# Exploring teacher talk and its role in learner understanding of science content

Student: Hlologelo Climant Khoza (461653)

Supervisor: Dr Audrey Msimanga

*A research report submitted to the Faculty of Science for the partial fulfillment of the degree Masters of Science (MSc), University of the Witwatersrand, Johannesburg.*

June 2016

## Table of contents

List of tables and figures (numbered according to chapters)

## Abstract

In order for educational researchers to make informed decisions about science education, careful attention should be given to what happens in science classrooms. What teachers do shapes the interaction and influences learner cognitive development. Classroom talk is an important part of what goes on in science classrooms. Research has shown that teacher facilitation of talk is important for learner understanding of science content. The purpose of this study was to explore how teachers facilitate talk in their science classrooms for learner understanding of content. However, I looked at their views on classroom talk first. Teachers have the ability to either open up or close learner interaction through talk. The interaction triggers certain kinds of engagement which may or may not promote understanding. The participants in this study were three male science teachers from an independent school with their Grade 11 learners. Teachers were chosen based on their availability. I interviewed teachers for their views on classroom talk. The interviews were audio recorded. Teachers were also observed teaching and the observations were video-recorded and transcribed. Classroom observations were analyzed using Mortimer and Scott's analytical framework on teacher communicative approaches. Findings suggest that although teachers value interaction and engage learners in dialogue, teachers use interactive authoritative approach more than interactive dialogic approach in their classrooms. The recommendation is that teacher education needs to find ways to make teachers aware of engaging learners in dialogic discourse in a science classroom.

## Keywords

Teacher talk, communicative approaches, learner understanding, analytical framework, mediation

## Dedication and acknowledgement

I dedicate this work to my mother Ramolokoane Johanna Khoza for the sacrifices she made for me up to today.


- First, I want to thank my supervisor Dr Audrey Msimanga for the guidance throughout this research. Your comments and meetings were very helpful and helped me refine my thinking and understanding. I wouldn't have reached this point without you.
- I am grateful to the schools operational leaders for allowing me into their schools.
- I thank Mr. D, Mr. N and Mr. S and their Grade 11 learners for allowing me into their classroom. I learnt a lot from observing your lessons.
- I am grateful to NRF for providing me with a bursary for my study.
- I thank God for making everything possible. More importantly, for giving me such an admirable and understanding supervisor (Dr Audrey Msimanga)

## Declaration

I Hlologelo Climant Khoza declare that this research report is my own, unaided work. It is being submitted for the partial fulfillment of the Degree of Masters of Science in Science Education at the University of the Witwatersrand, Johannesburg, South Africa. It has not been submitted before for any degree or examination in any other University.

30 Day of July 2016

# Chapter 1: Introduction to the study

## 1.0 Introduction

Talk is the most important aspect in science classrooms as it has implications for learning for conceptual development (Lemke, 1990). Lisanza (2014) outlines that the significance of classroom talk is embedded in the development of our conception of self. Through this development, we strive to display our competence as members of the science classroom community. In other words, it is through talk that we are able to understand the purposes and outcomes of science classrooms**.** Teacher talk is the primary tool of teaching. Studies suggest that teacher talk which promotes dialogic interactions where learners focus on the construction of knowledge maximize learning (Nystrand, 1997). Despite these efforts, there are still questions about what constitute quality teaching and learning (Anderson, 2004). However, quality teaching is highly dependent on teacher practices and teachers' views about teaching and learning of science.

Teaching and learning can be thought of in two dimensions; the traditional teacher-centered where the teacher is seen as the main source of knowledge and the learner-centered where learners engage with each other and the teacher acting as a mediator. In the teacher-centered classroom, learners become passive and recipients of information. In the learner-centered classroom, learners engage with the knowledge and fellow participants for a common understanding (Lyle, 2008). It has been shown that the way in which interaction is shaped will determine the extent to which learners understand the content taught (Mercer, 2008). That is, certain kinds of teacher talk and learner interaction can lead to learner understanding. Dialogue is one form of the important forms of interactions that the teacher and learners can engage in. Science education studies are interested in finding ways in which classroom dialogue contribute to development of learners' understanding of science concepts (Scott, Ametller, Mercer, Staarman & Dawes, 2007). However, this is not the only kind of talk happening in science classrooms. Social talk is another kind of talk that can also form part of the interaction (Solomon & Harrison, 1991).

In this chapter, I present an overview and introduction of the study. I start by presenting the background and context of the study to understand its social location and how it arises. I then identify the research problem and outline the rationale and significance of this research. I then outline the purpose of the study and that will lead me to the research questions that guided my study.

**1.1 Background and context**

Lisanza (2014) argues that the context of the study shapes its outcomes. Therefore, in order for the readers to understand the outcomes, they need to be familiar with the context. In this section, I talk about the background and the context of my study. The context is about where the study was conducted and providing the nature of settings and situations taking place (Morrell & Carroll, 2010).

To contextualize the study, I draw on the current South African curriculum - Curriculum and Assessment Policy Statement (CAPS). For two decades, curriculum designers have been trying to find ways of improving teacher practices in South African schools. In particular, the science curriculum has been altered and reconstructed. The curriculum was reconstructed to improve the results as well as moving from rote learning to more interactive approaches in order to maximize learner engagement (Chisholm, 2005; Brodie, Lelliott & Davis, 2002). Amongst other aims, the current policy is designed to improve individual's thinking skills. The curriculum's aim of improving learners' higher order thinking skills has been there in the post-Apartheid curricular. For example, the outcome-based education has encouraged teaching and learning to be a reflective process where teachers can reflect on their teaching approaches. Furthermore learners should be able to construct their own understandings through critical thinking and active participation in the lessons (Department of Basic Education, 2003). Although this aim has been in curriculum statements for more than 20 years, teachers still have difficulties in letting go of teaching by transmission of knowledge and seeing themselves as the sources of information that needs to be transferred to learners (Stoffels, 2008).

Studies have suggested that transmission still prevails in many classrooms (Stoffels, 2008). However, most South African studies have focused on public schools. There is little done in independent schools– schools which have their own way of doing things but following the CAPS syllabus. My research was based in two independent schools that is; intervention, private schools situated in Johannesburg. An intervention school is a school that aims at improving specific learner results by employing a more differentiated approach either by extending hours or working with individual learners (Houssart, 2012). The schools consist of learners who come from previously disadvantaged backgrounds and seen through recruitment to have the potential of performing well in the Mathematics and Science subjects. The schools target learners from low socio-economic background.

My research was based on secondary schools. Researchers have studied how primary school teachers shape or facilitate talk in their classrooms as well as how children engage in dialogue (Mercer & Dawes, 2014). We still need to look at how secondary school teachers shape talk in science classrooms for learner understanding. Both the schools that I was working with are run in the same way and teachers from these schools communicate in terms of lesson planning, assessment and possible ways of teaching for meaningful understanding. The subject co-coordinators who develop or find materials and lesson plans share the materials amongst teachers in these schools. The school hours run from 7:30 in the morning to 16:30 in the afternoon. Furthermore learners are required to avail themselves on Saturdays for extra lessons. Learners are requested to interact and share their knowledge as much as possible in their classrooms while teachers are required to engage their learners in authentic activities. I looked at Physical Science because there is a tendency of learners to start taking their work serious in Grade 11 and therefore start to engage with the concepts in a certain manner for preparation of Grade 12.

## 1.2 Problem statement and rationale

It is important for researchers to conduct a study that is going to add knowledge and understandings in the field. One of the ways to do this is to look at what others have done in the same field. In this section, I present the problem of my study and provide its significance in the field. Both are presented in the light of literature and what other researchers have put forward as suggestions for future research.

The South African National Curriculum statement is based on the principle of active and critical learning (Department of Basic Education, 2011). This means that learning should be an active process. It is said that active learning and critical thinking equip learners with the necessary skills to participate and make decisions in political and economic structures of the country. Truth is that many science classrooms are still characterized by rote learning where the teacher just tells learners the science story.

Classroom talk is seen as the vehicle for helping learners understand science content. Alexander (2004) argues that talk is significant for “the building of the brain itself as a physical organism and thereby expanding its power” (p9). Talk as tool to mediate interaction becomes very important in science classrooms. The development and use of this talk with awareness opens learning opportunities for cognitive development and conceptual understanding. Barnes (2008) asserts that “the communication system that a teacher sets up in a lesson shapes the roles that the pupil can play”. Barnes bases his argument on the teacher and how teacher talk shapes learners’ engagement with the content knowledge. Since the teacher is seen as an authority, he or she is accountable for learner learning and the extent to which they understand.

I acknowledge the fact that a lot has been done on classroom based research specifically looking at classroom talk and significant contributions have been made in the educational field. In spite of this significant contribution, Hoadley (2012) argues that we still need to look at the relation between teacher-learner interaction and learners’ understanding of content. She argues that we need to relate what is going on in classrooms to the learner outcomes. My take is that these learner outcomes are the ability of learners to grasp the content knowledge of a particular subject or topic. However, one can argue that it is what the syllabus expects them to know at the end of teaching therefore not necessarily as a result of interaction. Furthermore, a lot of research has been done on teaching styles and it is argued that learner-centered approaches are more desirable than teacher-centered approaches (Mercer & Dawes, 2014). The problem arises when these approaches contradict teachers’ views of science teaching because these views should inform teachers’ classroom practices.

This research was worth doing because it brings into consideration the issue of how meaningful classroom talk is constructed and facilitated. This is talk which makes learners understand the science content. There are specific ways in which teachers engage in interaction with their learners in order for them to grasp content. The goal of this research was to look at teacher talk and how teachers facilitate talk for learner understanding. To do, this, I had to incorporate teachers’ views on classroom talk. This helped me understand the relationship between their views and their practices. I believe that teachers sometimes practice monologic teaching not because they are unable to practice dialogic teaching; but because they hold the conception that direct transmission of knowledge is a better way of teaching science. So, there is a need to understand how teachers can engage their learners in quality talk in science classrooms.

In this section, I have articulated the research problem and provided the rationale of my study. I have argued that knowledge-transmission still prevails in many science classrooms and this might be due to teacher views of science teaching and classroom talk. I argued that this study was significant because it adds knowledge to teacher education to understand classroom teacher talk and interaction.

### 1.3 Purpose of the study and Research Questions

The purpose of this study was to explore teacher talk facilitation and how that contributes to learner understanding in three Grade 11 science classrooms. However, we need to first look at teachers’ views as I have indicated earlier that teacher views of classroom talk and interaction with their learners influence their practices. To achieve this, I was guided by the following research questions:

1. What are teachers’ views on the role of classroom talk in understanding of content?
2. How do the teachers facilitate classroom talk in their science classrooms?
3. What is the relationship between teachers’ views of classroom talk and their classroom practices?
4. What evidence of learner understanding of science content can be gleaned from the classroom interaction?

