approaches were least used.

In the second observed lesson, table 7 above shows that Hlophe and Zuma did not employ the non-interactive/dialogic communicative approach and least used the interactive/dialogic communicative approach. However, in both pre-service Physical Sciences teachers, Zuma and Hlophe, the interactive/authoritative communicative approach was prevalent followed by the non-interactive/authoritative communicative approach. In Dlomo's lesson, the communicative approach interactive/authoritative communicative approach was mostly used followed by the non-interactive/authoritative, interactive/dialogic and the non-interactive/dialogic communicative approach, respectively. Similar to Dlomo's lesson, Nkosi's lesson was dominated by the non-interactive/authoritative communicative approach followed by the interactive/dialogic and non-interactive/dialogic communicative approach, which were equally used. The non-interactive/authoritative communicative approach was least used in the lesson.

During the third lesson, I was unable to observe Nkosi. However, I was able to observe the other pre-service Physical Sciences teachers. In Dlomo's lesson, non-interactive/authoritative communicative approach was most used followed by the interactive/authoritative, non-interactive/dialogic and interactive/dialogic, respectively. In Hlophe's lesson, only two communicative approaches were used. The interactive/authoritative communicative approach was used most, followed by the non-interactive/dialogic communicative approach. Similar to the first lesson pattern, Zuma had the interactive/dialogic communicative approach being the second most used communicative approach after the interactive/authoritative communicative approach. The non-interactive/authoritative communicative approach followed by the non-interactive/dialogic communicative approaches were least used. The figure below shows the summary of the communicative approaches as used by the pre-service Physical Sciences teachers during the three observed lessons.

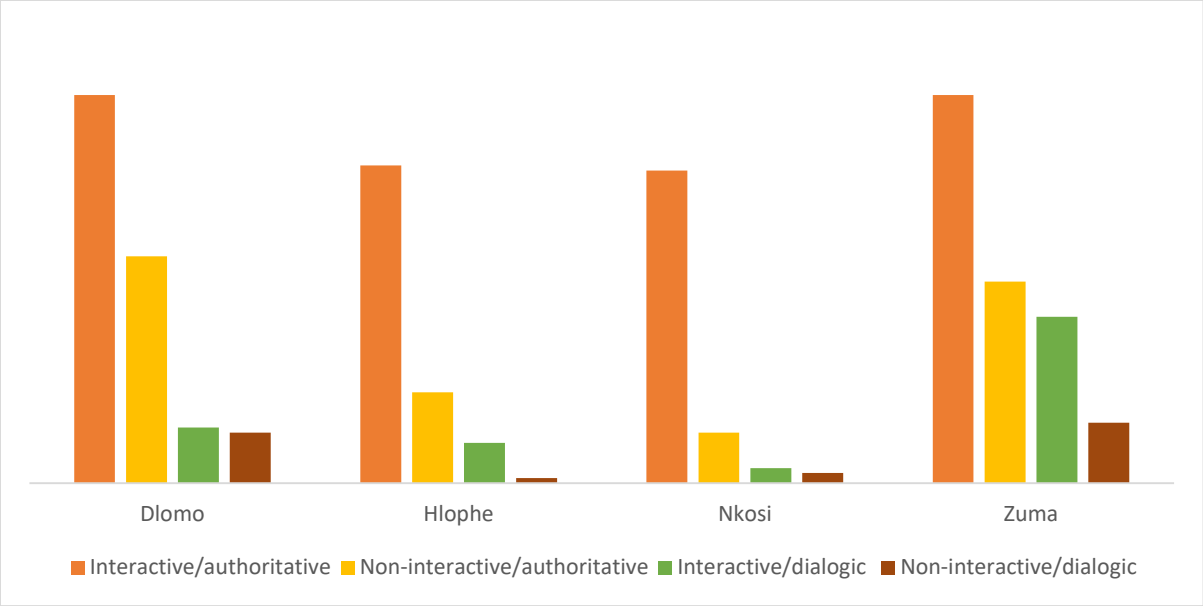


Figure 1: Frequency of each communicative approach during the three observed lessons per pre-service Physical Sciences teacher

The figure above shows that all pre-service Physical Sciences teachers mostly used the interactive/authoritative communicative approach during the observed lessons followed by the non-interactive/authoritative and interactive/dialogic communicative approaches. The non-interactive/dialogic communicative approach was the least used communicative approach by all pre-service Physical Sciences teachers. In another sense, this means that all pre-service Physical Sciences teachers largely employed the authoritative communicative approach than the dialogic communicative approach, meaning that they engaged more in low quality communicative approaches than high quality communicative approaches.

Findings from learner-learner talk audio-recordings

In chapter three, I mentioned that while pre-service Physical Sciences teachers were observed teaching, their verbal interaction with the learners were audio-recorded. Furthermore, the verbal interaction between their learners was audio-recorded. However, only one group was selected. Findings of this verbal interaction are presented below.

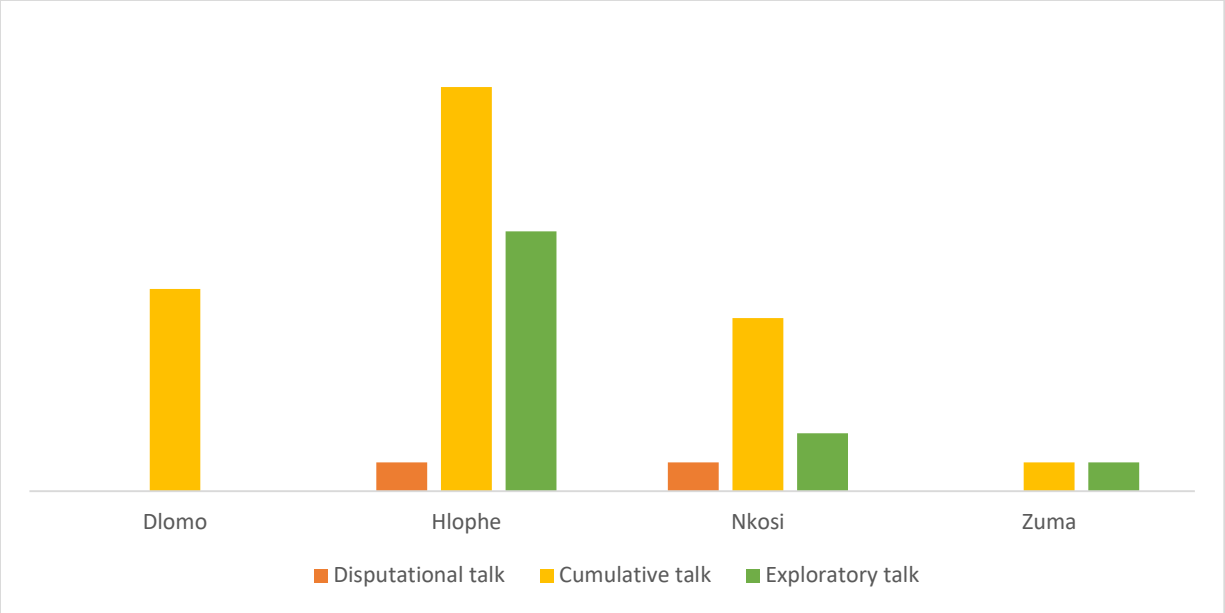


Figure 2: Frequency of each type of talk as observed in the pre-service Physical Sciences teachers lessons

Figure 2 above shows the frequency of each type of talk used by the learners taught by pre-service Physical Sciences teachers during the three observed lessons. The figure shows that learners in Dlomo's class engaged in cumulative talk only when given the opportunity to talk with peers. Unlike learners in Dlomo's class, Zuma's learners engaged in both cumulative and exploratory talk equally. Contrary to Dlomo and Zuma's learners, learners in Hlophe and Nkosi's class engaged in all three types of talk. In both pre-service Physical Sciences teachers class, the learners engaged mostly in cumulative talk followed by exploratory and disputational talk respectively. This means that they engaged in both high and low quality talk.

Findings from observations and post-lesson interview

This section represents findings obtained from observations and post-lesson interviews. The findings from these data collection techniques were merged and are represented holistically below. The first set of findings is tabled below and shows the classroom setting.

Table 8: Classroom setting

	Dlomo	Hlophe	Nkosi	Zuma
Lesson venue	Classroom	Classroom and laboratory	Classroom	Laboratory
Teaching equipment	Smart board and white board	Chalkboard	Chalkboard	Chalkboard
Learners sitting arrangement	Pairs	Groups of 4	Individually and in groups for activities	Individually in benches 4-6 learners
Teaching and learning material	Worksheet; past question papers and textbook	Chemicals for a laboratory session, and graphs of exothermic and endorthemic reactions and textbook for classroom session	Past question papers	Textbook, periodic table and electricity circuits microkit

Table 8 shows that Dlomo's lessons were held in a classroom similar to Nkosi and Hlophe's lessons. However, one of Hlophe's lessons was held in laboratory similar to Zuma's lessons. With an exception of Dlomo who used both a smart board and white board, all the other three pre-service Physical Sciences teachers used chalk boards as their teaching equipment. Throughout Dlomo; Hlophe and Zuma's lessons the sitting arrangement did not change. Learners in Dlomo; Hlophe and Zuma's lessons were sited in pairs; groups of four and individually in benches accommodating about 4-6 learners respectively. In Nkosi's lessons, at the beginning of the lesson, learners would be sited individually and during the lesson Nkosi would put them into small groups. Each group contained a well performing learner meant to help the struggling learners in that group.

Normally Nkosi and Dlomo used past question papers as both teaching and learning material. In addition to past question papers, Dlomo also used worksheets and textbook as teaching and learning material. The teaching and learning material used by both Zuma and Hlophe depended on the topic covered and thus changed with each lesson observed. For Hlophe, a textbook was used for the first two lessons. In addition to the textbook, charts of exothermic and endothermic reactions graphs were used in the second lesson. During the third lesson, laboratory equipment such as beakers and chemicals were used for the exothermic and endothermic reactions practical. Zuma, on the other hand, used electricity micro-kit and textbook during his first lesson. During his second and third lesson, a textbook only was used.

The role of learner-learner talk

The data from both observation and post-lesson interview shows that when learners were given an opportunity to talk with their peers by the pre-service Physical Sciences teachers, they were

helping each other. As the pre-service Physical Sciences teachers were moving around during learner-learner talk, they heard learners helping each other see things that their peers may have overlooked when it comes to certain conceptual problems. Learners were attending to each other's questions before even the pre-service Physical Sciences teachers could respond to those questions. The excerpt below how the learners were interacting in one of the pre-service Physical Sciences teachers.

> Interviewer: Do you think it worked out as you were moving around?
>
> Zuma: Yes, it was working out because there are some learners that would fight for an answer. So that's what I wanted to see, that conflict. Because some of them were explaining and some of them were actually looking at the coefficient used to balance equations and they would tell them that they should not look at that, they should look at charges. So that was the confusion I wanted to see and to have that environment in class.

From the excerpt, it is seen that learners were not only helping each other solve the given conceptual problem, they were also arguing why their answers to the given conceptual problem were correct. As such, making their talk exploratory rather than accumulative and the pre-service Physical Sciences teacher was thrilled when witnessing this episode. Based on such observation, the pre-service Physical Sciences teachers observed learner-learner talk in their respective classrooms to be effective and prevented learners from being dependent on them.

Reflections on why learner-learner talk does not work

Although the pre-service Physical Sciences teachers observed learner-learner talk to be effective, they shared some insights on why learner-learner talk does not work. They observed that learners tend to talk about their problems prior to starting the work they are instructed to do. This wastes time as learners end up taking more time in completing the activity. They also pointed out that some learners are shy and whenever they move around the groups of those learners during learner-learner talk, the learners would keep quiet. This makes it difficult to hear what they are talking about and to correct them if what they are talking about shows misunderstandings. They suggested that this may be overcome by asking these learners questions that will help reveal their understanding of the content studied as well as help them solve the conceptual problems.

Reflections on when learner-learner talk work.

Due to the observed role of learner-learner talk, the pre-service Physical Sciences teachers have shared their reflections revealing strategies to make learner-learner talk effective. The pre-service Physical Sciences teachers show that to make learner-learner talk effective, the groups in which learners interact with their peers have to be smaller. Also, the task given to the learners has to be challenging and a bit longer so that learners do not finish quickly, get bored and start making noise. Importantly, learners need to have the necessary background knowledge about the content the activity is based on. This is because learners can only talk effectively if they already have the necessary background knowledge about the content covered by the activity.