## 1.4 Chapter summary

In this chapter, I have given an overview and background of the study; where the study was situated and the nature of the schools. I have identified the gap; that is, looking at the link between teachers' views of classroom talk on their practices and how they facilitate talk in their science classrooms. I have argued that teachers' views on classroom talk influence the way they teach. Therefore, we need to look at this notion. I have also stated that the significance of this study was to reveal how teachers facilitate talk so that teacher educators can make informed decisions on making teachers aware of their practices.

My aim in the following chapter is to look at the theoretical framework underpinning my study and literature around classroom talk and teachers views on classroom talk. Chapter 3 deals with research methods and methodology specifically looking at participants, methods of data collection and analysis, ethical considerations and research rigour. Chapter 4 looks at the results and discussions. In Chapter 5, I deal with conclusions drawn from the study and recommendations. Finally, I present the reference list and the appendices.

# Chapter 2: Theoretical framework and literature review

## 2.0 Introduction

According to Morrell and Carroll (2010), researchers need to think of the underlying concepts and theories which describe the situation and the study itself. This is the theoretical framework which functions as the "thinking tool of the researcher" to integrate his/her own thinking with what is already found in that specific field (p.42). Similarly, Maxwell (2005) has pointed out that theoretical framework provides us with the model of what is out there and helps with the rest of the research design. In other words, it is the pillar of the whole research since it is helpful in refining goals and developing realistic and well thought research questions. It is therefore argued that theoretical framework should be seen throughout the research report. However, in this section, I present a more detailed theoretical framework and concepts underpinning my study.

I start by providing the literature around teachers' views on classroom talk, interaction as well as how teachers generally view science teaching and learning. I then provide an overview of the socio-cultural theory of learning. Next, I deal with monologic and dialogic teaching practices. Lastly, I provide literature on teacher talk and learner engagement.

## 2.1 Teachers' views about classroom talk and interaction

Research has shown that it is through teacher beliefs that teaching and learning is defined and conducted (Chan, 2003). On the other hand, Brownlee, Purdie, and Boulton-Lewis (2001) note the importance of what is called the epistemological belief/view. They argue that these beliefs are based upon an individual's views which may be due to the knowledge, experiences, attitudes and/or values. Prewad (1992) looked at teachers' beliefs about teaching and learning from a constructivist perspective. I his report, he used the words beliefs, perspectives and views interchangeably to describe how teachers 'see' the constructivist approach. Similar to Prewad, I use the three words (views, beliefs and perspectives) interchangeably.

According to Howell-Richardson, Christodoulou, Osborne, Richardson, & Simon (2009), what teachers do in science classroom is as a result of their views of teaching and learning. Teachers transform content knowledge based on what they believe is the best way to teach and learn science. The significance of teacher beliefs has been acknowledged by researchers who focused on Pedagogical Content Knowledge (e.g. Davidowits & Rollnick, 2011; Rollnick & Mavhunga, 2013). They assert that beliefs play a key role in teachers' pedagogical decisions. For example, teachers decide to use classroom discussions because they think discussions always work for certain topics in science. In contradiction, some teachers may decide not to use class discussion because they believe that teaching science is about telling the science story. Teachers' views may be influenced by preparation, the way they were taught how to teach and the way they learnt science as learners (Bryan, 2003).

Studies have looked at how classroom interaction is influenced by what teachers do. It has been found that what learners do in the classroom is as a result of teachers' practices which arise from their views. Furtak and Ruiz-Primo (2008) found that learners were unable to vocalize their thinking understandings because teachers tended to value written answers. This is not because learners were told; but it is what teachers have been doing. Teachers may not hold specific views about their talk but the way they view the instructional approaches says a lot about the kind of talk they employ in classrooms. It has been shown that more dialogic approaches were used in Mathematics classrooms due to constrains in the curriculum demands (Cross, 2009). So, the practices were not belief-driven but curricula-driven. Wallace and Kang (2004) found that teacher beliefs about teaching of science form a barrier for the implementation of reformed instructional practices. In this context, the reformed instructional practices are the allow learners to engage with each other and promote conceptual understanding. Teachers often do not show consistency in their views and the actual practices (Bryan, 2003). Put in another way, teachers may value the significance of constructivist approach in teaching and learning science without implementing it in their science classrooms. What teachers say about science teaching does not necessarily reflect what they do in their classrooms (Simmons *et al.*, 1999). Feyzioglu (2012) revealed that teachers' views are aligned with teachers' experiences in teaching science. So, teachers who believe in and value the influence of classroom talk are likely to be the experienced ones. This is to say that you can still find new teachers who were taught the theory of social constructivism but still having the mentality that rote learning will help learners grasp science content. It can be argued that it helps learners pass the exams but it does not help them understand sustainably in a way that they can apply what they learnt in new situations.

According to Tsai (2002), this poses some instructional problems because knowing about teaching science in a constructive manner does not necessarily mean implementing that knowledge of ‘knowing about teaching’.

The consistencies seen in some teachers may be explained by the concept of efficacy (Riggs & Enochs, 1992). Pajares (1996) defined self-efficacy as “the individual’s perceived capabilities to attain designated types of performances and achieve specific results” (p546). So, the teacher’s view that classroom discussion, for example is important may be based on the outcomes that it yields. It is important to note that these self-efficacy beliefs are dependent on context and may change to suit individual and different contexts. However, context is highly dependent on experiences and this makes beliefs more dynamic and complex to understand.

## 2.2 Socio-cultural perspectives of learning

My study is underpinned by the socio-cultural theory of learning. The socio-cultural theory of learning seems to be aligned to this study because of the nature of teacher talk which serves as a tool to either promote or inhibit active engagement in science lessons. The theory of social constructivism stresses that learning takes place within social settings (Vygotsky, 1978). An individual’s interaction with his or her peers leads to cognitive development. Vygotsky does not set aside the individual perspective of learning. He says that we need to take a step further and look at the way in which an individual interacts with the people around and look at the individual’s cognitive development. In other words, learning starts to take place in the social context and then extends to the individual’s mind. There are two levels which are involved in the process of learning. Wertsh (1985) distinguished between the social level and the psychological level by using the terms interpsychological plane and intrapsychological planes, respectively. He argues that learning begins in the interpsychological plane where the individual interacts with other people. The individual then makes meanings in the intrapsychological plane based on what is acquired through interaction with other people. The process is then called internalization. Wertsh (1985) says that it this is a process in which “certain aspects of patterns of activity that had been performed on an external plane come to be executed to an internal plane” (p61). So, what the individual does in his or her mind is as a result of what has been happening in the social setting.

Vygotsky does not merely claim that learning takes place through social interaction but goes further to argue on the necessity of mediation for the learning process. In order for learning to be meaningful, mediation has to happen and the process of mediation is embedded in the concept of Zone of Proximal Development (ZPD). Vygotsky defined ZPD as:

> The distance between the actual developmental level as determined by independent problem solving, and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers. (Vygotsky, 1978, p86)

This says that there is a place where the learner needs assistance in order to fulfil some learning duties. According to Wells (1999), the process of teaching and learning in the ZPD depends on social interaction, and this certainly involves a constructive and effective talk in a classroom. Halliday (1976) asserts that there is a relationship between classroom discourse and educational aims in all levels. In other words, a particular classroom discourse is dependent on the aims and level of education. Therefore, some teachers would choose to establish a particular discourse to fulfil the objectives of their lessons or suit the classroom set-up that they are working with.

According to Vygotsky (1978), learning and development are determined by the child's schematic construction of the world. He goes on to argue that learning leads to development. In order for these two processes to be possible, there has to be some form of mediation or facilitation from someone who knows better than the child. Mediation and facilitation comes through recognition of the 'need' to do that and this 'need' is determined by the rate of progression of learning and development. Noting Wertsh's (1985) conceptions ofintrapsychological plane and interpsychological plane, it is worthwhile to say that the zone of proximal development is 'within the intrapsychological plane'. However, learning and development takes place in both planes.

Another way of viewing the zone of proximal development is in terms of the concept of 'known and the unknown'. Wertsh (1985) says that the fact that children need mediation does not mean that they do not know anything. It is not about what children do not know but what they are struggling with. Vygotsky (1978) explained this in terms of 'functions' and said that the necessity of recognizing the zone of proximal development is to examine "functions that have not yet matured but are in the process of maturation…" (p86). This suggests that children already have those structures that need someone who knows better to develop them so that they can become matured functions. So, the zone of proximal development is within the matured functions and those functions which are still in what Vygotsky calls embryonic state yet, capable of maturing.

It is important to note that the zone of proximal development is a 'gap' that the child is experiencing and this gap is to be filled in by what the child acquires from the society. However, it does not mean that learning is directly acquiring of knowledge from the social world as interaction proceed. It should be seen as reconstruction of knowledge with the help of the person who knows better. The process of filling this gap is neither entirely on the child nor the mediator but collaboration of the two working on maturation of those functions which are still in the embryonic state. The teacher should therefore act as a mediator in the science classroom.

I believe that the significance of the mediation is influenced by the classroom talk and the communicative approaches that the teacher uses. Vygotsky (1978) argues that learners need to assimilate information. However, there will be some information which contrasts with what they already know causing a discomfort. Learners will therefore try to accommodate the new information. The teacher is the one who should try to help learners come to a comfort zone when they re-construct the acquired information through talk. Leach and Scott (2003) argue that the current state of the internal plane influences the process of internalization. They go further to argue that the teacher's role is to "introduce and support the use of new knowledge on the social plane of the classroom, such that scientific knowledge becomes the common knowledge" (p102). So, mediation and facilitation of talk and interaction is primarily dependent on the teacher, while taking into consideration learners' contributions. For this reason, science teachers should teach in a way that opens up interaction, mediated through science talk. This is referred to as a dialogic teaching approach.

### *2*.3 Monologic and dialogic practices in science teaching

The distinction between monologic and dialogic teaching is traced from Bahktin's work. Bahktin and Vygotsky have a common understanding of learning, that is, learning is socially embedded and the knowledge is not possessed by an individual. Lyle (2008) draws on Bahktin's concepts and argues that monologic teaching is associated with teacher transmission of knowledge. It is more like the traditional way of teaching where the teacher is seen as the only source of information. With dialogic teaching, all individuals engage with the activity and interact with other. So, the teacher is just there as a mediator. Maybin (1999) asserts that the way in which children engage with each other "plays an important part in the learning process" (p34). Learners should share their experiences and ideas. On the other hand, Lyle (2008) argues that the teacher's establishment of dialogic discourse allows learners to actively participate in developing their personally constructed understanding of the content whereas in monologic teaching, one voice is heard and it happens to be that of the teacher.