In chapter two, section 2.3.4; I discussed factors that may influence the yield of high level exchanges during learner-learner talk. These factors included the design of the task, arrangement of learners and also the laying out of ground rules. These factors were also considered in this study and their findings are tabled below.

Table 9: Factors influencing the level of exchanges possible during learner-learner interaction when observing Pre-service Physical Sciences teachers teach

	LESSON ONE			LESSON TWO			LESSON THREE		
	Learners arrangement when doing task	Ground rules for discussing	Task design	Learners arrangement when doing task	Ground rules for discussing	Task design	Learners arrangement when doing task	Ground rules for discussing	Task design
Dlomo	Pairs/groups (arranged by learners)	Stated	Promote talk	Pairs/groups (arranged by learners)	Not stated	Promote talk	No task given		
Hlophe	Individually		Promote talk	Individually		Promote talk	Groups (arranged by the learners	Not stated	Promote talk
Nkosi	Groups (arranged by the teacher)	Not stated	Promote talk	Groups (arranged by the teacher)	Not stated	Promote talk			
Zuma	Individually		Does not promote talk	Groups (arranged by the teacher)	Stated	Promote talk	Individually		Promote talk

Table 9 above shows that Dlomo was teaching vectors in all three observed lessons. During the first two lessons, learners were allowed to work in pairs or groups, which learners themselves arranged. In other words, the learners selected the individuals they wanted to work with. The activities that learners were given during those two lessons promoted talk. However, only one type of talk was observed in the two lessons, cumulative talk, as seen in figure 2 above. During the third lesson, Dlomo did not give learners an activity and he spoke throughout the lesson.

When asked after the lesson, he said this was because he was giving them feedback on the topic taught as they were to write a test the following day. During the first lesson Dlomo also stated ground rules for discussing, although he did not state all the rules but he did mention that learners should not scream at each other and make noise as their partners are close by. This rule may be the reason why the learners did not engage in any other type of talk other than cumulative talk. They may have interpreted that to mean they have to agree with whatever their partners are saying.

The table above shows that Hlophe, during the first two lessons, gave learners an individual activity and a group activity during the last lesson. The individual activities given promoted learner-learner talk. Evidence of this can be seen in figure 2 above where her learners had more exchanges with their peers than any other pre-service Physical Sciences teacher with cumulative talk being prevalent followed by exploratory talk and disputational talk respectively. During a post-lesson interview with Hlophe, she expressed that her learners always discuss even when they are supposed to do the activity individually. She clearly stated that not only do the learners do this with her but also with their teacher and she is not happy about that as she wants the learners to engage with her also and its take them more time to finish a simple activity. The third lesson was a practical session where learners grouped themselves. In this lesson, Hlophe did not tell learners the rules of engaging in discussions or enforced them since these learners are used to discussing. As a result, there was an episode of disputational talk though more exploratory talk exchanges were present. The numerous account of exploratory talk episodes could be attributed to the fact that these learners are used to engaging with their peers with or without the teacher's permission.

Nkosi, as seen in table 9 above, allowed learners to talk amongst themselves. In both cases, learners were not given ground rules on how to engage with their peers, however, their activities promoted talk. Figure 2 shows that the learners used cumulative talk more followed by exploratory talk. The figure also shows that there were few episodes of disputational talk in these lessons meaning that this type of talk was least used when compared to the other two types of talk.

Lastly, table 9 shows that Zuma gave learners an individual activity during the first and last lesson. The first activity did not promote leaner-learner talk while the last activity did and learners were discussing it. From that discussion, episodes of exploratory talk only were present.

During the second lesson, learners were given a group activity. The groups were arranged by the teacher though learners did not have to move from their initial positions. The teacher did state the ground rules for discussing that learners should speak as polite as possible without making noise. From this discussion, only cumulative episodes were observed.

4.4. DISCUSSION OF FINDINGS

With regards to the first research question of this study, the findings above shows that pre-service Physical Sciences teachers are given opportunities to talk during practical sessions, tutorial sessions and lectures. However, they talk more during practical sessions followed by tutorial sessions and lectures. The findings correspond to the arrangement of the pre-service Physical Sciences teachers during practical and tutorial sessions. This is because practical sessions are about three hours long while tutorial sessions are an hour long and they are placed into small groups with two tutors/laboratory demonstrators to assist them or guide their discussions during these sessions. This makes it easier for each group's feedback to be taken whenever they are told to discuss something. Lectures, on the other hand, consist of only one lecturer making it unlikely for all groups/peers' responses to be taken or to be assisted for that matter whenever pre-service Physical Sciences teachers are given the opportunity to talk to their peers.

The findings revealed that the pre-service Physical Sciences teachers had a positive experience of learner-learner talk. They found learner-learner talk to be enhancing understanding, promoting motivation and positive attitude; increasing participation and also improving academic performance. Due to this positive experience, they ended up thinking that learner-learner talk will also motivate learners about their academic work, promote positive attitude and motivation in learners with regard to the subject and content. This would then encourage participation in the classroom and improve learners understanding of content or concepts consequently improving their performance in the subject. In other words, the pre-service Physical Sciences teachers' positive experience of learner-learner talk led them to think that learner-learner talk will promote learning in learners as well thus providing them with a belief system, observability and predictability as Norman (2014) postulated. This means that their perceptions, influenced by their experiences, enabled them to anticipate what they could possibly find if they were to allow

learners in their classrooms to talk to their peers. As such, during their lessons they gave learners an opportunity to talk with their peers.

During the interaction between learners and their peers, learners were observed to be helping each other solve conceptual problems, understand content being studied and engaging in arguments with their peers. The pre-service Physical Sciences teachers found this interaction between their learners effective and necessary. As such, these findings concur with Routman (2005) postulate that learner-learner talk enables learners to learn provided that learners are actively engaged in the talk. They also correspond to the socio-cultural theory postulate by Vygotsky (1978) that learning is a social activity.

From the findings, it is clear that the pre-service Physical Sciences teachers were allowed to talk, mostly in practical and tutorial sessions, and they were extending the same experience to their learners in the classroom during teaching experience. However, their use of learner-learner talk in class is limited as per their experience in lectures hence the authoritative communicative approaches were prevalent in their lessons. Even though learner-learner talk helps but the pre-service Physical Sciences teachers look ill-equipped to use it in class because they do not have the experience of using it when taking up the teacher's role. Therefore, pre-service Physical Sciences teachers' perceptions about the value of learners talking to their fellow learners in the classroom are dependent on their own experiences of this type of talk. This is also notable in how Hlophe insists on having learners talking with their peers during practical sessions only since most talk with peers took place during these sessions as compared to tutorial sessions and lecturers. Furthermore, this indicates that the pre-service Physical Sciences teachers' experience of learner-learner talk not only influenced their perceptions, it also influenced their teaching practice.

From the data presented above, it is found that the pre-service Physical Sciences teachers used similar methods as their laboratory demonstrators when facilitating learner-learner talk during their lessons. For example, they kept the groups as small as possible and were walking around checking the learners as they engaged in learner-learner talk. This is an indication showing that the pre-service Physical Sciences teachers' experiences and perceptions influenced their teaching practice. Their experiences and perceptions served as a guide in terms of how they should facilitate learner-learner talk in their lessons.

The findings show that the pre-service Physical Sciences teachers used mostly the interactive/authoritative communicative approach than the non-interactive/authoritative communicative approach. These findings are similar to the findings of studies conducted by Kaya et al. (2016) and Zulu (2018) where the interactive/authoritative communicative approach was found to be dominant in teachers' lessons. According to Mortimer and Scott (2003), teachers use this communicative approach to interact with their learners by asking them questions that they already know answers for. This may have also been the case with the pre-service Physical Sciences teachers' frequent use of this communicative approach.

With regards to ground rules, I have mentioned above that whenever Dlomo and Zuma mentioned that learners should speak politely and not make noise, episodes from only one type of talk, cumulative talk, were present. This implies that learners associate this instruction with the idea that they should agree with each other because when they disagree they might make noise. This finding shows the limitations of not making the rules of working in pairs/groups clear to learners and implies that whenever learner-learner talk is to be employed, an appropriate set of ground rules, which are explicit, should be established so as to guide learners talk during the interaction.

Again, the findings show that Hlophe's learners had more exchanges compared to any other pre-service Physical Sciences teacher observed. In these exchanges, there were quite numerous exchanges of exploratory talk, although cumulative talk was dominant. This is because these learners are used to talking to their peers. It could also be said that they have learnt the ground rules of discussing through consistent engagement with their peers; hence they had quite a number of meaningful exchanges. These findings are relatable to those of Barnes (1999) where tutored learners doing collaborative tasks had more meaningful exchanges than untutored learners. Barnes attributed this finding to maturity that the more mature learners are; the less they engage in disputational talk. Also, Barnes postulated that this could also be an effort put in by the teachers in training learners to engage in meaningful exchanges. The first attribution can also be applied in this study as the learners used disputational talk the least and were also in Grade 11, a Grade higher than the learners Barnes worked with. As for the second attribution, it does not apply to this study's participants as the learners were not trained to work in groups. Therefore, it can be said that the learners taught by the pre-service Physical Sciences teachers were matured

although they were untutored in working in groups, although they may have learnt this through their consistent engagement with peers.

Furthermore, the findings from Hlophe's learners are in line with what Almasi & Gambrell (1997) found, that by allowing learners to talk to their peers, their ability to consider their peers points of view and verbalize their thoughts will be improved. This is because these learners frequent use of learner-learner talk resulted into their exchanges being meaningful. They have learnt to respect and consider their peers ideas and criticising them in a manner that will not create conflict. Hence, I say that these findings correspond to Almasi & Gambrell (1997) finding.

Since the pre-services Physical Sciences teachers did use the dialogic communicative approach, mostly the interactive/dialogic communicative approach than the non-interactive/dialogic communicative approach, it means that these teachers consistently engaged learners into exploration of ideas although they were at its centre, directing the talk. It can then be said that their experiences and perceptions positively influenced their teaching practice. This implies that if they were explicitly taught how they can encourage exploratory talk when teaching or the interactive/dialogic communicative approach, more episodes of exploratory talk may have been produced in their classrooms.

In other words, these teachers limited episodes of interactive/dialogic communicative approach or exploratory talk, mostly weak, may be attributed to the fact that they are not taught how such can be done when taking up the teacher's role, they only know this from a learner or student perspective. But because they know that learners need to be engaged during the lesson, they end up opting for the interactive/authoritative communicative approach which uses closed questions and do not enable ideas to be explored. This should be seen as a gap in their training which should be filled because this communicative approach, interactive/dialogic, enable learners to be critical thinkers, a skill necessary for problem solving and to be developed in Physical Sciences students as this subject is seen as an entrance ticket to high profile professions such as scientists.

Therefore, these findings from pre-service Physical Sciences teachers should not be seen as one of the common findings where teachers are thought to teach the way they were taught. They should be seen as an attempt by these pre-service Physical Sciences teachers to do their best in developing critical thinking skills in their learners without the adequate knowledge of how to do so. Thus, further research in this area should focus on developing the pre-service Physical

Sciences teachers in employing the dialogic communicative approach or exploratory talk in their teaching whenever they take the teacher's role.

Findings obtained from observing pre-service Physical Sciences teachers shows that these teachers mostly used the authoritative communicative approach than the dialogic communicative approach. These findings are relatable to the findings of a study conducted by Kaya et al (2016) and Zulu (2018) who found that the authoritative communicative approach is most prevalent in teaching, although this study was conducted on experienced teachers. In another study, Makgato (2007) found that the use of traditional teaching methods is still prevalent in South African schools and that is partly the cause of poor performance in Physical Sciences. In light of the findings from these two studies, the revealed incompetence by pre-service Physical Sciences teachers in conducting whole class discussions using the most effective communicative approaches or type of talk may also be revealing experienced and novice Physical Sciences teachers' incompetence in conducting effective whole class discussions using the dialogic communicative approaches or exploratory talk. That is the reason for the prevalent use of traditional teaching methods and probably the prevailing poor performance in Physical Sciences.

4.5. CHAPTER SUMMARY

This chapter has presented findings regarding pre-service Physical Sciences teachers' experiences and perceptions. The findings show that the pre-service Physical Sciences teachers largely use the interactive/authoritative communicative approach followed by the non-interactive/authoritative, interactive/dialogic and non-interactive/dialogic communicative approach, respectively. Also, the learners taught by these pre-service Physical Sciences teachers used cumulative talk the most followed by exploratory talk and disputational talk respectively. The significance and relevance of these results was also discussed in this chapter. A detailed summary of the findings is presented in the next chapter.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1. INTRODUCTION

The purpose of this study was to investigate pre-service Physical Sciences teachers' experiences and perceptions of the value of learners talking to their fellow learners in the classroom. In order to address the purpose of this study, the following research questions needed to be answered:

1. What are pre-service Physical Sciences teachers' experiences of learner-learner talk?
2. How do pre-service Physical Sciences teachers' experiences influence their perceptions of learner-learner talk?
3. How do pre-service Physical Sciences teachers' experiences and perceptions about learner-learner talk influence their teaching practice?

To answer the above research questions, this study adopted a qualitative approach and used a case study methodology where a group of four pre-service Physical Sciences teachers currently in their fourth year of study when this study was conducted were targeted. These teachers were interviewed individually prior to going to schools for teaching experience. The purpose of these interviews was to determine the pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk. After the interviews, these teachers were followed during teaching experience and three of their lessons were observed. While observing their lessons, their verbal interaction with the learners was audio-recorded. Furthermore, the verbal interaction between learners as they worked in small groups was audio-recorded. The findings have been presented in the previous chapter. In this chapter, I will present a summary of the findings, draw conclusions based on the presented findings and make recommendations for further research. In addition to this, I will also point out the limitations of this study.

5.2. SUMMARY OF THE FINDINGS

The purpose of this study was to investigate pre-service Physical Sciences teachers' experiences and perceptions of the value of learners talking to their fellow learners in the classroom. Findings of this study show that the pre-service Physical Sciences teachers are given opportunities to talk to their peers during lectures, practical sessions and tutorial sessions. However, the pre-service Physical Sciences teachers explained that they engage more with their peers during practical

sessions as compared to tutorial sessions and lectures. During practical sessions they mentioned that they normally talk about the resources they would use for the experiment, the procedure they will follow in conducting the experiment, the requirements of the experiment, obtained results and how they would use the experiment for teaching and learning purposes. In tutorial sessions, they said that they are normally given questions prior to the session to attempt at home and then come up with questions they found challenging to do together during the tutorial session. During lectures, these teachers mentioned that they are rarely allowed to talk to their peers and such opportunities are often opened up only if they say they do not understand something. Otherwise, they would have their own discussions without the knowledge of the lecturer for a limited time.

This study also found out that the pre-service Physical Sciences teachers find talking to their peers beneficial. They pointed out that talking to their peers motivated them about their academic work. It has also improved their attitude towards Physical Sciences, participation in the classroom, academic performance and understanding of Physical Sciences concepts. Most importantly, they explained that they learn better from talking to their peers.

The very same pre-service Physical Sciences teachers reported that since working with their peers has been beneficial to them, it could also be beneficial to the learners at schools. Thus, they pointed out that they think learners from schools can learn Physical Sciences better from talking to their peers, their motivation towards Physical Sciences can be promoted, attitude, understanding of concepts and academic performance can also be improved. They even said that they would encourage this type of talk in their classrooms.

They have also pointed out drawbacks of allowing learners to talk to their peers. One of the drawback identified was that learner-learner talk can cause discipline issues as learners may be noisy and waste time not doing what they are instructed to do. They also pointed out that as much as learner-learner talk may be found to have a positive effect on learning, it may also demotivate learners and change their attitude from positive to negative, consequently negatively affect their participation in the classroom and academic performance. As such, they pointed out that learner-learner talk needs to be monitored and the groups have to be structured.

The findings also showed that all the pre-service Physical Sciences teachers largely employed the authoritative communicative approaches than the dialogic communicative approaches. Within the authoritative communicative approach, the interactive/authoritative communicative

approach was prevalent when compared to the non-interactive/authoritative communicative approach. Also, within the dialogic communicative approach, the interactive/dialogic communicative approach was prevalent than the non-interactive/dialogic communicative approach. In other words, the interactive/authoritative communicative approach was prevalent followed by the non-interactive/authoritative, interactive/dialogic and non-interactive/dialogic communicative approaches, respectively.

Also, the learners taught by the pre-service Physical Sciences teachers largely employed cumulative talk than any other type of talk followed by exploratory talk. Disputational talk was the least employed type of talk. The data shows that although these learners were given an opportunity to talk to their peers, they were untutored on how to go about talking to their peers. In some cases, one rule of engaging with peers was stated however implicitly so. Thus, it did not do any good in making the interactions productive. Instead, the learners ended up agreeing with whatever it is that their peers were saying, without challenging it or building upon it.

The study also found that in one pre-service Physical Sciences teacher's lessons, the learners would simply engage in learner-learner talk even if the given activity was meant to be done individually. This resulted in the learners having more exchanges than any other learners from the pre-service Physical Sciences teachers' classes. Not only were their exchanges more but there were quite a number of exploratory talk episodes, although cumulative talk was dominant, as compared to the other pre-service Physical Sciences teachers' learners.

5.3. CONCLUSION

The findings above show that experiences form a basis for perceptions, meaning that one's experience of a phenomenon serve as a sieve of how one will view such phenomenon in the future. In this case, pre-service Physical Sciences teachers' positive experience of learner-learner talk led them to view this kind of talk as being beneficial and worth being encouraged in the classrooms. In other words, pre-service Physical Sciences teachers' perceptions about the value of learners talking to their fellow learners in the classroom is dependent on the pre-service Physical Sciences teachers' own experience of learner-learner talk.

These findings also show that the pre-service Physical Sciences teachers were able to employ the dialogic communicative approaches in their teaching and at times, particularly when employing

the interactive/dialogic communicative approach that promoted learner-learner talk. Beside the incompetence revealed in chapter four, it is clear from the findings that these pre-service Physical Sciences teachers have found learner-learner talk to be effective in their own studies, they have also tried to facilitate it in their own classrooms. Therefore, it can be concluded that these pre-service Physical Sciences teachers teaching practice is influenced by their experience which ultimately forms perceptions, permanent mental images of that particular phenomenon, in this case, learner-learner talk.

5.4. LIMITATIONS OF THE STUDY

This study's limitation is that non-probability sampling, purposive and convenience sampling, was used to select a small sample $(n = 4)$ of pre-service Physical Sciences teachers from one school of education in Gauteng province. As such, findings of this study cannot be generalised to the larger population of pre-service Physical Sciences teachers at different schools of education or to a different population of pre-service Physical Sciences teachers in the same school of education. However, they can be relatable to the larger population of pre-service Physical Sciences teachers from which the targeted group of pre-service Physical Sciences teachers was selected from.

5.5. RECOMMENDATIONS

The findings of this study revealed that pre-service Physical Sciences teachers are aware of the benefits of talking with fellow pre-service Physical Sciences teachers. However, they are not competent in how they should facilitate such talk in their classrooms such that it is effective in enabling learning. This is because they are taught this implicitly during tutorial sessions, practical sessions and lectures. Therefore, I recommend that pre-service Physical Sciences teachers be taught explicitly how to facilitate whole class discussions that will also promote learner-learner talk, using the dialogic communicative approaches or exploratory talk. This competence will be translated to the learners they teach, meaning that the learners they are teaching will increasingly engage in exchanges involving exploration of ideas. This has the potential to improve their understanding of the content taught in Physical Sciences. As a consequence, these learners' academic performance will improve and that will be a step into addressing the poor performance challenges experienced in Physical Sciences in South African schools.

A study conducted by Makgato (2007) found that traditional teaching methods are partly the cause of poor performances in Physical Sciences in South Africa. Other studies, such as Kaya et al (2016) and Zulu (2018) found that the authoritative communicative approaches are prevalent in teaching in South Africa. In light of the findings from these studies, the findings of this study revealed a possibility of incompetence in experienced and novice Physical Sciences in conducting class discussions using dialogic communicative approaches and/or exploratory talk. Therefore, I recommend that this research be extended to experienced and novice Physical Sciences teachers and to a larger population of pre-service Physical Sciences teachers from the same school of education and at different schools in different provinces. Furthermore, I recommend that support groups that will develop experienced and novice Physical Sciences teachers' competences in using the dialogic communicative approaches and exploratory talk be established.

Lastly, considering that the nature of content knowledge in Chemistry and Physics components is different, this may have influenced how the pre-service Physical Sciences teachers interacted with the learners, particularly Zuma and Hlophe who taught both these components. In this study, this aspect was not explored. Perhaps further research may investigate the influence of the nature of content knowledge on the interaction between the teachers and learners and between learners alone. This may be used to supplement our understanding of why learners perform better in other topics than in others.

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APPENDIX A: ETHICS CLEARANCE CENRTIFICATE

WITS SCHOOL OF EDUCATION

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

SCHOOL OF EDUCATION ETHICS COMMITTEE
CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: 2019ECE017M**
PROJECT TITLE	Exploring Pre-service Physical Sciences Teachers' Experiences and Perceptions of Learner-Learner Talk in the Classroom
INVESTIGATOR	Nomfundo Knowledge Radebe
SCHOOL/DEPARTMENT OF INVESTIGATOR	WITS SCHOOL OF EDUCATION
DATE CONSIDERED	18 June 2019
DECISION OF THE COMMITTEE	Approved unconditionally
EXPIRY DATE	Date of submission of the project report

ISSUE DATE OF CERTIFICATE 24 June 2019 **CHAIRPERSON** (Dr. Paul Goldschagg)

cc: Supervisors: Dr. Emmanuel Mushayikwa; Dr. Tirivaviri Mamvura; Dr. Caleb Mandikonza

---

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

I fully understand the conditions under which I am authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

N.K. Radebe
Signature

25/06/2019
Date

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

APPENDIX B: UNIVERSITY APPROVAL LETTER

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

OFFICE OF THE DEPUTY REGISTRAR

03 July 2019

Nomfundo Radebe
Student number 851590
Masters in Education
Wits School of Education

TO WHOM IT MAY CONCERN

"Exploring Pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk in the classroom"

This letter serves to confirm that the above project has received permission to be conducted on University premises, and/or involving staff and/or students of the University as research participants. In undertaking this research, you agree to abide by all University regulations for conducting research on campus and to respect participants' rights to withdraw from participation at any time.

If you are conducting research on certain student cohorts, year groups or courses within specific Schools and within the teaching term, permission must be sought from Heads of School or individual academics.

Ethical clearance has been obtained. (Protocol Number: 2019ECE017M)

Nicoleen Potgieter
University Deputy Registrar

Private Bag 3, Wits, 2050, South Africa | T +27 11 717 1204/8 | F +27 86 553 2271 | www.wits.ac.za

APPENDIX C: SCHOOL OF EDUCATION APPROVAL LETTER

Wits School of Education

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

27 St Andrews Road, Parktown, Johannesburg, 2193 • Private Bag 3, Wits 2050, South Africa
Tel: +27 11 717-3221 • Fax: +27 11 717-3009 • E-mail: enquiries@educ.wits.ac.za • Website: www.wits.ac.za

02 July 2019

To The Chair of Ethics

Permission is granted for the below named student to conduct research involving data collection at the school subject to the granting of full ethics permission by the relevant School or University Ethics Committee.

Student details
Name: Nomfundo Knowledge Radebe
Student Number: 851590
Course Code: EDUC7031A
Research Title: Exploring pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk in the classroom.

Signature

Professor Felix Maringe
Head of School: WSoE

APPENDIX D: SCIENCE EDUCATION DIVISION APPROVAL LETTER

Wits School of Education

27 St Andrews Road, Parktown, Johannesburg, 2193 • Private Bag 3, Wits 2050, South Africa
Tel: +27 11 717-3007 • Fax: +27 11 717-3009 • E-mail: enquiries@educ.wits.ac.za • Website: www.wits.ac.za

17 July 2019

RE: Permission to collect research data in the Division of Science Education

Dear Nomfundo Radebe,

I am glad to inform you that the Division of Science is giving you permission to contact your study entitled: *Exploring pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk in the classroom;* involving Physical Science pre-service teachers.

I hope that during your data collection, you will adhere to strict ethical and protocol procedures.

I am wishing you the best in your studies.