Children learn as they interact with their peers and teachers in schools. Their peers and the school social activities can be seen as their social context (Vygotsky, 1978). Although the school is seen as the social context for interaction, a science classroom is more specific to understand these social interactions when working with science knowledge. Bakhtin's emphasis was that learning happens through *dialogic* interaction. Bakhtin's notion of construction of knowledge through dialogue has been noted and used in research that analyses classroom settings with the aim of identifying dialogic and monologic features (e.g. see Haworth, 1999; Maclean, 1994).

Dialogic teaching is more than just sharing ideas and engaging in a conversation. It goes beyond solving problems and generating and building that new knowledge. However, to do this, dialogue needs to be an extended structured talk and systematic. Hayness (2008) explains aspects that need to be considered in dialogue. Some of the aspects include being able to work with others and building team work. So, dialogue which leads certain kinds of engagement for understanding of concepts requires the teacher and learners to listen to each other while appreciating every contribution made. The teacher then has to help learners to process information, make links as well as co-construct knowledge (Boyd & Markarian, 2011). Information processing is about how the teacher enables learners to process information in their minds so that it is understandable to them. It may be through the teacher asking learners to classify or evaluate some science concepts through probing. In a dialogic process, teacher probes help learners to make meaning out of the subject matter.

From what all these authors are saying, one can conclude that engaging in a dialogic discourse promotes critical thinking. That is, if it goes beyond looking at explanation to negotiation of meaning amongst participants (Alexander, 2004). Interaction which seems to lead to learner engagement and promote understanding is the one which involves higher order thinking and engagement with the subject matter like assessing evidence, questioning assumptions and questioning concepts and values (Haworth, 1999). The way in which teachers and ask questions influences learners' thinking and engagement. Dialogic teaching can therefore, enhance the quality of learning (Skidmore, 2006).

It is necessary to point out that while monologic teaching simply focuses on the teacher as a source of information (the teacher is the one doing most of the work), dialogic teaching needs proper planning and proper facilitation. In order for the teacher to engage learners in dialogue, specific classroom methods are needed to promote effective talk, the kind that enables learning and understanding of concepts. In the whole class interaction, the most important thing that will determine the effectiveness of talk/dialogue is the use of questions. It is necessary for the teacher to use questions which allow learners to think critically. The questions should not have pre-specified answers. By doing this, ideas will be refined and clarified with the objective of understanding the topic in question (Skidmore, 2006).

To understand the nature of dialogue or classroom discourse, I needed to look at the teacher questioning, techniques of mediating classroom talk and their communicative approaches. To do this, I used Mortimer and Scott's (2003) framework.

<u>Table 2.1: Mortimer and Scott's teacher-learner interaction model (Taken from Mortimer and Scott, 2003, p397).</u>

| **ASPECT OF ANALYSIS** | | |
|---|---|---|
| **i. Focus** | 1. Teaching purposes | 2. Content |
| **ii. Approach** | 3. Communicative approach | |
| **iii. Action** | 4. Patterns of discourse | 5. Teacher interventions |

The framework shows communicative approaches as central to interactions in the classroom. The kind of communicative approach used is determined by the focus of the lesson which can either be due to teaching purposes or the content. This will then determine the kind of classroom discourse and allow certain teacher interventions. The teaching purpose may include exploring learners' ideas, developing learners' scientific content, engaging learners in solving science problems as well as developing learners' conceptual understanding and helping them how different concepts fit together. The content can either be everyday knowledge or the scientific content that needs to be transferred to learners. This framework fits in Vygotsky's theory of social constructivism because it is useful in understanding how the teacher facilitates interactions for meaning-making. Furthermore, it is useful in determining the kind of communicative approaches used by the teacher in assisting learners gain conceptual understanding.

Mortimer and Scott (2003) elaborated on the patterns of discourse that can develop during classroom interaction. These can be triads or chains. They argue that triads (IRE) are dominant in many science classrooms. The teacher asks a question (I), the learners responds (R) and finally the teacher evaluates the response by giving feedback (E). Mortimer and Scott argue that triads are mostly evident in classrooms dominated by Interactive Authoritative communication (IA).In IA the teacher asks questions and only takes those answers which are based on the science story. As the teacher engages in dialogic interaction, the interactive chains start to emerge (IRPRPR…E/F). These chains are mostly evident in classrooms dominated by the Interactive Dialogic (ID) communicative approach. In the chain, there is initiation (I) followed by the response (R). Instead of the teacher giving feedback, he/she will probe (P). This probe will be followed by another response (R) by a learner and the chain continues until the teacher evaluates or gives feedback. This is where the teacher can explore learners' ideas and engage them meaningfully (Scott *et al.,* 2007). Louca, Zaccharia and Tzialli (2012) argue that looking at classroom discourse using interactive patterns as a framework is a useful way of understanding the instructional practices of teachers. The framework can also be used to understand how the teacher responds to learner contributions as well as looking at how the teacher asks and responds questions.

Teacher questioning determines classroom discourse. Classrooms which are dominated by recitation results monologic discourse (Nystrand, Wu, Gomoran, Zeiser & Long, 2001). This is primarily because teachers limit the extent to which learners are allowed to expand their contributions. In most classrooms, you will find clarification questions. It is therefore necessary for the teacher to provide a discourse which will enhance the emergent of meaningful questions for establishment of dialogic discourse. Contestation questions allow the teacher to get as many views as possible from learners (Richards & Lockhart, 1996). Boaler and Brodie (2004) looked at question in a mathematics classroom and argued that a range of questions can improve the quality of discussions. They argue that questions should be varied with the inclusion of "questions leading to a greater cognitive challenge" (p.780). This will also help learners ask meaningful questions which will drive the whole lesson to a more engaging one. It is therefore important for teachers to think about their questions to enhance their talk.

## 2.4 Teacher talk and learner engagement

There is a link between the way in which teachers communicate and learner engagement. In order for people to interact and engage with each other, they need to communicate. However, the communication has linguistic demands for both the teacher and learners. Linguistic demands can be explained as the demands brought by a body of language or languages of a specific setting or context. This particular language gives learners an opportunity to 'think' and process information based on whatever is being done at that moment so that they can develop the concept of 'self' and being. Furthermore, language can help learners articulate their thinking. Language is beyond the scope of my study but a fundamental factor that influences teacher talk and learner engagement. Edwards and Westgate (1987) state that communication takes into consideration the issue of language in classroom talk. They argue that the two are inseparable.

Learners make sense of the content by 'talking' and talk should be facilitated by the teacher (Barnes, 2008). It is through collaboration with the teacher as a mediator that learners are able to articulate their thinking. Different kinds of communication (talk) have different implications for learners' understanding and development. Therefore teachers should employ talk that is likely to engage learners in a meaningful interaction (Arguiar, Mortimer & Scott, 2010). Classroom talk supports learner engagement by exposing learners to interactions. More importantly, classroom talk is seen as the basic and foundation aspect of teaching and learning (Alexander, 2004). This is a way in which learners learn and develop while the teacher intervenes in their learning and development.

Barnes (1992) differentiates between presentational and exploratory talk. He says that presentational talk is the one that is focused more on the aims of the teacher while suppressing learners' needs and ideas. In most cases, it happens when the teacher wants to test learners' understanding based on the content that they have covered. When learners are given a chance to voice out their ideas, it becomes exploratory talk. In this case, learners are given an opportunity to construct meaning and arrange information. It is important for teachers' talk to allow learners to make links between each other's utterances for deeper engagement (Scott, Mortimer & Arguiar, 2006). Exploratory talk can also be used in group activities.  However, group activities remain to limit learner engagement in most classrooms (Mercer, Wegerif & Dawes, 1999). This is because teacher talk continues to be presentation when facilitating group discussions. Barnes has seen that talk that dominates many classrooms is presentational. He proposed that teachers need to see where they can use presentational or exploratory talk so that the teacher can make possible shifts between these two so that teachers can deeply engage their learners.

Alexander (2000) argues that the dialogue enables greater cognitive restructuring of learners. One of the reasons that dialogue is not commonly used in classrooms is that it requires skilled teachers. It is being noted that 'rote' does not scaffold learning as it is closely linked with monologic teaching. Recitation offers new opportunities for learning while dialogue and discussion helps the teacher to scaffold learning effectively. South African studies showed that although teachers engage learners in a whole class discussion, the utterances remain unidirectional (Webb & Treagust, 2006; Brodie, 2005).While Alexander says that recitation kind of talk offers new opportunities, Skidmore (2006) found that this kind of talk is mostly used by teachers and it seems to limit learner engagement. Approaches that can be used involve dialogic teaching. Alexander (2004) argues that dialogic teaching can deepen learner interaction if managed effectively. The effective management involves informed choices of communicative approaches.  Therefore, teacher-learner interaction as well as teacher mediation is important to promote deeper engagement.

## 2.5 Chapter summary

In this chapter, I explained how teacher perceptions can affect their classroom. Some inconsistencies are seen between what teachers vocalize and what they actually practice. I have established a theoretical framework that guided my study. This is the theory of social constructivism which stresses that learning takes place within the social settings. In order for learners to make sense of the subject matter; they have to get some sort of help from a knowledgeable person. To understand how teachers are able to make this possible, I differentiated from the concepts of monologic teaching and dialogic teaching. Although monologic teaching still prevails in many science classrooms, some teachers do make necessary attempts to engage their learners in an interaction or whole class discussion. It has been found that dialogic teaching is desired than monologic teaching for engagement reasons. However, the ability to establish a dialogic discourse in a classroom depends on teacher beliefs and experiences. Beliefs are rooted within what teachers value as important which might be due to teacher experiences and/or teacher knowledge. I finally gave an overview of hoe teacher talk is related to learner engagement and understanding. I argued that teacher talk can either open up or close certain kinds of learner engagement which may or may not lead to understanding. The following chapter is about research deign and methodology for this study.

# Chapter 3: Research design and methodology

## 3.0 Introduction

Research methods are basically ways in which data will be collected and analyzed (Opie, 2014). However, these methods have to be aligned with the research questions and they are determined by the research paradigm. Morrell and Carroll (2010) argue that educational researchers need to think about the research methods that they will use in their studies. In this chapter, I present the research design and methodology of my research. I begin by providing the paradigmatic considerations of my study. I then present methods of data collection in the light of the paradigm while acknowledging limitations of the design and data collection methods. I then outline how the participants were selected. Methods of data analysis is then presented and linked to the paradigm. Then, I explain how rigour of the study was ensured. I also explain the ethical considerations in this study.