Yours Sincerely,

Elaosi Vhurumuku (Ph.D.; M.Sc.; B.Ed. (Chemistry); Cert. Ed.)
Head: Division of Science Education, School of Education, University of Witwatersrand
Associate Professor of Science Education
E-mail: elaosi.vhurumuku@wits.ac.za
Phone (Bus): 011 717 3246
Cell: 078 054 7781

APPENDIX E: GDE APPROVAL LETTER



GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	**02 July 2019**
Validity of Research Approval:	**04 February 2019 – 30 September 2019** **2019/124**
Name of Researcher:	**Radebe N.K**
Address of Researcher:	**1600 Nkelenga Road, Lufhereng Ext 1**
	Braamfischerville,
	Dobsonville, 1875
Telephone Number:	**064 439 0086**
Email address:	**851590@students.wits.ac.za**
Research Topic:	**Exploring pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk in the classroom.**
Type of qualification	**Masters' in Education**
Number and type of schools:	**Four Secondary Schools**
District/s/HO	**Johannesburg East, Johannesburg South and Johannesburg North**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

02/07/2019

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

1. *Letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*
4. *A letter / document that outline the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

.....

Mr Gumani Mukatuni
Acting CES: Education Research and Knowledge Management

DATE: 02/07/2019

Making education a societal priority

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APPENDIX F: INTERVIEW PROTOCOL

Interviewee pseudonym:	
Interview date:	
Interviewer name:	
Interview location:	
Aim of the interview:	To investigate pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk

1.1. In the Physical Sciences content course may you please describe instances where you are expected to discuss during:

a. Practicals
b. Tutorials
c. Lectures

1.2. Who initiated and directed these discussions in practicals, tutorials and lectures? E.g. lecturer, fellow students, demonstrator?

1.3. How do the lecturer, fellow students and demonstrator initiate and lead the discussions? Egg, verbally/ using a tool such as a practical/ discussion questions, interpretation of practical activity (give examples for each response)

1.4. Did the lecturer/demonstrator move around or intervene during discussions? Elaborate

1.5. How frequent do you engage in discussions with your fellow students during:

a. Practical sessions
b. Tutorial sessions
c. Lectures

2. Do you learn better from talking/exchanging ideas with your peers? Can you explain by giving examples of your experience?

3. From your experience, in what ways did talking to peers help you to:

a) Understanding Physical Sciences concepts
b) Participate better in class discussions

c) Be more motivated about your class work
d) Improve your own academic performance
e) Develop a positive attitude towards Physical Sciences

4. Do you think learners from schools can learn Physical Sciences better from talking with their peers in the classroom? Can you justify your answer?
5. In your view, what role can discussions between learners play in promoting the following in science learning?
   a. Understanding
   b. Participation
   c. Motivation
   d. Academic performance
   e. Positive attitude
6. In your classroom, would you encourage learners to discuss concepts among themselves? Why or why not?
7. Give examples of concepts that may need learner discussion and how this discussion could be initiated (by whom), conducted and supported.

APPENDIX G: INTERVIEW TRANSCIPT

Interviewee:	Mr. Zuma
Interview date:	17 July 2019
Interview time:	12: 00 pm
Interviewer name:	Ms. N.K. Radebe
Interview location:	Wits school of education
Aim of the interview:	To investigate pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk

Interviewer: In the Physical Sciences content may you please just describe instances where you are expected to discuss during practicals

Zuma: During practicals umh…ok so during the practicals here at Wits?

Interviewer: Yes

Zuma: So we are usually expected to discuss I think usually at the beginning of our practical to look into what are actually dealing with for the day, what do we need, the resources that we need to take into consideration for the day. Yeah, I think it basically most like…I think it's crucial for us to discuss at the beginning before we can do any other thing. And then any other scenario at which we find ourselves discussing I think it's basically on the procedure of the experiment because the interpretation of the procedures sometimes can differ from person to person because I might interpret that this is how we have to set up this but someone else might have understanding on actually this has to be done and I think those are the instances in which we discussed the most. And then also when it comes to interpreting our results. We need to actually talk in the sense where we need to understand what is it that we actually found, what is the meaning behind these values or this kind of event that we've noticed. So yeah I think those are the times at which we find ourselves doing discussions in a group.

Interviewer: What about tutorials?

Zuma: Okay, during tutorials in Physical Sciences 4, we didn't have much tutorials to be honest about it. But tutorials they are basically straight forward problems. The problems are straight forward that we are dealing with. So it's a matter of do you understand this question better? How do you go about solving this kind of question? Those are the only times in tutorials in which we will discuss. But we discuss more in practicals compared to the tutorials.

Interviewer: What about lectures?

Zuma: Umh…lectures…the thing is lectures are lecturer-centred

Interviewer: Oh….

Zuma: Do you understand?

Interviewer: Yes

Zuma: There's no really time to talk. the only time we'd really find ourselves talking is when there's a question that during the lesson, the lecturer would just post like a question and that's the only time we'd like that five minutes to discuss the question around that but it's really not that much because questions pop up in every lecture. Some lecturers will just move on with the content without any quiz of the day…yeah.

Interviewer: Ok so normally during practical sessions who would initiate and direct those discussions?

Zuma: I think it would be anyone in the group. Just anyone because we all aware of the manual at that point which is usually…in my group, we usually divide ourselves for tasks like okay you guys today you are going to fetch the apparatus down there, we would be reading in the meantime what we need to do. So we separate each other in such a way that we don't waste time in one thing all of us. So just anyone would volunteer, like okay today I am going to fetch the stuff and then someone else would be reading in the meantime.

Interviewer: So you would say just us, the students?

Zuma: Yeah just us the students.

Interviewer: Okay, what about in tutorials?

Zuma: Tutorials ah…I think it might work the same but usually there is a tutor in tutorials so we would be told like you guys can start working, you can work up to here, don't do everything, blah, blah, blah. So I think on tutorials it's a little bit different whereby the tutor might tell us

when to start and all of that. But in labs, we want to leave the lab early. So the moment we get there, we know we need to work so that we can leave early before the tutor can even tell us what to do.

Interviewer: You are ready to work

Zuma: Yah we are ready to work.

Interviewer: What about in lecturers?

Zuma: Ah…in lectures, it's basically the lecturer who tells us to do the quiz now. So yeah I think that's how tutorials are directed and initiated.

Interviewer: Ok so in practical sessions like you say it could be the students or it could be you guys, how do you initiate and lead those discussions? Maybe do you use any tools or maybe questions you know?

Zuma: Well for us to be able to initiate like the discussion on a practical the tools that we look at it's basically the manual that we have for the day, and we look at what it is related to, what is the topic behind it, what is the nature of the experiment you see. We look at all of those things. So we take a lot of factors into consideration, time, resources and all of that and how long the experiment is because some of them they are actually long with part 1, part 2 and part 2. So we look into consideration of such things, you understand?

Interviewer: Yah and then in tutorials?

Zuma: Ah…in tutorials…

Interviewer: Since you said it's normally the demonstrator and sometimes the students, which tools do they normally use to initiate and lead those discussions?

Zuma: Practically it's the manual that we have for the tutorial for the day. So we'd look…because it's already stated that its tutorial 1, so we know we have to open to that page. But it's up to the demonstrator to tell us that okay you guys are just doing the five questions and that's it. So the manual is the tool, the number one guide for us.

Interviewer: Okay, and then during those discussions, do the lecturer or demonstrator move around and intervene during those discussions?

Zuma: Yes they actually do because we ask a lot so all the time whether they like it or not, they will walk around and come to our table. But they generally do walk around to supervise if people are working, they have any questions…yah they actually do move around and check.

Interviewer: And then how frequent would you say you discuss, you engage in discussions during practical sessions?

Zuma: How often?

Interviewer: Yes, how frequent

Zuma: I mean all the time during the experiment because my group is actually I don't know but we actually love talking about what we actually do. So we do have discussions like almost all the time, arguing that no, this means that, no this means that, this is how we should do it for us to get our results faster this is what we should do, you understand?

Interviewer: Mh…

Zuma: Yes I think we actually discuss almost the whole session, we are busy.

Interviewer: And then what about tutorial sessions?

Zuma: Tutorial sessions they are a little bit chilled I think. Because we are just going to talk to someone probably if we don't understand something. We are going to ask if we have any issue. But if the tutorial is straight forward, I can just move with it alone without asking anyone.

Interviewer: What about lectures

Zuma: We hardly discuss in lectures. But there are instances where you actually discuss without the permission of the lecturer. When someone is close to you and there's something that you probably relate to or probably blown away, you don't see what is happening. At that point, you talk to the person next to you, asking is this that and that, or is this what we once did. So I think we do actually during lectures discuss but it's not as frequent as compared to the lab during practical. So I think also we can't be talking while the lecturer is also talking. So for that fact, we need to keep it as low as possible and as short as possible.

Interviewer: Do you learn better from talking or exchanging ideas with your peers?

Zuma: 100 percent.

Interviewer: May you give me examples from your experience.

Zuma: Because you know when you discuss, especially for Physical Sciences, it's a very broad subject and there are people who understand certain things more than you. Let's say for instance electricity or any topic, forces or whatever, there are people who understand electricity to the core and you are likely to make a mistake into interpreting certain things. Let's say in electric circuit, we can interpret it, you know how the voltage is divided in certain circuits and wherever. So there are people who actually have practiced that thing more than I did. So I can come with a misconception and if I come with that misconception but the moment they talk to someone and they pick up that actually you are making a mistake here. So they are more likely to actually help me rather than me just moving on with the mistake that I'm doing and I'm gonna end up writing the same wrong information in my tests or my exams. So I think its better… it has always worked perfect to discuss especially content related material.

Interviewer: Then from your experiences, in what ways did talking to appears help you to understand Physical Science concepts?

Zuma: From my experiences… well I think it's more similar to the question that I've just answered. I've had cases where I slightly understand something or I think I understood something whilst I've been grasping the concept wrong. So it means I've been having this misconception for a long time thinking that my information is correct while am not there. So it has always helped from my experience. That's why I always encourage talking to people, asking questions to people next to you, they might know something that you don't know. They can actually build-up into what you already know. So I think they always help me.

Interviewer: And how about participation in the classroom, how has that help you to…

Zuma: Are we talking about a lecture context or?

Interviewer: In the Physical Science content course in general.

Zuma: Well, considering that we…okay, personally, I think am more comfortable talking with a small group that I have compared to talking to the wide class. Because I am a person who doesn't ask questions in a lecture for example. So I am more comfortable with asking a person next to me, what that means instead of just raising my hand to the lecture to get attention and then ask the question. But I usually ask the people next to me and am like does that mean that… And even if I have a question for the lecturer, am just gonna ask the person next to me. Do you mind asking this…?

Interviewer: Asking on your behalf?

Zuma: Yes. Because personality wise, I am not that kind of a person who can talk like that in front of my own colleges.

Interviewer: So would you say it has helped you to participate better in those…

Zuma: It does help. Yes, it does.

Interviewer: In terms of motivation about your academic work, how has it helped you?

Zuma: It does help because the moment you realise that you actually need help, the moment you realise that you are far step behind, it's the moment you actually get motivation. Some people can be discouraged thinking that they don't know anything and thinking of leaving the whole thing. But some of us, the moment we get our own setbacks, it's the more we seek help, it's the more we try to improve as much as we can. So hence discussing with people, especially with my smaller groups, it has always been of huge help. Because that's where I see my strength because they do trust me at certain areas and I also trust them with certain things. So I think that discussion has not just helped me as an individual, but I believe it has helped them also in the group because there are cases in which there is only one person who understands that thing and that person will try as much as they can to unpack this. So that gives you motivation to… you keep yourself motivated towards the subject.

Interviewer: And how has it help you to improve your own academic performance.

Zuma: Well it does help I think. Well it does help like in a fact it does. Because the moment you talk to people is the more you learn. So my own academic performance personally, if you had told me what force is according to the definition and it's the most relevant definition that I have gotten through a discussion. Like, I am more likely to use it now, when I write my own test and when I write my own assignment. That means that I've improved from my probably weak definition of something to a more broad definition and it's more straightforward to what we actually dealing with. So in that case it does help me, it does help my academic performance, and it does boost my academic performance from where I was to where I am currently at. So it always help I think.

Interviewer: And then how has it helped you to develop a positive attitude towards Physical Sciences as a course?

Zuma: Ok so generally there's a stereotype that is out there that Physical Sciences is hard, you know such things. But the moment you discover something and you realize that it's actually not that hard, this is really not that bad, it's the more you develop interest into the subjects. So it means you become more positive about it and the more you get away with the mentality that this is difficult, this is not for me. It's the more you going to see improvements, the more you going to develop interest into the subject, you going to have positive attitude toward it.