## 3.1 Underlying paradigmatic approaches

The world can be viewed in different perspectives and so knowledge can be gathered in multiple ways. This worldview is what is referred to as a paradigm. According to Hatch (2002), what constitute a paradigm is the nature or reality and methods of obtaining the knowledge that explains reality. However, our view of reality is underpinned by our assumptions which tend to have field or traditional specificity (Maxwell, 2005). In this study, I took a view that reality has multiple perspectives. In other words, multiple realities are constructed and knowing is as a result of human construction of knowledge. Therefore, social interaction in a classroom is valued. For this reason, I took a Vygotskian perspective that learning and construction of knowledge takes place within social contexts.

This is a qualitative study and looks at an in-depth analysis of talk and interactions in science classrooms. Although the findings of a qualitative study may not be generalized as different settings have their own contexts, it provides a significant meaning of incidences and phenomena embedded in certain context (Onwuegbuzie, 2004; Hatch, 2002). Following this particular paradigm leads to more subjected results due to the influence of the researcher. What still remains is the attempt to explain and/or provide warranted assertions about teacher facilitation of talk and interaction in a particular science classroom (Onwuegbuzie, 2004).

### 3.2 Methods of data collection and instruments

Data was collected through lesson observations and semi-structured interviews. The observations were the primary data collection strategy. Lichtman (2006) argues that observations form the basis of a qualitative study. Observations allowed me to look deeply at what is actually happening in science classrooms. Teachers were observed teaching a science topic. The number of lessons observed per teacher with topics is summarized in table 3.1 below. Note that I only observed two lessons by Mr. D as they were double periods.

<u>Table 3.1: Lessons transcribed and analyzed for each teacher.</u>

| Teacher | Lesson topic | Duration (minutes) | Total time (minutes) |
|---|---|---|---|
| Mr. D. | *L1. Introduction to electrostatics, Coulomb's law* | 90 min. | 170 min. |
| | *L2. Electrostatics: Application of Coulomb's law.* | 80 min. | |
| Mr. N. | *L1. Introduction to electrostatics, atomic structure, Coulomb's law.* | 50 min. | 150 min |
| | *L2. Electrostatics: Application of Coulomb's law* | 50 min. | |
| | *L3. Application of Coulomb's law continued* | 50 min. | |
| Mr. S. | *L1. Introduction to electrostatics: Coulomb's law* | 50 min. | 150 min |
| | *L2. Electrostatics: Application of Coulomb's law* | 40 min. | |
| | *L3. Application of Coulomb's law continued* | 60 min. | |

The lessons were video-recorded, transcribed and analyzed so that I could critically look at the incidents in the process of teaching and learning. This enabled a deep analysis of classroom talk and interaction. I therefore did not need an observation schedule.

Although classroom observations were the primary data collection method, in order to answer research question one: "What are science teachers' views on classroom talk for learner understanding of science content?" I needed to incorporate semi - structured interviews as my second data collection method. Opie (2004) says that in order to elicit people's ideas and opinions, we need to conduct interviews and I used the interviews to elicit teachers' views in order to answer my first research question. Similarly, Cresswell (2007) argues that interviews provide in-depth information on particular aspects; classroom talk in this case. An interview protocol was designed in the light of my research question (see Appendix A). The interviews were audio-recorded, transcribed and analyzed for teachers' views.

## 3.3 Sampling and participants

Convenience sampling was used in this study (Opie, 2004). I have been to one of the teachers' lessons during my teaching practice. The other two teachers were chosen because they teach Grade 11 Physical Sciences at the same independent school although situated in different places. I deliberately chose these teachers because they regularly interact with each other in terms of lesson planning and assessment for their classes. All learners in these schools also write the same tests set by one of the teachers. An interesting point is that the learners and teachers come from different socio-cultural background. I wondered how this may affect the way they interact with each other in a science classroom. Although this is interesting, it was not part of my study. So, the participants in this study were 3 teachers who happened to be all males.

## 3.4 Data analysis

### *3.4.1 Analysis of semi-structured interviews*

I used an inductive approach to make meaning out of the interview transcripts. Hatch (2002) argues that some kinds of data are well understood when analyzed inductively. The inductive analysis means moving from the specific to general while spotting specific elements in the data and finding connections amongst them for generalizations.

I started by listening and/or reading the interview transcripts repeatedly so as to get a sense of what was in the data. From the data, I identified frames of analysis which are basically segments of teacher utterances (Hatch, 2002). I then assigned codes to the segments which I thought are of importance to answer my research questions. These codes were assigned where teachers uttered words related to social interaction, mediation and meaning making. For example, an utterance was coded "teacher facilitates talk" where the teacher elaborated on helping learners. Some of the codes were derived from Mortimer and Scott's (2003) framework as it formed part of my analysis of classroom observations (See Appendices B – D).The codes changed as I continued and some were removed while some were merged. From the codes, I identified domains or categories across all three interview transcripts. This then led me to the four themes on teachers' views: teachers' role, learners' role, forms of communication and nature of school science content. Construction of these four themes enabled me to answer the first research question on teachers' views about the role of classroom talk for learner understanding of science content.

### *3.4.2 Analysis of the classroom observations*

The three teachers' lessons were transcribed and analyzed by identifying the interactions which took place between learners and the teacher. These interactions were categorized according to the Mortimer and Scott's (2003) model of communicative approaches. The number of communicative approaches was counted for each teacher as summarized in Chapter 4. The table below (Table 3.2) shows Mortimer and Scott's communicative approach model that was used in the analysis of classroom observations. This model focuses on the middle part of the learner-teacher interaction model described in Chapter 2.The framework is normally used to analyze general teacher-student interaction in science classrooms including the forms of teacher communicative approaches. I only used the communicative approaches because I was interested in how the teacher facilitates talk. The four communicative approaches can be used as a vehicle to understand teacher talk, which was the focus of my study. I referred to the second aspect of the framework, patterns of discourse just to show how learners respond but I did not explore the other three aspects as they were not relevant.

Table 3.2: Communicative approaches according to Mortimer and Scott (2003)

| | **Interactive** | **Non-interactive** |
|---|---|---|
| **Dialogic** | Interactive and Dialogic | Non-interactive and Dialogic |
| **Authoritative** | Interactive and Authoritative | Non-interactive and Authoritative |

## 3.5 Research rigour

Research rigour has to do with the validity and reliability of the study. According to Opie (2004), validity is about the extent to which the research tools measure what they are supposed to measure. Reliability has to do with reproducibility of the results if the study was conducted again using the same instruments under same conditions. Litchman (2006) argues that reliability and validity are less applicable to qualitative study. However, internal validity was ensured through my supervisor checking the capturing tools and looking at the classroom observation transcripts. The emerging themes on the interviews were also validated by the supervisor.

Credibility has to do with whether the study measures what it is supposed to measure. Conformability refers to the extent to which the findings reflect participants’ practices and not the researcher’s interests (Lincoln & Guba, 1985). Credibility was ensured during the interviews by asking teachers to clarify what they are saying. Teachers were probed as much as possible based on what they say. Shenton (2004) argues that iterative questioning by probing may be used to uncover deliberate lies and reveal honesty. This enabled me to make sure that I do not mis-interpret them. I also ensured credibility by providing thick descriptions of the data and giving detailed explanations of the situation (Shenton, 2004).

### 3.6 Ethical considerations

Opie (2004) says that educational research which involves human beings has to be conducted in an ethical manner. Ethical considerations include being able to give your participants assurance that their dignity will not be compromised or they will not be endangered in any way by participating in the study. For example, that their participation is voluntary, that their names will not be revealed, that the data will not be abused. For ethical considerations, permission from University of the Witwatersrand Human Research Ethics Committee was sought. I also got permission from the schools. I asked permission from the teachers, learners and their parents since the learners are still minors. Teachers and learners were given informed consent forms that explained the study and provided for them to sign if they were willing to participate. Anonymity and confidentiality was assured and all the participants were reminded that their participation in the study was voluntary. They could therefore withdraw at any time. Participants were assured that withdrawing from participating in the study does not have any consequences on their marks or anything else. When transcribing the interviews and observations, pseudonyms were used instead of participants' real names.

### 3.7 Chapter summary

In this chapter, I started by outlining my position in terms of paradigms and explained that I am taking a constructivist approach. I explained that data would be collected through semi-structured interviews and classroom observations. I illustrated the alignment of these methods to my research questions. I then explained how the sampling was done and who the participants were. I explained that I used the Mortimer and Scott's (2003) communicative approach model to analyze the classroom observation transcripts and used an inductive approach to analyze the semi-structured interview transcript. I finally, dealt with the ethical considerations and how confidentiality was ensured.

# Chapter 4: Results, interpretations and discussions

## 4.0 Introduction

Following from the description of the analytical tool presented in Chapter 3, this Chapter is designed to provide insights into the results. The purpose of this study was to explore teacher talk facilitation and how that contributes to learner understanding in three Grade 11 science classrooms. The results and interpretations are presented in answer to the research questions. The questions which guided my study were:

1) What are science teachers' views on the role on classroom talk in understanding of content?
2) How do teachers facilitate classroom talk in their science classrooms?
3) What is the relationship between teachers' views of talk and their classroom practices?
4) What evidence of learner understanding of science content can be gleaned from the classroom interaction?

I therefore start by presenting the results from the interviews on teachers' views about the role of talk in meaningful understanding of science content. Then, I present results on classroom talk gathered through counting the number of instances where the three teachers used certain communicative approaches in their talk. I then link the interviews about teachers' views and their instructional practices. Lastly, I do an in-depth analysis, interpretation and discussion of teacher talk by providing excerpts from the lesson transcripts. Out of these excerpts, I argue for learner understanding where there is evidence.

## 4.1. Results of science teachers' views on the role of talk and interaction

The results of semi-structured interviews of the three teachers are presented following from the method of analysis for semi-structured interviews described in Chapter 3. I provide examples of teachers' utterances based on the themes that emerged from the interviews (i.e. teacher's role, forms of communication, learners' role and nature of school science content). The significance of the teacher utterances provided is to show how teachers view the role of talk in their science classrooms and this will later be linked with what they do in their classrooms.

### *4.1.1 Teacher's role*

All three teachers said that they are there to help and give guidance. They mentioned the word 'facilitate' to denote how teachers should function in a science classroom. This is what two of them said when they were asked to describe their role in a science classroom:

> *Mr. D: [1]I think the role of a science teacher in a science classroom is to help the [2] learners to understand the science principles and apply them…*
>
> *Mr. N: I see the role of a teacher, one, is to actually [1]pre-amble the basics about a particular topic and the kind of a [2]guide the learners are able to get the answers… you kind of play the [3]facilitator role…you actually play a facilitator role where you actually create a learning environment…[5]outcome that is to be inquisitive and also to be able to apply principles and rules and theorems in solving certain problems.*
>
> *Mr. S: [7]I have the knowledge and it is also in the textbooks and possible other sources and I must make sure that the learners acquire it"* and "*[10]I am saying that they don't know everything that they need to know. They are not entirely empty vessels but on the other end, there is a lot that they don't know"*

Although the third teacher (Mr. S) talked about the role of a teacher as facilitator, he mentioned something that one can argue is concerned with transmitive way of teaching. He said that "[2]*the role of a teacher is to transfer knowledge in the first place…"* However, as the interview continued, he clarified what he meant by saying that he possesses the knowledge that learners need to acquire. This has some implications for teacher communicative approaches I will show later on.

McNeil & Pimintel (2010) argue that teachers' role is an important part of the interaction. Teachers' views on their roles are more aligned to a Vygotskian perspective of teaching and learning. Phrases like 'guiding learners, helping learners' denote that teachers see themselves as more knowledgeable persons who are able to move learners from what they do not know to what they know. Similar findings state that teachers acknowledge their role of giving learners the opportunity to collaborate (Mansour, 2009). Also, Webb (2009) outlines that this is desired as it can promote active learning. Ada and Okwu (2001) say one of expected teachers' role is to help learners grow and achieve their goals. This role is evident here as teachers say they want to guide learners. However, Agama (2013) found no correlation between teachers' expected views and what they vocalised.

### *4.1.2 Forms of communication*

Teachers referred to the forms of communication that they use in their classrooms. All teachers valued interaction and involving learners in a science classroom. The forms of communication are explained by Mortimer and Scott (2003) as communicative approaches. Teachers were unclear as to whether the communicative approach valued is interactive authoritative or interactive dialogic. For example, Mr. D seems to be of the view that learners' answers matter more as he said that: *"[40]Usually if I asked for answers, I don't write one answer on the board. I would be open to as many answers as possible and then from that, I would (inaudible)"*. He continued to say that to get learners engaged in the lesson, you need to make use of what learners bring to class to their benefit: *"We talk about each answer…"*

When Mr. N was asked about how he deals with learners' answers; he provided an answer in terms of what teachers do and what he believes should be done:

> "*… as teachers, you find that a learner gives a certain answer argued at a certain angle and because you have expected a particular answer we tend to say that it is not true and then maybe that is true. So, the best way is…if the answer that they have given does not satisfy my expectation, then maybe I might have to look at my question, maybe my questioning is not proper. So I have to make sure that the question, I have to look at the question again and ask the same aspect that I am looking for…"*

It is important to note that his response has components which show some tension between the communicative approaches. Mortimer and Scott (2003) have documented the tension between these two approaches based on classroom observations and not on what teachers vocalize. However, Pimintel (2012) found that the teachers valued both authoritative and dialogic communicative approaches and noted the influence of context on using certain communicative approaches.

Mr. S viewed questioning as important and necessary for classroom discussion. For learner engagement to be possible, one has to think about his/her questioning techniques. For Mr. S, leading questions have a way of making them think: "[29]*by asking leading questions and force them to think about it.*" When he asked to explain the concept of 'leading question', he referred to these questions as the ones which prompt some curiosity – you ask them based on what they already know. For example, "what does this equation reminds you of…?" He further emphasized that "*I want to teach, so I should ask questions. It is my method of teaching*" in order to send the message that interaction is highly dependent on teacher question. Similarly, teacher question together with the nature of interaction reveals teacher communicative approaches.

When teachers were asked about the role of whole class discussion in their classroom, they all had doubts on using that as a strategy even though they regarded it as an important teaching and learning tool in a science classroom. All of them justified their positions by referring to the complexity of managing whole class discussion and the implications for that. This is what they said:

> *Mr. D: "I think class discussion could be good if it is following group discussion…[27]fact that you may not get to everyone and you may frustrate learners that want to talk or being carried away by following certain learners"*

> *Mr. N: "[11]I would rather split that into maybe smaller groups where you can move around monitoring and ensure that everybody is participating because if it's a bigger group,[12] the tendency is that you find those who hide behind others and they might give a community answer like, yes we understand but there are certain people who don't"*

> *Mr. S: "but it is important that you managed it well because what can easily happen is that you have some stars in the classroom that are always answering the questions and the rest are not really participating. [23]You must also appoint those who seem to be absent to join the discussion otherwise they won't benefit…"*

Mansour (2008) noted the contextual influences on teachers' views. In the utterances above, it can be seen that teachers' use of whole class discussion is based on context. They say that they are unable to use it because of classroom sizes. For example, Mr. N said: "*if it's a bigger group,[12] the tendency is that you find those who hide behind others"*. Webb (2009) asserts that student collaboration in small groups result in learning. Therefore, we can say teachers' desire is to maximize participation by using small group discussion.

#### *4.1.3 Learners' role*

Despite the fact that teachers see themselves as the source of knowledge and/or facilitators, they still proclaimed that for meaningful interaction in a classroom, learners have to play a role too. From the teacher's utterances, it is shown that learners have to be critical thinkers and apply knowledge they learn at school and the only way to do that is to actively engage with the 'principles' of science.

> *Mr. D: "[28]the role of questioning is to lead them to [29]find out on certain principles…is to help them make their own investigations…it is to give them [30]lead to apply their own mind in finding out things…"*
>
> *Mr. N: "…learners might try to come up with new ways of trying to solve some typical problems in the world of technology and let them play games which have aspects where somebody would come and present their findings about any aspect in science or any aspect related to what they would be covering at that particular time…"*
>
> *Mr. S: "…they really need to do some serious thinking and ….yah, find bits and pieces of information and combine it in the correct way and so on…"*

It is important to note that Mr. D still perceive that his questioning has an effect to what learners do in class. Although teachers think of getting their learners involved in the lesson, they acknowledge that it is a bit difficult to do that. One of the teachers (Mr. N) explicitly stated that it is not about teachers but learners. Therefore they need to do lot of talking about science: "[50]*Certainly…yah we just have to engage learners as much as possible. Even if we have to talk we must not forget that they also need to be heard"* Similarly, Mr. D says "[13]*I also involve other learners, that is why I say group discussion if not a class discussion*" while he motivates them and try as much as possible to make them enjoy the subject.

It seems like teachers have a good understanding that their talk and mediation have no effect if it is not followed by learner involvement. Through mediation and facilitation, they play a leadership role. However, the power is sometimes shared with learners. While teachers serve the leadership role in their classroom, they are able to guide learners to their roles (Menke& Pressley, 1994). Through this perception, teachers are able to see that teaching science goes beyond just telling learning the science story.

### *4.1.4 Nature of school science content*

What seems to be the center of all the three themes emerging from the interviews is the nature of school science content. All teachers viewed science as an abstract subject with lots of application and principles.

*Mr. D: "[6]science is an abstract subject. [7]Sometimes it is very difficult for a learner to imagine the scientific things."*

*Mr. N: "…but with science, [7]there is lot of practice and practicals. In essence, [8]science is a practical subject kind of hands- on subject"*

*Mr. S: "[42]it is important to use visual means to aid the theory that you are explaining. [43]Otherwise, it becomes a very abstract subject"*

Mr. N clearly stated that in order for science teaching to be successful, both the teacher and learners need to work as community to deal with content knowledge. He used the word 'club' and argued that members of the club have to be willing to come up with something new that can be applied outside. Similarly, Mr. D and Mr. S have also pointed that science needs to be relevant to learners.

Because of how school science content is, teachers feel they need to use certain strategies to teach it. Lederman (1992) states the teachers' awareness of the 'nature of science' can improve their teaching. In this case, what seems to come out is the abstract nature of science which influences the role of teachers and their forms of communication.

### *4.1.5 Discussions on science teachers' views about the role of classroom talk for understanding of content*

Looking at the three themes that emerged from the interview transcripts, one could argue that they do not specifically address the teachers' view of talk in science classrooms. It should be noted that talk does not exist on its own with isolation of the contextual factors and some teaching and learning strategies. Talk is embedded within teacher practices as one of the participants has pointed that it should be 'a blended kind of a thing'. It looks like all the three themes influence one another in determining teachers' views about classroom talk with the last theme 'nature of school science content' being at the center. Jones and Carter (2007) argue that there are elements which influence teacher 'beliefs' that could or could influence teacher practices. I view 'beliefs' as equivalent to 'views'. Classroom size has been noted as one of the factors influencing teachers' views. Similarly, in these interviews teachers indicated that they value whole class discussion as a way of getting learners to talk and establishing a dialogic discourse. However, instead of whole class discussion, they rather use group discussion due to the number of learners in the class. This ties with the influence of context on teacher's views and practices (Pajares, 1992). So, teachers' views about talk are contextual-based which Cross (2009) referred to as peripheral beliefs.

Although teachers know their roles in science classrooms – mainly as facilitators, they perceive 'talk' as being more than the exchange of words between them and learners. They see *their* talk as being a necessity to learning. Mr. D indicated that he tries to get every learner's answer and talk about those answers. On the other end he "[4]*direct learners towards scientific aspects and principles"* so that learners can *"be inquisitive and also to be able to apply principles and rules and theorems in solving certain problems"*. Although one can argue that Mr. D's response was based on helping learners to 'solve certain problems' which they will find in the exams, the word 'inquisitive' makes this go beyond learners passing the exams. If learners were only prepared to pass the exams, then the teacher would be viewing Interactive Authoritative (IA) as the necessary kind of talk in a science classroom. However, making possible shifts between Interactive Dialogic (ID) and Interactive Authoritative (IA) would bring a desire of understanding both the intended science content and preparing learners for the future. Similarly, Mr. N also pointed that learners need to come up with something that can be applied outside; therefore through talk and approaching science as a club, a teacher is able to open those opportunities of exploration. According to Hoadley (2012), this kind of view is desired from teachers. However, the desire cannot always be made possible. What teachers view may not necessarily be enacted in the classroom (Bryan, 2003; Louca, Elby, Hammer, & Kagey, 2004).