Interviewer: Okay. And then do you think learners from schools can learn Physical Sciences better from talking with their peers in the classroom?

Zuma: That one is debatable. I will explain why I am saying that. For learners to…okay here we are talking about a case where learners have to discuss between themselves. But before learners can discuss between themselves, they need to have gotten the right information from the teacher. They need to have been taught correctly by the teacher. They need to have been given motivation enough to be interested on the subject from the teacher. Because for example, if I am a boring teacher, I am going to make my subject boring and make them lose interest. If I can give them a group work, they might end up not doing it. As much as we are in a Physical Sciences content class, they might not do it at all. And if try as much as I can to make sure that positive attitude towards the subject is there, the subject matter it's there, the understand to what they are actually working with, they will never lose interest. So the group work, the pair activities, they will be as productive as we want them to be compared to when they already have a negative attitude toward the subject. They would be just drawing stuff their books instead of working and they would start working when you just come around instead. So for them to actually be working, it doesn't just start with them but you must also have been given them the right information, the right attitude towards the subject. So it's more like developing a positive environment of the subject because learners have attitudes towards different subjects. They have different attitudes toward different subjects. So a subject that I don't like, that I think I find it difficult, I think the teacher does not also show interest, I might… actually the moment they give me group work, I am like "thank God, you won't be talking". You are like "Thank God I have found my break". But if it's a lesson that you actually enjoy, you'll be hands on into the group work and it's going to come out perfectly.

Interviewer: Then in your view, what role can discussions between learners play in promoting understanding? Between learners.

Zuma: So between learners. Between them considering that one learner might have more knowledge towards a subject it easy to have the one that is struggling with this subject. So in that way they can both benefit. I remember when I was in school, there were times where even I myself explaining something to you made me understand it more. So it is not just a matter of me explaining to someone that does not really understand the subject well but it also helped me to be more confident even about what I'm talking about.

Interviewer: And then what about participation?

Zuma: In class?

Interviewer: Yes,

Zuma: I think participation in class is very good because it gives you the platform to be corrected if you a mistake or a misconception towards something and if you're correct also if I say that is a correct answer, it more like I'm approving the knowledge that you have to stay inside you. It's more like I am approving to say "Keep that knowledge that is the one that you need". So it's more like, yeah it's more like that. But also, learners do participate and give us wrong answers. It's a matter of how I insure that this answer…how do I fix that knowledge around there, making sure I give them the right answer in a right way so that I don't discourage them to participate next time.

Interviewer: And then what about motivation? What role can motivation play in promoting science learning?

Zuma: Learners need to be motivated towards the subject and not lose interest towards the subject because this is a very sensitive subject. It has a lot of critics out there, saying it's hard. So the moment learners are motivated to investigate things and motivated to find a wonder inside Physical Sciences in general it's the more they learn. It's difficult as a learner to be learning about something in paper, you've never done a practical about forces, you've never done anything. So you can't even relate to it like in real life. So they need that motivation that they actually know these things, even if they see it, they can even explain it from their everyday life. So I think a way to motivate them which has motivated me it was actually doing it, seeing it practically instead of just learning about in paper. We have plenty of forces but if I have never seen them I'll just know them here on black-and-white.

Interviewer: What about discussions, so do you think discussions in science learning can promote motivation?

Zuma: Very much

Interviewer: And then what about academic performance, what role can academic performance play in promoting science learning?

Zuma: Looking at academic performance, it's a matter of how you are actually performing at that moment. Some people will tend to be discouraged if they are not doing well. Some people like us, we learn when we are not doing well. Trust yourself. So the way you man up it's a matter of them looking at it in a positive way and trying to go out there. If this book is not working for you, try using a different book. Because the more you investigate, the more you read different books is the more you gain more knowledge towards the subject. So my academic performance, probably, I might if I am not doing well in a subject at this point and I feel like I need to go out there and do some research. Probably the way they wrote these books, it's not related to my experiences, the language they are using at that point is not related to me. So going out there and finding another textbook, it means that am going to get an understanding from that book, am going to get knowledge. So that mean I am boosting my knowledge in the field through my academic performance because it's the one that motivated me to go out there and…but also if you are actually doing well and that's a good thing. So I think it's around those things.

Interviewer: So would you say then the discussions among learners they can promote and enhance one's own academic performance

Zuma: They can if they discuss the right things. Only if they discuss the right things.

Interviewer: Why do you keep on saying "The right things"?

Zuma: No, they can discuss the wrong things, we do discuss the wrong things. We do sit as the group and talk the wrong things and when we get our marks back then we ask ourselves what happened there. We thought we were right at that point. So if you have a good background knowledge and we get ourselves into a scenario and we discuss that thing. The moment we discuss that, definitely it will positively impact our academic performance towards a subject.

Interviewer: And then what role can discussions between learners play in promoting positive attitude in science learning?

Zuma: It's a matter of how they feel towards the subject. So if they have like this positive towards it, it will definitely help them because as always it's even difficult… it's actually easier for me to be discouraged if my friend tells me that these thing is hard, this thing is not for me. It is easier for me to probably believe that compared to when I'm reflecting alone saying "But I can do this I know my strength". But if I can see my friend also not having interest towards the subject, so this is more to…

Interviewer: What I am picking up from what you are saying is that if you've got a negative attitude towards the subject, you can kind of brush it off to me.

Zuma: Yes, that's true. There's a lot of learners others going down the drain because the people around and the environment is negative towards that particular thing. And you don't even give yourself a chance to try and see for yourself if these things are really out of my space or what.

Interviewer: So then if I understand you well, you are saying that learner-learner talk can play a positive role in terms of promoting positive attitude only if both learners have got positive attitude and it can enhance academic performance if only they are discussing the right things. And it can also promote motivation.

Zuma: Yes, I mean it's discouraging if I was discussing with you about this assignment and then you come and fail. I am going to be discouraged.

Interviewer: And then it also promote participation?

Zuma: Yes

Interviewer: Because you have someone challenging you and understanding

Zuma: True

Interviewer: In your classroom, would you encourage learners to discuss concepts among themselves?

Zuma: I would. I would but I need to ensure that first, I've given off positive energy. You don't you just create that. I can't go there on the first day and expect them to do that. They need to get used to me, they need to get used to my energy, to my attitude towards the subject. They need to see that I actually love what I am doing and try to show them "guys does not difficult at all". But the moment I introduce a topic "I'm saying a Newtown's laws guys this topic is actually one of the hardest topics in physics". The moment you tell them that, some brains switch off. And then

there are those that are trying to survive, without even me telling them what's happening. They will switch off already. So it's a matter of what kind of energy do I bring on to the classroom. By telling you "Guys Newton's law it's very interesting, you guys will love it. It's amongst the good topics in physics that you guys will use in the future" definitely they'll be interested. Before you give them a problem they'll want to know what this Newtown's stuff is. By saying "guys this one is a no-go-area in Physics" they will never, trust me. They will never.

Interviewer: Other than that, is there any other reason why you would want to encourage learner-learner talk in the classroom?

Zuma: Yes, I want them to discover themselves, to discover their strengths where they are because I don't have to be the one telling them that they can do this or can't. They need to find it themselves. You see, it's so brilliant when you discover something on your own. It's always amazing and you will never go wrong. So the moment they, themselves, talk about that, that's when they are freer. They are free to actually do whatever. In a field like this, there's numbers, calculations, some learners can find answers in a way compared to the one I would be dictating to them that "guys this is the one way you can find this". On the other hand, the learners would have found an easier one, a more economic one for them. So that's the reason why I would personally encourage learner-learner talk, group work yes. So that people discover themselves and learn to work with other people. They learn to listen because they need to know that it's not about them all the time, you won't be always right. Someone else knows this thing.

Interviewer: Would you give me examples of concepts that you think may need learners to discuss and how these discussions could be initiated, by whom? And how could they be conducted and supported?

Zuma: In Physical Sciences in general?

Interviewer: Yes

Zuma: Concepts in Physical Sciences… for example, organic chemistry is too broad, very broad. That topic needs people to be careful. So trying to go for through it alone you might sometimes make mistakes like we have a lot of functional groups in organic chemistry. There are some where you need to understand that if we have the double bond in between, what is, and if you have a double bond to the end, what it is. Such things that you might not notice. If am studying individually I might say if each time I see a double bond, this is it, its end. You might find out

that no, it matters where position of the double bond is. See someone else is coming and telling you that. So that way you discovered those small things that you would neglect as a person because some of us when we open a book we just see how it looks and just move on, and then you look at how ketones look and then I move on. Then when it comes to a test, the double bond is not here, it's here and then you conclude that this thing is a ketone. So trying to avoid such things. But an external person coming to discuss such a thing with me, telling me that "No guys, this is how you do it. If you see a double bond here it is that". So I think in that way learner-learner talk can help me, help a lot of things and change the way I even read that "Okay next time am going to read everything, am not just going to look".

Interviewer: And then in your classroom, how would you support such discussion amongst learners? How would you support that?

Zuma: I need to be active. When I give them group work, it doesn't mean that I have to isolate myself and not care about them, assume that they are fine. I need to go there and see if they are actually discussing the right and ask how far they are "What does this mean" I can just show them there "what are they saying about this". So to see if the group session is working or not because it's not all the time that it's going to be positive as we wish. It won't always be like that. So we also need to be active as much as we can. It doesn't mean it's a break for me as a teacher, I can start marking, and I can start doing whatever. But I need to also check them out.

Interviewer: Okay. That's the end of our interview.

Zuma: That was fast, I was still rolling.

APPENDIX H: OBSERVATION SCHEDULE

This observation schedule was enacted during teaching experience when pre-service Physical Sciences teachers are teaching.

Exploring pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk in the classroom

Participant pseudonym:	
Observation date:	
Observed by:	
Topic taught:	
Where is the lesson taking place?	
Number of pupils in the classroom	

The aim of this observation was to determine classroom interactions as facilitated by pre-service Physical Sciences teachers during teaching experience.

Preparation for learning	Describe the Physical environment
	Describe the environment made by the teacher to ensure effective teaching conditions
Agreeing learning outcomes	What are the learning outcomes of this lesson?

Construction of meaning	Describe the main activities that the learners use to construct meaning
Demonstrating new understanding	What ways are learners expected to show new understanding e.g. group presentations
Reviewing new learning	Describe ways in which learners check whether they have met the learning outcomes set the lesson

APPENDIX I: OBSERVATION TRANSCRIPT

This observation schedule is enacted during teaching experience when pre-service Physical Sciences teachers were teaching.

Exploring pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk in the classroom

Participant: Ms Hlophe
Observation date: 7 August 2019
Observed by: Ms N.K. Radebe
Topic taught: Power
Lesson duration: 45 minutes
Number of pupils in the classroom: 29

The aim of this observation is to determine classroom interactions as facilitated by pre-service Physical Sciences teachers during teaching experience.

Preparation for learning	**DESCRIBE THE PHYSICAL ENVIRONMENT** Lesson takes place in a classroom In this lesson, learners are seated in groups of 4 facing each other. Groups consists of mixed gender. Chalk board is ready/cleaned. There are no additional resources bought to the classroom to aid learners understanding of power.
Agreeing learning outcomes	**WHAT ARE THE LEARNING OUTCOMES OF THIS LESSON?** Learners are required to know what power is, how to calculate it and how to derive its formula using the Ohm's law formula. To help the learners achieve the learning outcomes of the lesson, the teacher is writing notes on the board for the learners. She also explains these notes to the learners. She is also showing them how to derive two other power formulas by relating power to Ohm's law formula.
Construction of meaning	**DESCRIBE THE MAIN ACTIVITIES THAT THE LEARNERS USE TO CONSTRUCT MEANING**

	Learners are given an activity to do individually in a textbook. In this activity, learners are to relate power to energy in order to find the amount of energy transformed by a light bulb per minute. This requires learners to use one of the formulas derived from Ohm's law formula. They are supposed to also find the relationship between power and voltage.
Demonstrating new understanding	**WHAT WAYS ARE LEARNERS EXPECTED TO SHOW NEW UNDERSTANDING E.G. GROUP PRESENTATIONS** The teacher invites learners to do corrections on the board. While writing corrections, learners are expected to explain the steps they took in finding the answers. Learners are marking themselves as they are doing corrections.
Reviewing new learning	**DESCRIBE WAYS IN WHICH LEARNERS CHECK WHETHER THEY HAVE MET THE LEARNING OUTCOMES SET FOR THE LESSON** Learners' answers to the activity are their ways of checking whether they met the learning outcomes set for the lesson. If learners are getting correct answers that means that they have met the learning outcomes set for the lesson.

APPENDIX J: TRANSCRIPT OF AUDIO-RECORDED TEACHER TALK

Participant code: Mr Nkosi

Observation date: 16 August 2019

Observed by: Ms N.K. Radebe

Topic taught: Faraday's law of induction

Lesson duration: 30 minutes

Number of pupils in the classroom: 5

Nkosi: Morning.

Class: Morning sir

Nkosi: Morning

Class: Morning sir. We'll do things a little bit differently, so I am trying to find a way to balance four people and three at the same time, I don't know how. So today we are working in a group. Remember, yesterday we did a direction of magnetic field in what? E? The direction of magnetic field yesterday in what?

Learner E: Solenoid

Nkosi: In a solenoid. Yesterday we were dealing with a solenoid. D, what is a solenoid?

Learner D: A solenoid is a loop of wires wounded together

Nkosi: It's a loop of wires wounded together. So remember I said that the right hand rule differs from just one single wire and solenoid. How is it different? A, how is it different?

Learner A: What's different sir?

Nkosi: The right hand rule, how is it different from the one we use for single wire and the one we use for a solenoid.

Learner A: I think… [*Inaudible*]

Nkosi: D?

Learner D: For a single wire, the thumb points in the direction of the current and the four fingers point in the direction of the magnetic field.

Nkosi: So for a single wire, we said the thumb points in the direction of the current and the four fingers…

Learner D: Point in the direction of the magnetic field

Nkosi: B, show me how if the current is going up and the magnetic field? No, we are talking about the single wire. A single wire not a solenoid. C, A single wire, not a solenoid. If the current is going up, the direction of the magnetic field.

Learner C: Like this sir

Nkosi: It's a single wire not a solenoid. Remember, there's a difference between a solenoid and single wire.

Learner C: The thumb points in this direction sir

Nkosi: The direction of what?

Learner C: Current

Nkosi: And then the fingers? The magnetic field

Learner C: Yes the magnetic field

Nkosi: So when you have your wire, single wire right, and the current is going up, your thumb points up and your fingers represent what? Magnetic field. Remember yesterday, since it is going up and then the fingers…so do you understand? That was for a single wire. So for a solenoid, things changes remember I said a little bit different. Now E, in a solenoid, the thumb represent what? C, it represents what?

Learner C: Current

Nkosi: In a solenoid

Learner C: The magnetic field.

Nkosi: And the four fingers?

Learner C: Current

Nkosi: So when you are having a North, remember a bar magnet, what did I say about the direction of magnetic field in a bar magnet? D?

Learner D: It always moves from North to South.

Nkosi: Its always from North to South. If the direction of magnetic field is moving from North to South, what is the direction of the current? B? Use your right hand rule. Use your right hand rule. So its going where?

Learner B: Its going up.

Nkosi: By up you mean it's going into the solenoid. E, are you okay?

Learner E: Yes

Nkosi: By the way you were writing a test yesterday. I gave them a trick yesterday and said that when you are using your palm, this part of your hand, you have to curl your fingers. But when you are using the back of your fingers, you don't curl your fingers. Remember first day, we had a magnet and then we said magnetic field moves from North to South remember. So in North, it moves out remember and in South it goes in. so here, you are having a north and south and magnetic field moves from North to South. Let's use the back of our hands A to show the direction of magnetic field, there we go, moving from North to South. The four fingers represent what A?

Learner A: Current

Nkosi: And it's going where?

Learner A: Up

Nkosi: Up which means into the solenoid. So if you use this part, your palm, you have to curl your fingers which is something you were failing to do yesterday. If you are going to use your palm, this part and then going up. Do you understand? But I said use the back of your hand its simple, you just place it and then it shows everything. This is what we did yesterday. And then today we are moving. I told you that today we are moving to Faraday's law. Now we'll begin with calculations. Faraday's law. Am only going to give you the basics and do one calculation with you.

Learner D: Yesterday I think you made a mistake I don't know

Nkosi: Where? In your classwork?

Learner D: In your notes, am sure everyone wrote like this.

Nkosi: Where we were using the north and the south?

Learner D: Yes, am confused again.

Nkosi: You are confused again? Let's start afresh. What happened?

Learner D: Why is the current going down?

Nkosi: If North Pole is going towards, then it's going out.

Learner D: What did you write?

Nkosi: Yes, if North Pole…remember what I said to you, if South Pole is moving towards current is going down. If North Pole is towards, current is going up. That's the mistake you made, you see. You didn't use the right hand rule. Use the right hand rule you'll see that you are wrong. Remember I told you that the right hand rule is your guide. The right hand rule always helps you, it's always guide you. You made a mistake you see.

Learner D: But I saw it.

Nkosi: You did?

Learner D: Yes sir

Nkosi: You use the right hand rule always and you place your hand on your classwork book. So we were just talking about the direction of the magnetic field. Remember I first said that the magnetic field is a vector quantity. What does that mean A?

Learner A: It has magnitude and direction sir.

Nkosi: It has magnitude and direction. If it has magnitude, it means that there must be units.

Learner A: Yes sir

Nkosi: So magnetic field is measured in tesla which is capital letter T. So you need to know this because now we are moving to Faraday's law and you will have to do calculations in a group. I will give you two calculations and I will give you time to do them on your own and then give me the answers. I will only do one calculation with you. We are fusing Faraday's law with Ohm's law, you'll see how. Now we know that magnetic field is measured in tesla, just T. Now we get into Faraday's law. Remember the first lesson, I had a circuit board, where's my circuit board? Here's our circuit board. When you are stating Faraday's law, you are stating that the induced EMF…what is an EMF A? You don't know what's an EMF? You did circuits but you don't know what EMF is. C?

Learner C: Electromagnetic force

Nkosi: EMF?

Learner C: It's an electromagnetic force

Nkosi: The induced EMF is equal to the rate of change of magnetic flux through the circuit. EMF is the total voltage of the battery. Do you understand? It's the total voltage of the battery. So they are saying induced EMF in a circuit, in this circuit you see, this one, is equal to the rate of change of magnetic flux through this circuit, through this circuit I am carrying right now. And remember in a circuit we have wire and they are circular.

Learner D: That means they have magnetic field

Nkosi: That's where we are going now. Magnetic flux, write this down, is the product of the magnetic field perpendicular, you know what perpendicular means, to the surface and area. Of the surface. Remember I just told you that wires are shaped in circle. So B, how do we calculate the area of a circle?

Learner B: πr^2

Nkosi: An area of a circle is πr^2. You'll never be given this in a formula sheet, you need to know this. So magnetic flux, this part, we said it's the product of magnetic field. So we are having magnetic field. Remember we said that we represent a magnetic field with B. magnetic flux is a product of magnetic field perpendicular to the surface. When you say perpendicular, you already know that there's an angle involve and the area of the surface. So we are having magnetic field and area. The angle we use is cos theta. That's just the magnetic flux. And the sign we use for magnetic flux is this one. So this is the formula we use to calculate the magnetic flux. Magnetic flux is equal to magnetic field multiply by area *cos theta*. B, do you understand?

Learner B: Yes sir

Nkosi: E, do you understand?

Learner E: Yes sir. A, is the area?

Nkosi: Yes, A is the area. Now there are instances where you will be given the solenoid and you will be told that the magnetic field is parallel, not perpendicular, so magnetic field will be going in that direction. Then they say the angle, the magnetic field next to the normal, the magnetic field is just parallel. So the angle these two make is ninety. Listen carefully and use your calculator, cos90 is what A?

Learner A: Zero

Nkosi: Its zero. And then this explains this motion that you can have a magnitude of magnetic field in a solenoid but you can have the magnetic flux being equal to zero. Do you understand? You can have a magnetic field of a solenoid, maybe its equal to 2 tesla, and have a magnetic flux being equal to zero. Are you aware? Do you know how? I've just explained it now. If you are having cross lines, everything is zero. If you multiply by two or one, this whole thing becomes zero. This explains why you can have a magnetic field and a magnetic flux being zero. Let's move on, I wanted to get this point across. Let's carry on with our Faraday's law. Remember we said the Faraday's law says the induced EMF in a circuit is equal to the rate of change of magnetic flux. Now it's a change. By rate, when they mention rate, what do you think of? A? C? Its time. When they say rate, which means there's time. So Faraday's law is this E for EMF, equal to minus N which is the number of coils, you know we have a solenoid so there are number of coils. You'll be given. So the N is for the number of coils. And it said change, it didn't say magnetic field. Then we are having a change in magnetic flux equal to change in time. This is your Faraday's law. Let me explain the negative sign, what it means. If you calculate and you find that your EMF is positive, write that down. If your EMF is positive, it means the change in magnetic flux is negative. But if the EMF is negative, the change in magnetic flux is positive.

Learner A: If what sir?

Nkosi: If you calculate and find that your EMF being equal to 4 volts, this simply means that the change in magnetic flux is negative. But if this EMF is negative 4 volts, it simply means that the change in magnetic flux is positive. Remember, I always tell you that the units are always important. You have your time in seconds, your coils will be in turns. Now the change in magnetic flux is going to be different, it's going to be the B_{final} A cos theta and then $B_{initial}$ A cos theta. You can factor out here and have A cos theta open bracket and have B_{final} minus $B_{initial}$ and close bracket. Now this is your change in magnetic flux. Are you okay B?

Learner B: No sir

Nkosi: You not okay. Remember we said magnetic flux is equal to BAcosϴ. Now it's no longer magnetic flux, its change in magnetic flux, which means you'll have initial and final. So when its change, you'll have BAcosϴ for final minus BAcosϴ for initial. But since you are doing Maths, you can just factor this out. You have A and cosϴ this side and that side, so just take one and

then open bracket and place B_{final} minus $B_{initial,}$ close bracket. That's your change in magnetic flux. I am going to do one calculation with you and then am going to give you two calculations you'll do them in groups. So the question can be phrased in this way, they will say consider a circular coil, we already know that by circular we mean that $A = \pi r^2$. So they are telling you that it's a circular coil of five turns, N is equal to 5, with a radius of 1.73m. Then we are having a magnetic field and they are saying is uniformly at 2.18 tesla firstly and it goes to 12.7 tesla that's the magnetic field. All this took place in 3 minutes. This is what we have. Then the first question says calculate the EMF. The second question says calculate the current flowing, the induced current. E, which formula can we use to calculate the EMF?

Learner E: Faraday's law

Nkosi: Give me Faraday's law

Learner E: It says minus N multiply by change in magnetic flux over change in time.

Nkosi: Do we have the number of coils?

Class: Yes

Nkosi: A, how many?

Learner A: 5

Nkosi: The formula for change in magnetic flux, B?

Learner B: It's a cosϴ open bracket, B_f minus B_i, close bracket.

Nkosi: Oh, I forgot something, the angle its 27 degrees. So from here, how do you calculate the area, C? How do we get the area? We are not given the area. Which formula can we use?

Learner C: πr^2

Nkosi: What's our r E?

Learner E: 1.73

Nkosi: 1.73 Squared. Then we have our angle which is cos27. What's our final magnetic field?

Class: 12.7

Nkosi: Our final magnetic field is 12.7. What's our initial magnetic field?

Class: 2.18

Nkosi: So its 12.7 minus 2.18. We are given time as 3 minutes. Can we put it there as just 3 minutes?

Learner D: It has to be in seconds

Nkosi: Yes, then how do we convert from minutes to seconds? E, how do you convert from minutes to seconds?

Learner E: Its multiplication

Nkosi: You multiply by?

Learner E: 60.

Nkosi: In 1 minutes, you have 60 seconds. So we'll have 3 multiply by 60. So I need the induced EMF. Remember the first time we met, I told you that I am not punching the calculator for you. You must learn to punch the calculator for yourself. Calculate. You'll have to explain to me why you got a negative answer right. Write your answer and then explain to me why your answer is negative. Remember I explained to you the reason why you would get the EMF as negative. You'll have to explain to me. So what's the answer D?

Learner D: Negative 2.45

Nkosi: Negative 2.45, this answer is not complete.

Learner D: V

Nkosi: V. So D, explain to me why your answer is negative.

Learner D: The EMF is negative because the magnetic flux is positive right.

Nkosi: Magnetic flux or change in magnetic flux?