It is interesting that teachers view talk as having an impact on learner understanding because they note that questioning is important. They think that questions form a large part of their teaching and without questioning, the lesson is meaningless. For example, Mr. S highlighted the role of questioning by saying that "*I want to teach, so I should ask questions. It is my method of teaching*". The question arises when we start to think about the kind of questions that they use. Since they want to help learners learn the science 'principles', they ask leading questions which would direct them to the desired answer. Although they were basing their argument on 'principles', it was unclear on what they mean by principles. Assuming the principles are science theories and laws, Scott and Mortimer (2005) aligned this kind of view with an authoritative talk yet, interactive. Teachers interact with their learners and wanting them to learn theories but learning the theories only is more content based therefore authoritative. Teachers noted that what is important is for them to facilitate the talk discussions while learners engage with the principles to be learnt and "*do some serious thinking"*. 'Serious thinking' is facilitated by what two teachers called 'leading questions'. Chin (2007) called leading questions 'pumping questions' as the teacher directs learners to the desired answer while there is no guarantee that the teacher would evaluate the answer provided. However, feedback to students is important as it focus the lessons and gets learners to think deeply (Chin, 2006).This might not be viewing talk as being dialogic but it moves away from the transmittive way of teaching to an interactive teaching approach. It turns out that teacher talk might not take a dialogic form yet not transmittive.

Even though it can be seen from teachers' interviews that they are aware of the influence of talk in helping learners understand science content, there seems to be what I would call 'constrains'. These constrains happen to relate to how school science content is. Teachers say that talk should go beyond 'talking' and having conversation with learners. For this reason, talk should be not just be considered in isolation with other teaching and learning strategies which involve practical work, using simulations and research projects. This view is based on what I termed the 'nature of school science content'. From the interviews, teachers seem to be making decisions about communicative approaches to be used in a science classroom based on how science content is for the purposes of the desired learner outcomes. This included its abstract nature while populated with principles and skills that learners need to learn. They therefore say it should be a 'blended' kind of talk where it is not only about explanations from the teacher.

**4.2 How teachers facilitate talk in their science classrooms**

In this section, I present an analysis of teacher talk from the classroom observations. I used Mortimer and Scott's (2003) communicative approaches model. For each teacher, I provide the number of instances of each communicative approach. The use of communicative approaches to analyze teacher talk becomes useful to see if there is any interaction and how the teacher engages with learners; to what extent the teacher engages with learners' ideas for conceptual understanding. Table 3.1 in Chapter 3 shows the distribution of lessons for the three teachers. The table provided the reader with length of lessons and topics covered by each teacher. From the transcribed lessons, I counted the number of occurrences of each communicative approach in all the lessons (Table 4.1).

Table 4.1: Number of instances where teachers used each communicative approach per lesson

| | Mr. D | | Mr. N | | | Mr. S | | | |
|---|---|---|---|---|---|---|---|---|---|
| Communicative Approaches | **L1** | **L2** | **L1** | **L2** | **L3** | **L1** | **L2** | **L3** | **Total** |
| *Interactive Dialogic (ID)* | 2 | 1 | 3 | 2 | 2 | 0 | 0 | 1 | 11 |
| *Non-Interactive Dialogic (NID)* | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 6 |
| *Interactive Authoritative (IA)* | 7 | 6 | 4 | 3 | 3 | 4 | 5 | 4 | 36 |
| *Non-Interactive Authoritative (NIA)* | 3 | 5 | 1 | 0 | 0 | 3 | 5 | 2 | 19 |
| Total | 13 | 14 | 10 | 6 | 5 | 7 | 10 | 7 | 72 |
| | 27 | | 21 | | | 24 | | | |

From the table, it can be seen that the communicative approach which has the highest number for all teachers is interactive authoritative. Mr. S did not use NID at all while Mr. D and Mr. N have the same number of NID instances. Mr. N used ID the most. See Appendix E on how communicative approaches were coded and counted.

To give a clearer picture of the results of classroom talk, I present a graph (Figure 4.1) which shows the transformation of Table 4.1. This graph is drawn so that emerging trends can be seen more easily.

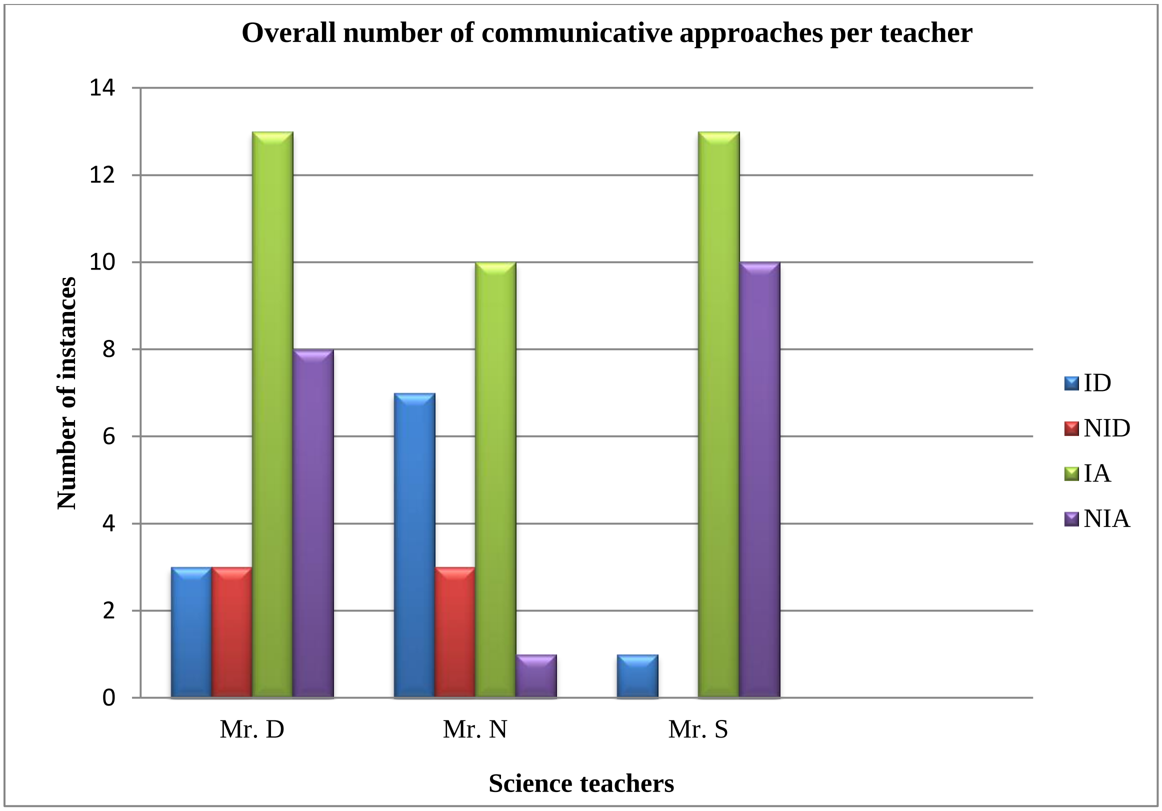


Figure 4.1: Trends in teacher communicative approaches

Communicative approaches are employed to facilitate discussions while engaging with the science concepts. Teachers' choices of the communicative approaches can lead to an interactive classroom or a non-interactive classroom. Figure 4.1 shows that the lessons were generally interactive as seen from the prevalence of ID and IA in all three teachers' classrooms. However, teachers' communication was authoritative where they used a question-answer strategy with the aim of conveying the science concepts and principles to learners. This is supported by the total number 36 IA instances out of 72 of all communicative approaches for all teachers. There were 19 instances of NIA and 6 NID communicative approaches.

The total numbers of instances of each approach varies with each teacher. From the graph, Mr. D and Mr. S used the NIA approach mostly than Mr. N. Mr. N seems to be using ID approach more than Mr. D and Mr. S. More specifically, the data shows that he engaged his learners by using an ID approach more than the NIA. Although in most of his lessons he was taking the authoritative stance, he did establish a dialogic discourse. It is interesting to note that Mr. S only used the ID approach once in his lessons and never employed the NID approach. On the other hand, Mr. D used the NID and ID approaches equally. Although Mr. D has an overall of 27 instances of communicative approaches, considerable time in his lesson were spent training learners to solve problems and applying Coulomb's law.

### 4.3 The relationship between teachers' views and their classroom practices

In this section, I link teachers' views about classroom talk and their classroom practices. The link is done through the themes outlined in the first section of this chapter.

Roehrig and Luft (2004) argue that teacher views do not exist in isolation. They exist in a wide range of other factors. What teachers said in the interviews and what they do in classrooms seem to have been influenced by nature of school science content both in a consistent way and inconsistent way. This is illustrated in the Figure 4.2 below:

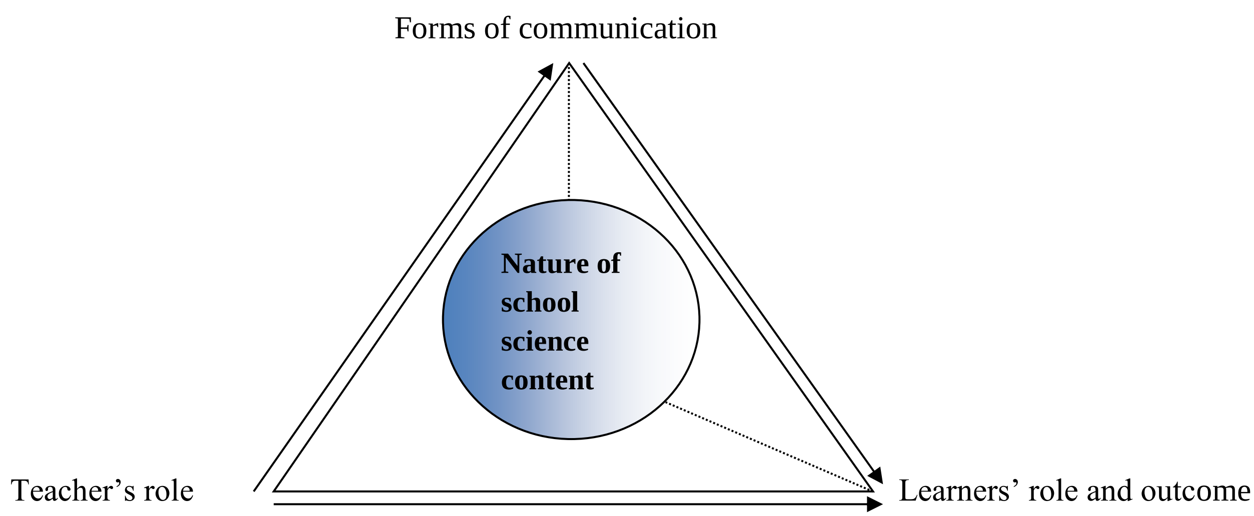


Figure 4.2: Nature of school science content influences teacher talk

The diagram above shows how teachers' view of their roles impact (implicitly or explicitly) the forms of communication (communicative approaches) that they employ in a science classroom. Teachers' talk and their perceived role, leads to a specific role for their learners as determined by ultimate outcome they want for their learners. However, there is what I call 'nature of school science content' which cannot be ignored as it impacts teacher's role, forms of communication although it seems to have a more significant impact on teacher decisions than learner decisions.