Learner D: Magnetic flux.

Nkosi: The change in magnetic flux is positive hence why the magnetic field is negative. So the second question is calculate the induced current. How can we calculate the induced current? A, give me a formula we can use to calculate the induced current. Or a law that we can use to calculate the current. B, how can we calculate current? D, give me a formula.

Learner D: I don't know the formula but it's Ohm's law

Nkosi: Give me Ohm's law then

Learner D: Its I is equal to V over R.

Nkosi: Do we have R?

Class: Yes.

Nkosi: R is your what?

Class: Resistance

Nkosi: Do we have resistance?

Class: Yes

Nkosi: Its what?

Class: 3 Ohms

Nkosi: 3 Ohms. Do we have V?

Class: We've just found it.

Nkosi: We have 2.45 and then we are looking for current. Remember the current is moving in a different direction to a magnetic field. So your current is?

Learner D: 0.82

Nkosi: 0.82 Amperes. You can decide to use the negative and say negative 0.82 but this negative is telling you one thing that current is moving in opposite direction with magnetic field. It's telling you just that, opposite direction.

Learner D: So if the negative is not there, won't they mark us wrong

Nkosi: It depends on who's marking.

Learner D: No sir.

Nkosi: It either you put it, if you don't then you have to explain why it's not there. It's either you put it or you don't.

Learner D: I don't know what to do.

Nkosi: So I am going to split you, you can't work in such a group. I'll have E working with D, so you too can go work at the back and you'll have your own questions. You three will work together. So you have how many minutes, let me check, 10 minutes to finish.

Class: Is it a classwork?

Nkosi: No, write this on your notebook. This question is for D and E. So here's your question D and E. you have a circular coil which has 4 turns, you have radius of 3 times ten to the power 2 meters. You have magnetic field moving from 3.4 tesla to 0.4 tesla. So this is the initial magnetic field (*referring to 3.4 tesla*) and this is the final magnetic field (*referring to 0.4 tesla*). A, this is not for your group. Your angle is 35 degrees. This whole thing is going to take 36 seconds. Now you have the induced current that is flowing which is 3.4 amperes. You are calculating two things, the EMF and the resistance. You have ten minutes. A, B and C, come together. You can discuss, you are doing it together. You can discuss while doing it. You guys [*referring to A, B and C*] have your own question as well. So here's your question. Your coil is circular, it has five turns right. It has a diameter of two meters, magnetic field ranging from 9 tesla to 14 tesla. This is an initial (*referring to 9 tesla*), this is a final (*referring to 14 tesla*). You having an angle as 45 degrees, your time as two minutes. Right, so you have your diameter and you know that your coil is circular and your magnetic field is initially 9 and finally 14. So I need you to calculate the EMF. Once you get your EMF, you discuss. Once you get your value, you discuss why it is negative or positive. You can start. So you are discussing amongst the three of you how you are going to get to the final answer, which law are you using right? A, bear in mind, this is not a radius it's a diameter. You are not just writing on your own, you work as a group and discuss how you are going to get your answers.

Groups doing corrections on the board

Nkosi: D and E, you can do corrections on this side, then A and B this side. We don't have much time, we have less than two minutes of time remaining. And you must explain to us how did you get to this answer. We need to understand how you got to the answer.

Learner D: So we were given N as 4, the radius is 3 times ten to power negative 2, our initial magnetic field is 3.4 tesla and our final is 0.4 tesla. And then theta is 45 degrees and then I is 3.4 amperes and then change in t is 36 seconds. So firstly we find the area. In order for us to find the area, the formula is πr^2 . Our r is…

Learner E: Pi times, open bracket, 3 times ten to power negative 2 which is 2.8 times ten to the power negative three.

Learner D: To the power negative what?

Nkosi and E: To the power negative three.

Nkosi: So that's your area?

Learner E: Yes

Nkosi: What's the unit for area? Thank you.

Learner D: Then question one says find the EMF. So we used the Faraday's law

Nkosi: Which is?

Learner D: E is equal to negative N multiply by change in magnetic flux over change in t.

Nkosi: Thank you

Learner D: Our N was 4, then here?

Nkosi: Where here? When you say here, where?

Learner D: The formula for this, the change in magnetic flux is $Acos\theta(B_{final} - B_{initial})$ over change in time which is 36 seconds. So we don't have to do anything, change in time remains like this. So E is negative 4, A is 2 comma 8 times ten to the power negative three, our cos angle is 45 degrees and then B_f….

Learner E: We got 0.4 minus 3.4

Learner D: B_i is 3.4 then our answer, E, is 4

Nkosi: D, why is your EMF positive?

Learner D: Our EMF is positive because the change in magnetic flux is negative.

Nkosi: Alright, you can carry on.

Learner D: Our second question was to find resistance and we used the Ohm's law formula

Nkosi: What did you use?

Learner E and D: Ohm's law

Learner D: Which is I is equal to V over R. V is our EMF and I we were given. So R is equal to 4 over 3.4 then our R was 1.18 ohms.

Nkosi: Alright, thank you

Class clapping hands for D.

Nkosi: Second group. We don't have much time.

Learner B: We'll start by listing the things we were given. Our number of coils turns was 5…

Learner A: The diameter was 2m and MF…

Nkosi: What is MF A?

Learner A: Sir?

Nkosi: What is MF?

Learner A and B: Magnetic field.

Nkosi: Alright

Learner A: Is equal to 9 tesla minus 14 tesla.

Nkosi: Is this minus?

Learner B: No

Nkosi: This is not minus

Learner A: Negative

Nkosi: This is not a minus, what does it mean? Which one is the initial and which one is the final?

Learner A: The initial is 9 and the final is 14.

Nkosi: There is no minus

Learner A & B: Yes sir.

Nkosi: Carry on

Learner A: Theta is equal to 45 degrees and the change in time is equal to 2 minutes.

Learner B: Is that all?

Learner A: Yes

Learner B: Okay, so we are calculating the EMF.

Nkosi: What are you going to use to calculate the EMF?

Learner B: Faraday's law

Nkosi: What is it saying?

Learner B: Negative N multiply by change in magnetic flux over change in time.

Nkosi: Alright.

Learner B: Okay first of all we have to calculate our radius

Nkosi: How do you calculate the radius?

Learner B: The radius is half of the diameter so its 2 multiply by half which is 1

Nkosi: 1m

Learner B: Equal to negative five. Negative five multiple by cos45˚, open bracket, B_f minus B_i, close bracket, all over change in time.

Nkosi: Carry on this side

Learner B: Negative five

Nkosi: Its E, for EMF is equal to! Its E not just negative five.

Learner A: Cos45, open bracket, 14 minus 9, close bracket, all over 2 multiply by 60

Learner B: For seconds

Nkosi: So why did you write 2 times 60 for time?

Learner B: Because we need the time in seconds and it was given to us in minutes.

Nkosi: Oh, okay. I understand. Your E?

Learner B: So our E is equal to…

Learner A: Negative 0.46 volts.

Nkosi: Alright. So tell me, why is your answer negative? Why is E negative?

Learner B: Our E is negative because our…

Learner A: Change in magnetic flux is positive.

Nkosi: So the change in magnetic flux is positive?

Learner B: Yes

Nkosi: Hence why your EMF is negative

Learner B: Yes

Nkosi: Alright thank you. On Monday, we'll do more calculations but in a different aspect. This was just the basics. We'll just do two complicated calculations on Monday, we'll do two calculations and then move on. We are far behind, a week behind so we'll move on to something else.

Class is dismissed

APPENDIX K: TRANSCRIPT OF LEARNER-LEARNER TALK

Participant: Ms Hlophe

Observation date: 7 August 2019

Observed by: Ms N.K. Radebe

Topic taught: Power

Lesson duration: 45 minutes

Number of pupils in the classroom: 29

Learner C: Do we have time?

Learner B: Yes we do

Learner C: What is it?

Learner B: Its one minutes

Learner C: We have to convert from minutes to seconds. What is time in seconds?

Learner B: Its 60 second. 60 times 240. What is the answer?

Learner C: 14400

Learner D: Mam, are you marking?

Hlophe: Isn't that you are given the voltage then you converted it to?

Learner B: Watts

Hlophe: Yes. What are we looking for?

Learner D: Joules

Learner B: Power its work done over what?

Learner D: Time

Learner B: What is our power?

Learner D: Its 100

Learner C: We have power and voltage, we are looking for resistance, its cross multiplication.

Learner A: We don't have I, V won't allow us to do what you guys are saying

Learner B: What are we saying? We don't have I.

Hlophe: Why didn't you show me that I wrote an incorrect thing here?

Class: We told you

Hlophe: So this is power not R. Power is equal to V squared over R.

Class: We told you mam

Hlophe: You told me? I didn't hear that my apologies.

Learner B: Here it is, voltage divide by P, here it is, its 240 divided by 100

Learner D: Where did you get 240?

Learner B: Its P is equal to V squared over R.

Learner D: I got it then you say 240 divide by 100

Learner B: Mam, what do they want here? Joules or Ohms?

Learner D: Didn't they say Ohms?

Hlophe: What question is that?

Learner B & D: Its question 2.

Hlophe [*talking to B*]: Yes but Ohm's…what did they want?

Learner B: The resistance

Hlophe: What is the definition of a resistance? When we talk about electric power, resistance is equivalent to a power. Not power, I mean it is equivalent to work. That's the definition of a resistance.

Learner D: When we looking for power, the resistance becomes joules.

Hlophe [*talking to B, C and D*]: You have to look at the definition for both. Isn't that we said that one is the amount of work needed…what does the resistance do? It work is to oppose the amount of current passing through per second. That work is the same as work that you are looking for when you are talking about power. So its equivalent to work. Isn't that resistance does it function of controlling the amount of current passing though. So it's doing work. So resistance is similar to work.

Learner B: Joules?

Hlophe [*talking to B*]: Yes, but that applies in power but in electric circuits we just use the names we are used to.

Learner B: Resistance?

Hlophe: Yes

Learner B: Last one hey, am done.

Hlophe: are you done?

Learner A, B, C & D: Yes we are done.

Learner H: We'll be done soon

Hlophe: Okay, let's finish up. Okay, let's mark. C come and write the corrections. Okay let's look at C doing number A.

APPENDIX L: TRANSCRIPT OF POST LESSON INTERVIEW

Interviewee:	Mr Nkosi
Interview date:	16 August 2019
Interviewer name:	Ms N.K. Radebe
Aim of the interview:	To understand some aspects of the observed lesson as facilitated by a pre-service Physical Sciences teacher

Interviewer: Tell me about the activity that you've given them

Nkosi: I gave them two different activities reason for the difference was based on their cognitive ability. In a classroom, you have learners who can do certain activities and learners who cannot do certain activities. So when grouping them, I had a group of D and E, E is struggling so I had D to balance the team and help E with calculations. And then I had a group of A, B and C. A and B are both good and then I have C who's struggling. So having those two in a group, they are not as good as D. So having them in a group it balances and they can help C. You saw C was participating and stuff which means he understood the way they were explaining the questions to him and helping him with the calculations. So that's why I decided that the question of D and E be longer because they are quick, D understand and E will also understand. Then the question for C's group was short because when I was teaching I realised that he's still struggling to understand why EMF is negative and why EMF being negative is affected by the magnetic flux hence I changed their question to be just calculating EMF and discussing why they found it to be negative.

Interviewer: Would you then say the type of questions given to the learners were low level or high level and why.

Nkosi: For today, it was just lower level reason being that we've just started the chapter yesterday where we did the basics. So today we were doing Faraday's law. And also it was just a first lesson and I had to introduce them to the content first. So it was just lower level and as I said next week we'll start doing calculations which have diagrams from previous question papers. I usually use previous question papers, even these questions were from the previous question paper but I just took the lower level questions.

Interviewer: Would you then say group work works best for you when the questions are lower level?

Nkosi: Yes, when they start to be high level they'll have to do them individually. I would give them a task, go around and helping them where I can. So when its high level, group work doesn't work because they will be more confused and once they are confused, they will start misbehaving.

Interviewer: That's it from me, thank you

Nkosi: Alright

APPENDIX M: INFORMATION SHEETS AND CONSENT LETTERS

STUDENT INFORMATION SHEET

DATE: 01 July 2019

Dear Student

My name is Nomfundo Knowledge Radebe and I am a Masters student in the School of Education at the University of the Witwatersrand.

I am doing research on pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk in the classroom.