*Teacher forms of communication, teachers' role and learner's role*

The three teachers viewed themselves as being there to help learners understand the science concepts. What seemed to be important to these teachers was preparing learners for the future by making them to think deeply about problems in the classroom. Mr. S in particular, emphasized that questioning is very important as it is a significant strategy of teaching and learning science. Because they want to prepare learners for the future while making them to be critical thinkers, teachers value interaction in a science classroom. For example, Mr. N stated "[50]*Certainly…yah we just have to engage learners as much as possible. Even if we have to talk we must forget that they also need to be heard"*. From the graph shown in Figure 4.1, it can be seen that there is interaction in these three teachers' classrooms even though the communicative approach used is authoritative. Therefore the issue of engaging learners and helping them to become critical thinkers introduces a contradiction between their views and their practices.

Although the three teachers value interaction, they interact with their learners on science content only. This means that they are interested in helping learners to pass the exams. For example, Mr. S stated in one of his lessons *"Right, you realize how it was supposed to be done. How many of us did that? So, next time…it is very, very important"* and Mr. S state that *"You get questions like this in the exam…"* to denote the importance of doing the 'right thing'. Tsai (2002) classified these kinds of views as traditional teaching beliefs, because learners should memorize and remember science principles. However for my three teachers, there are some parts in lessons where learners were genuinely involved. This is a constructivist approach of teaching science. Teachers help learners construct the knowledge by creating new understandings based on the existing understandings but the knowledge is what they need to know according to the syllabus.

Mr. S perceived himself as a facilitator. In contrary, he stated that learners are empty vessels: "[10]*I am saying that they don't know everything that they need to know. They are not entirely empty vessels but on the other end, there is a lot that they don't know".* It is interesting to note that his perception influenced his pedagogical decisions. Because he wanted to break what he called ‘*impasse’*, he started off his topic of electrostatics with what he called ‘*challenge*’ that was followed by the discussion outlined in Excerpt G. However, at the beginning of the lesson, he never asked them about their understanding of the topic of electrostatics which is consistent with his view that learners are close to empty vessels but they should be scaffolded through challenges. It is through getting learners’ preconceived ideas where discussions are mediated. Teachers will be able to look at misconceptions or alternative ideas that they have about the topic of electrostatics (Scott, Asoko, Driver & Emberton, 1994). The teacher did not do this. The advantage of getting their ideas is that the teacher can work from learners’ responses in order to teach for conceptual change (Duit, 2002). The “challenge” followed from an authoritative, yet interactive talk where he used pith balls to demonstrate electrostatics therefore validating his words that together with talk, science teachers need to use representations and demonstrations to scaffold learning.

Although teachers viewed themselves as facilitators, what they did in the classroom was more like mediating instead of facilitating. Facilitating is more aligned to the Piagetian approach while mediation is more aligned to Vygotskian perspective. Teachers ‘helped’ learners to make meaning out of the science content. They did not just provide them with the tools (textbooks, worksheets, etc.) but mediated the process. Tiberghien & Buty (2007) found that mediation is complex in nature and most teachers are not aware of it. This then explains the quality of mediation in most classrooms. The contradiction on what teachers said (facilitators) and what they do (mediators) may be due to little knowledge they have on these two terms and might not necessarily reflect their true views.

*Tension between teacher talk and the nature of school science content*

Although the science curriculum requires teachers to engage their learners in dialogic discourse for meaning making and maximized participation, science teaching continues to favour authoritative over dialogic communication. This may be because of what Riggs and Enochs (1990) call self efficacy beliefs and outcome efficacy beliefs. Teachers view classroom discussion as a distraction to learning because it seems to throw off their classroom management. This is their self efficacy belief. Rather than engaging learners in a whole class discussion which most researchers have argued on its usefulness, they value group discussion more. Therefore, their outcome expectancy is that whole class discussion will bring fruitful learner outcome. Looking at their views and what they do in the classrooms, none of the teachers engaged learners in group discussion. Whole class discussion which they felt is not a suitable strategy was predominant in their lessons. This is in line with Simmons *et al.*'s (1999) finding that teachers' views and classroom practices are usually in contradiction. Teachers may not be aware of these contradictions and how their talk constrains learner participation and engagement (Scott *et al.*, 2006). This then denotes the complex nature of the relationship between teachers' views and their pedagogical decisions. According to Jones and Carter (2007), the complex nature and these inconsistencies may be as a result of context and teacher experiences. This is corroborated by Pajares's (1992) notion of the influence of knowledge on beliefs. Although Cross (2009) found that what teachers believed to be useful in classroom predicted their instructional practices, the results in this study show that these instructional beliefs were partially predicted from teachers' views because of some consistencies and inconsistencies.

Teachers did not value passive ways of learning and some parts of their teaching were based on constructivist approaches. They valued textbooks and themselves as credible sources of information and this led to teacher-centered practices. For example, Mr. S stated that the information that learners need to know is in the textbook and in him. Yet, Kang and Keys (2000) say that because teachers perceive science as acquiring knowledge, then they believe teaching it should be transmission of knowledge. It is evident that teachers' views are complex and there might not necessarily be a link between their views and classroom practices. This is complicated by the authoritative nature of school science.

**4.4 Teacher talk and understanding of science content**

From the macro-analysis above on classroom and teacher talk, it can be seen that these three teachers used the communicative approaches differently and for different reasons. To provide evidence of the instances where the above communicative approaches were employed and account for the differences in the use of those communicative approaches, I present some excerpts from the three teachers' lessons. I also use these excerpts to argue that certain engagements seem to lead to learner understanding. The utterances in each excerpt start at 1; they are not numbered continuously for each lesson.

Table 4.2: Excerpts to illustrate teacher talk and justification for using those excerpts

| Teacher | Excerpt | Justification |
|---|---|---|
| Mr. D | 1 | To indicate that the teacher avoided to use Interactive Dialogic approach. |
| | 2 | To show that there was interaction during the lesson. |
| | 3 | To demonstrate a shift from an interactive discourse to a non-interactive discourse. |
| Mr. N | 4 | To demonstrate questioning and probing. |
| | 5 | To show how the teacher shifted his focus to deal with basics which learners seemed have misconceptions |
| | 6 | To indicate how the teacher facilitates talk when one learner is at the board. |
| Mr. S | 7 | To demonstrate questioning using Interactive Authoritative approach. |
| | 8 | To show the use of Non-Interactive Authoritative where interaction is suitable. |
| | 9 | To show the use of interactive authoritative approach for deeper thinking. |

***Excerpt 1: Mr. D avoids using Interactive Dialogic communicative approach where it was necessary.***

*Teacher talk*

This excerpt is taken from Lesson 1 towards the end. Learners were working on solving problems from the textbook on Coulomb's law. Just after the teacher helped one learner on how to draw a free body diagram, Koki raises her hand to voice out what she is planning to do for the question which required them to state how the electrostatic force would change if the distance between the two charges is doubled. This follows from some help which Koki got from the teacher a few minutes before she started asking again. The following are the utterances between the two learners and the teacher.

| | | |
|---|---|---|
| *(1)* | Koki: | Sir you said what? You said the what?? Question 5…what you change… |
| *(2)* | T: | I am listening |
| *(3)* | Koki: | I told you that I am going to say 5.4 times 10 to the power 14 minus the answer that I got here (pointing in her book) |
| *(4)* | T: | Why…? (Inaudible) |
| *(5)* | Koki: | To see the…the… |
| *(6)* | Bontle: | The factor… |
| *(7)* | Koki: | Huh? |

| | | |
|---|---|---|
| *(8)* | Bontle: | The factor which it changed by… |
| *(9)* | Koki: | Yes…Is it correct? |
| *(10)* | T: | (Laughter) Aiii…No…for the factor, it is multiplication and division…for subtraction… ok, it is alright because they say how does it change |
| *(11)* | Koki: | It decreases |
| *(12)* | T: | You can say it decreases it is fine |
| *(13)* | Koki: | By this, from this (pointing in her book) |
| *(14)* | T: | You can say it decreases from there to that…it is fine. |
| *(15)* | Koki: | Okay. |

After listening to the learner's concern, the teacher asks 'why' (turn 4) to show that he is interested in the learner's reasoning and thinking. In other words, the teacher probes the learner instead of responding with a straight-forward answer. Talk seemed to be taking more of a dialogic approach. Koki tries to describe what the question while trying to respond to the teacher's question of why she subtracted the two answers. However, she seemed to be unsure until she got help from Bontle (Turn 6 & 8). Unexpectedly, Koki asks if what she is doing (subtracting the two answers to see how the force would change) is correct. The teacher then takes an authoritative stance by saying that it is ok because the question was asking how the force changes (turn 10). In turn 12, the teacher goes on to say that it is fine if Koki says it decreases. The possibility is that Mr. D did not want to ask a further question because of Koki's utterance "*…is it correct?"* In other words, it might be possible that Koki was interested in getting the answer correct. However, Mr. D would have opened a dialogue through probing. One interesting thing about this excerpt is that the discourse starts off with a learner's question and proceeds to turn 2 as IRIRRRRRF. The conversation is joined by Bontle as she responds to Koki. Not many science classrooms are interactive. The teacher was able to make his learners feel safe and free to engage with each other instead of waiting for learners to provide answers.

One could argue that Mr. D. had a choice of letting learners interact more. This argument can be on the basis of what he said in turn 10: *"no"*. After responding with a no, the teacher paused and instead of asking the two learners about their understanding of what is mathematically involved when talking about a factor, he went on to say that it does not matter since the question did not require the factor. Mr. D could have used this opportunity to engage other learners and opening for a class discussion. However, since they were working on their own, some learners could have not been at the question yet. Therefore the teacher's decision was somehow in the interest of learners and learning. He was helping learners to only answer what they have been asked in the question. This is more like an authoritative approach. It keeps learners focused in the science content. This illustrates what Scott and Mortimer (2005) call the tension between ID and IA which is seen in most science classrooms.