The purpose of this research study is to investigate pre-service Physical Sciences teachers' experiences and perceptions of the value of learners talking to their fellow learners in the classroom. This study is triggered by my observation of poor performance on this subject and the decreasing number of learners opting for this subject in the 2018 National Senior Certificate (NSC) diagnostic report.

In order to address the purpose of this study, data will be collected through individual interviews and observations. The interviews will be focused on determining your experiences and perceptions of learner-learner talk and will be audio-recorded.

The observations will be conducted during teaching experience and will be focusing on how you facilitate learner-learner talk in the classroom. A minimum of three lessons will observed.

I will also audio-record your talk when teaching as well as your learners talk during groups' discussions where they will be organized into small groups to discuss tasks you will give them. From the groups formed, I will select one group to audio-record their talk. However,

the selection of the group will be based on voluntary participation, i.e. those who will have agreed to participate in the study will be placed in their own group, and data collection will be focused on this group.

Furthermore, I will analyse the activities that you will give to your learners during teaching experience to determine the extent in which they promote learner-learner talk as well as the lesson plans you would have prepared to determine any changes in your perceptions regarding learner-learner talk.

The reason why I have chosen you is because you are soon to be a qualified Physical Sciences teacher, currently doing your year of study four in Physical Sciences and have more experience of group work as all practical sessions at Wits school of education are conducted in groups/pairs.

Would you mind if I ask you to participate in the study by giving me a permission to interview you, observe you when teaching and also audio-record your talk with your pre-learners?

Remember, this is not a test, it is not for marks and it is voluntary, which means that you don't have to do it. Also, if you decide halfway through that you prefer to stop, this is completely your choice and will not affect you negatively in any way. You will also not be paid for participating in this study

I will not be using your own name or any features that will identify you in any part of this study but I will pseudonyms so that no one can identify you. All information about you will be kept confidential in all my writing about the study. Also, all collected information will be stored safely and destroyed between 3-5 years after I have completed my study.

Please let me know if you require any further information.

Thank you very much for your support.

Yours sincerely,
Nomfundo Radebe

SIGNATURE N.K. Radebe.

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STUDENT CONSENT FORM

Please fill in and return the reply slip below indicating your willingness to be a participant in my voluntary research project called: EXPLORING PRE-SERVICE PHYSICAL SCIENCES TEACHERS' EXPERIENCES AND PERCEPTIONS OF LEARNER-LEARNER TALK IN THE CLASSROOM

I, _____ give my consent for the following:

Permission to be interviewed	**Circle one**
I would like to be interviewed for this study.	YES/NO
I know that I can stop the interview at any time	YES/NO
I don't have to answer all the questions asked.	YES/NO

Permission to be observed	
I agree to be observed in classroom during TE	YES/NO

Permission to be audiotaped	
I agree that my talk with my peers can be audiotaped during Physical Sciences practical sessions	YES/NO
I agree that my talk when teaching can be audiotaped	YES/NO
I agree that my learners be audiotaped during observations	YES/NO
I know that the audiotapes will be used for this project only	YES/NO

Permission to review lesson plans	
I agree that the lesson plans I have prepared can be used for this study only.	YES/NO

Permission to review activities given to learners	
I agree that the activities I have prepared for learners can be used for this study only.	YES/NO

Informed Consent

I understand that:

- My name and information will be kept confidential and safe.
- My name, the name of the school that I will be attending during TE and the university I am currently registered at for the BEd degree will not be revealed.
- I can withdraw from the study at any time.
- I can ask not to be audiotaped
- All the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____ Date_____

LETTER TO THE PRINCIPAL and SGB chair

DATE: 01 July 2019

Dear Principal

My name is Nomfundo Knowledge Radebe and I am a Masters student in the School of Education at the University of the Witwatersrand.

I am doing research on Pre-service Physical Sciences teachers' experiences and perceptions of learner-learner talk in the classroom.

The purpose of this research study is to investigate Pre-service Physical Sciences teachers' experiences and perceptions of the value of learners talking to their fellow learners in the classroom. This study is triggered by my observation of poor performance on this subject and the decreasing number of learners opting for this subject in the 2018 National Senior Certificate (NSC) diagnostic report.

In order to address the purpose of this study, data will be collected through classroom observations. These observations will be focusing on the interactions in the classroom between learners and their fellow learners as well as between learners and their pre-service Physical Sciences teacher. A minimum of three lessons will be observed. I will also audio-record the talk between learners and their pre-service Physical Sciences teacher and between learners and their fellow learners during groups' discussions, where they will be organized into small groups to discuss tasks provided by their pre-service Physical Sciences teacher. From the groups formed, I will select one group to audio-record their talk. However, the selection of the group will be based on voluntary participation, i.e. those who will have agreed to participate in the study will be placed in their own group, and data collection will be focused on this group. Furthermore, I will analyse the activities that the pre-service Physical Sciences teacher will give to their learners to determine the extent in which they promote learner-learner talk.

The reason why I have chosen your school is because the pre-service Physical Sciences teacher who is voluntarily participating in this study is currently located in your school for teaching experience. I need to observe how the pre-service Physical Sciences teacher facilitate learner-learner talk in the classroom.

I am inviting your school to participate in this research through the participating pre-service Physical Sciences teacher to help me fulfill my requirement for the Masters in Education degree. I also invite your school to participate in this research study so as to provide a deeper insight on this subject in terms of learner-learner talk.

The research participants will not be advantaged or disadvantaged in any way. Consenting participants will be placed in respective groups and will be audio-recorded during group discussions. Non consenting participants will not be observed or recorded although they will be expected to participate in class as normal. All participants will be reassured that they can withdraw their permission at any time during this project without any penalty. There are no foreseeable risks in participating in this study. The participants will not be paid for this study.

The identity of the school and that of individual participants will not be revealed, instead pseudonyms will be used to identify individual participants where names are necessary. Data obtained from the study will be kept confidential and will only be used for purposes of the publication of my report. All names of participants and the school will be kept anonymous.

All research data will be destroyed between 3-5 years after completion of the project.

Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Yours sincerely,
Nomfundo Radebe

SIGNATURE: NK.Radebe.

NAME: Nomfundo Knowledge Radebe
ADDRESS: 1600 Nkelenga Road Lufhereng Ext.1 1875
EMAIL: knowmfundo@gmail.com/851590@students.wits.ac.za
TELEPHONE NUMBERS: 0644390086

LEARNER INFORMATION SHEET

DATE: 01 July 2019

Dear Learner

My name is Nomfundo Knowledge Radebe and I am a Masters student in the School of Education at the University of the Witwatersrand.

I am doing research on Physical Sciences student teachers' experiences and perceptions of learner-learner talk in the classroom.

The purpose of this research study is to investigate Physical Sciences student teachers' experiences and perceptions of the value of learners talking to their fellow learners in the classroom. This study is triggered by my observation of poor performance on this subject and the decreasing number of learners opting for this subject in the 2018 National Senior Certificate (NSC) diagnostic report.

In order to address the purpose of this study, data will be collected through classroom observations. These observations will be focusing on the interactions in the classroom between you and your fellow learners as well as between you and your Physical Sciences student teacher. I will also audio-record the talk between you and your Physical Sciences student teacher and between you and your peers during groups' discussions where you will be organized into small groups to discuss tasks provided by your teacher. From the groups formed, I will select one group to audio-record their talk. However, the selection of the group will be based on voluntary participation, i.e. those who will have agreed to participate in the study will be placed in their own group, and data collection will be focused on this group.

Would you mind if I ask you to participate in the study by giving me a permission to observe you in class and also audio-record your talk with other learners and your Physical Sciences student teacher?

Remember, this is not a test, it is not for marks and it is voluntary, which means that you don't have to do it. Also, if you decide halfway through that you prefer to stop, this is completely your choice and will not affect you negatively in any way.

I will not be using your own name but I will make one up so no one can identify you. All information about you will be kept confidential in all my writing about the study. Also, all collected information will be stored safely and destroyed between 3-5 years after I have completed my study.

Your parents have also been given an information sheet and consent form, but at the end of the day it is your decision to join us in the study.

I look forward to working with you!

Please feel free to contact me if you have any questions.

Thank you

SIGNATURE: N.K. Radebe.

NAME: Nomfundo Knowledge Radebe
ADDRESS: 1600 Nkelenga Road Lufhereng Ext. 1 1875
EMAIL: knowmfundo@gmail.com/851590@students.wits.ac.za
TELEPHONE NUMBERS: 0644390086

LEARNER CONSENT FORM

Please fill in the reply slip below if you agree to participate in my study called: EXPLORING PRE-SERVICE PHYSICAL SCIENCES TEACHERS' EXPERIENCES AND PERCEPTIONS OF LEARNER-LEARNER TALK IN THE CLASSROOM

My name is: _____

	Circle one
Permission to observe you in class	YES/NO
I agree to be observed in class.	
Permission to be audiotaped	
I agree to be audiotaped during group and class discussions	YES/NO
I know that the audiotapes will be used for this project only	YES/NO

Informed Consent

I understand that:

- My name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I can withdraw from the study at any time.
- I can ask not to be audiotaped
- All the data collected during this study will be destroyed within 3-5 years after completion of this project.

Sign_____ Date_____

PARENTS INFORMATION SHEET

DATE: 01 July 2019

Dear Parent

My name is Nomfundo Knowledge Radebe and I am a Masters student in the School of Education at the University of the Witwatersrand.

I am doing research on Physical Sciences student teachers' experiences and perceptions of learner-learner talk in the classroom.

The purpose of this research study is to investigate Physical Sciences student teachers' experiences and perceptions of the value of learners talking to their fellow learners in the classroom. This study is triggered by my observation of poor performance on this subject and the decreasing number of learners opting for this subject in the 2018 National Senior Certificate (NSC) diagnostic report.

In order to address the purpose of this study, data will be collected through classroom observations. These observations will be focusing on the interactions in the classroom between learners and their fellow learners as well as between learners and their Physical Sciences student teacher. At least three lessons will be observed. I will also audio-record the talk between learners and their Physical Sciences student teacher and between learners and their fellow learners during groups' discussions where they will be organized into small groups to discuss tasks provided by their teacher. From the groups formed, I will select one group to audio-record their talk. However, the selection of the group will be based on voluntary participation, i.e. those who will have agreed to participate in the study will be placed in their own group, and data collection will be focused on this group.

The reason why I have chosen your child's class is because she/he is currently being taught by the Physical Sciences student teacher who is voluntarily participating in this study.

Would you mind if your child participates in this study where he/she will be observed and audio-recorded during Physical Sciences lessons?

Your child will not be advantaged or disadvantaged in any way. Learners who will have agreed to participate in the study will be placed into small groups and only one group will be audio-recorded during group discussions. Non-consenting learners will not be observed or recorded although they will be expected to participate in class as normal. Your child will be reassured that she/he can withdraw her/his permission at any time during this project without any penalty. There are no foreseeable risks in participating and your child will not be paid for participating in this study.

Your child's name and identity and that of the school will be kept confidential at all times and in all academic writing about the study. His/her individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

Please let me know if you require any further information.

Thank you very much for your support.

Yours sincerely
Nomfundo Radebe
SIGNATURE: N.K. Radebe.
NAME: Nomfundo Knowledge Radebe
ADDRESS: 1600 Nkelenga Road Lufhereng Ext. 1 1875
EMAIL: knowmfundo@gmail.com/851590@students.wits.ac.za
TELEPHONE NUMBERS: 0644390086

PARENTS CONSENT FORM

Please fill in and return the reply slip below indicating your willingness to allow your child to participate in the research project called: EXPLORING PRE-SERVICE PHYSICAL SCIENCES TEACHERS' EXPERIENCES AND PERCEPTIONS OF LEARNER-LEARNER TALK IN THE CLASSROOM

I, _____ the parent of _____

Permission to observe my child in class	**Circle one**
I agree that my child may be observed in class.	YES/NO

Permission for my child to be audiotaped	
I agree that my child may be audiotaped during observations.	YES/NO
I know that the audiotapes will be used for this project only	YES/NO

Informed Consent

I understand that:

- My child's name and information will be kept confidential and safe and that the name of my child and the name of the school will not be revealed.
- He/she can withdraw from the study at any time.
- He/she can ask not to be audiotaped.
- All the data collected during this study will be destroyed within 3-5 years after completion of this project.

Sign_____ Date_____

APPENDIX N: PLAGIARISM REPORT

851590:851590.docx

ORIGINALITY REPORT

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SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

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