*Learner understanding*

Although Koki seemed to understand the question and how subtracting the two answers would help her, her understanding is limited. Limited understanding is due to the missed opportunity of Mr. D to engage her with the meaning of a 'factor'. Bontle understands that she needs to find the factor (turn 6 and 8) because of a previous interaction that happened between her and Mr. D shown below:

*(1).* T: You have to conclude here…you are just calculating (Teacher looking in Bontle's book)
*(2).* Bontle: The force yes…
*(3).* T: I agree with you but I want to…
*(4).* Bontle: So, I need to include a fraction…
*(5).* T: Yes because they ask how…does it increase, does it decrease, becomes smaller or decrease by a certain factor…Don't just jump in, go to the question
*(6).* Bontle: Yes, I understand what I am writing

Bontle associated the word factor with fraction. Her understanding was then limited because the teacher was not interested in the factor as the question did not ask one. Bontle's understanding was not explored, yet it could have been through this exploration that she starts to engage in proving the change of the force by a certain factor. This could have opened a whole class discussion.

*Linking teacher talk to learning*

Interaction as well as collaboration can be seen in this excerpt. Wells (2009) argues that it is through this collaboration that learners engage with the science concepts. One can argue that the collaboration seen in the excerpt does not lead to meaning making as it is authoritative. Mortimer and Scott (2003) assert that it is through a dialogic interaction where learners bring ideas together for meaning making. The teacher missed the opportunity to engage learners in such collaboration. Although it is argued that dialogic interaction is likely to lead to understanding of science content, authoritative approach seems to have an impact on learning which might lead to understanding. As long as the discourse is still scientific where learners talk science, there might be development of shared understanding (Manouchehri, 2007; Mortimer & Scott, 2003). The teacher might have wanted to engage his learners in a dialogic discourse but the authoritative communication is also needed. Both dialogic and authoritative communicative approach can lead to argumentation (Osborne, Eduran & Simon, 2004). It is therefore necessary to mention that employing authoritative is at the interest of letting learners 'learning' science content on its own.

***Excerpt 2: An example of an IA communicative approach in Mr. D's class***

*Teacher talk*

The significance of this excerpt is to show how the teacher uses Interactive Authoritative approach to help learners grasp the science concepts and making sure that they have solid foundation before applying Coulomb's law. This excerpt is obtained from Mr. D's first lesson. The teacher was introducing the topic of electrostatics.

| | | |
|---|---|---|
| (1) | T: | Right, so we are talking about electrostatics. This is the topic that has been done from grade 8. So, what do you remember about electrostatics if I may ask? |
| (2) | Adolf: | Sir, electrostatics, it explains itself, there is electricity involved and like I can't break down the word. Yes, electricity, there was Q, always Q1 and Q2 and there is a part when we add both. It Is either we subtract, they become one, after they divide and equal |
| (3) | T: | Well, that's his own understanding. Isn't it? |
| (4) | Ls: | Yes |
| (5) | T: | Sister Koketso, what do you…(interruption)…is there anyone by the door? You can come in. |
| (6) | T: | So, you said you want to break this word, electrostatic, static means what? |
| (7) | Ls: | Stationary |
| (8) | T: | Stationary. So, electricity, electricity in general is a flow of charge. In here we are talking about stationary charges. Anything that you can remember? I said Koketso |
| (9) | Koki: | Electricity is the language or the study of electrical object |
| (10) | T: | Electrical objects? |
| (11) | Koki: | Or electrically charged objects |
| (12) | T: | Prince, what do you remember? |
| (13) | Prince: | Electrostatics…there are charges there, we are calculating a force, given the charges |
| (14) | T: | You are saying there is a force…in other words, you are saying there is a force between charged particles (writing on the board). Right, okay…there is always a |

force between charged particles and when we were in lower grades, we said like charges what do they do?

(15) Ls: They repel

(16) T: Like charges repel and this repulsion here is a force. And unlike charges, what do they do?

(17) Ls: Attract

(18) Bontle: Which is the force of attraction

(19) T: they attract attraction force. Let me say attractive force. So, there is attractive force if you have different charges and repulsive force if you have like charges. Anything that you have? Grade 10? This is grade 8 and 9 [referring to their contributions]

(20) Ls: We didn't do it in Grade 10

(21) T: This is a grade 10 textbook (holding the textbook) and that topic is there

(22) Ls: Yah…yes we did it

(23) Adolf: We did that. But we didn't do electrostatics, we did static electricity

(24) T: So, what else can you remember?

(25) T: So, from here you guys also looked at some few things. You also looked at the conservation of charges, that a charge cannot be destroyed or created but can be transferred from one object to another. That is what you guys talked about

(26) Adolf: Ohhh *ke ela ya sekamo*, (the one where you use comb) and hair and there is a balloon involved

(27) T: Yes. I think as introduction, you get what this is. But now we have to move on to the topic of grade 11. We start by looking at the Coulomb's law. Anyone who is willing to give us that

Since this is the introduction of a topic of electrostatics, it is important that the teacher gets learners' prior knowledge about electrostatics. In the above excerpt, it is evident that the teacher did this by asking learners what they remembered from previous grades (turn 1). The dilemma starts when going deep into what the teacher actually wants. What he wanted was what they 'remember from previous grades' not 'their conceptions' about electrostatics. In turn 9, he explicitly direct learners to what he is looking for and the level at which it should be: "*they attract attraction force. Let me say attractive force. So, there is attractive force if you have different charges and repulsive force if you have like charges. Anything that you have? Grade 10? This is grade 8 and 9"*. Although Mr. D acknowledges learners' contributions, he is not that happy with the 'quality' of their contributions from what they remember from grade 8 and 9. What he is looking for is the work that learners did in grade 10 (turn 20). It should be noted that it is not just what they did in the previous grades but what they did about electrostatics – scientific view. This is also evident in turn 21 where he shows them the textbook. In his introduction, there was interaction. However, the teacher's communicative approach as he is searching for specific answers. Learners' contributions were limited because Mr. D kept on directing them to what he was looking for.

*Learner understanding*

Evidence of understanding can be seen here. In turn 9, Koki refers to electrostatics as the study of electrical objects and the teacher queries that (turn 10). Koki then rephrases her contribution and says it is the study of electrically charged objects. Instead of the teacher providing feedback to what Koki has said he picks another learner, Prince who responds with a more compressive answer. Prince's answer might have been influenced by what Koki had said. Mr. D acknowledges that this answer is enough for the introduction (turn 27). However, these learners' responses and their understanding might be because of what they have done in the previous grades. The argument here is that through the teacher eliciting learners' pre-conceived ideas, learners demonstrated and refined their understanding of a definition of electrostatics. This may have not been possible if Mr. D didn't ask about their understanding of the word electrostatics. Learners demonstrated their understanding of a concept because they were questioned and the questioning led to interaction.

*Linking teacher talk to learning*

The excerpt above shows that teacher questioning dominated in this lesson. Chin and Osborne (2008) assert that meaningful learning is limited if an interaction is dominated by teacher questions. In contrary, we see that learners refined their understanding of the concept of electrostatics even though teacher questioning dominated. Cazden's (1988) notion of triadic discourse is evident in the excerpt above through the question-answer exchanges. Although learner questioning in some parts of Mr. D's lessons are evident, they are mostly questions for clarity. These are the questions which Richards and Lockhart (1996) termed divergent questions which test understanding and facilitate comprehension of science concepts by promoting interactions. If learners use convergent questions there are possibilities of the teacher extracting misconceptions (Driver, Asoko, Leach, Mortimer& Scott, 1994). Although it might have been possible for Mr. D to get all the misconceptions about the topic of electrostatics, his response:

"*Yes. I think as introduction, you get what this is. But now we have to move on to the topic of grade 11"* does not indicate that is he was willing to deal with the misconceptions or misunderstandings that learners have.

***Excerpt 2: Teacher shifting from an interactive discourse to non-interactive discourse***

*Teacher talk*

The purpose of this excerpt is to illustrate teacher shifts from interactive communicative approach to non-interactive communicative approach. The excerpt is taken from the second lesson on application of Coulomb's law from Mr. D's class – towards the middle of the lesson. Learners were required to draw their free body diagrams on the board following from the activity that they had been working on individually. This is what happened after learners drew the free-body diagrams:

| | | |
|---|---|---|
| *(1)* | T: | Right, I love that. What I love is that there is A, B and there is a C [charges]. In fact, the net force is on what? |
| *(2)* | Ls: | B |
| *(3)* | T: | The net force is on B agreed? |
| *(4)* | Ls: | Yes |
| *(5)* | T | So, the net force is on B. I like it because we can start with that but at the end of the day I must find B there (drawing the dot on the board) with all the forces acting on B so that I can find the resultant force on B. Okay. That side? (Referring to the diagram). What is happening here? |
| *(6)* | Ls: | It is repulsion |
| *(7)* | T: | Yah, I can see there is repulsion. That is repulsion there… We have A, B and C (drawing dots to represent charges). In other words, what force is exerting A on B? |
| *(8)* | Ls: | Repulsion |
| *(9)* | T: | So, in which direction is the force? It is there (showing the direction by arrow). So that force is acting on what? |
| *(10)* | Ls: | A |
| *(11)* | T: | I want the force of A on B |

Learners start to giggle (inaudible) and the teacher just looks at them

| | | |
|---|---|---|
| *(12)* | T: | Alright, this is… |
| *(13)* | Lebo: | It is force A… |
| *(14)* | T: | A acting on B…? |
| *(15)* | Lebo: | Yes |
| *(16)* | T: | Ohh it means A is pulling B towards it? |
| *(17)* | Lebo: | Ahhh No…okay |
| *(18)* | T: | I want something that you have tried |
| *(19)* | Lebo: | Sir, it is fine |

(20) T: It is fine like that? So, in other words if C was not there, it means B would move towards A?

(21) Ls: A is…. 'running away'

(22) T: Inaudible

Silence for few seconds

(23) T: Okay, fine in other words, force of B on A is in that direction. Otherwise if we were to draw it as a push, we would draw it like that (drawing an arrow on the board) or you can still do it like that. But on the same…okay A is pushing B in that direction. Isn't it? So it means you can draw that force like that. Isn't it? You can draw that force like that. So this is…A is pouching B in that direction. This one [A] is pushing B in the opposite direction and this one [B] is pushing A in the opposite direction. Then you have, this is the force of A on B because we are saying A is pushing but we can still draw this arrow. Then you still have C. What is happening between C and A?

(24) Ls: They are attracting.

(25) T: So, in other words, A is pulling C and C is pulling A. In other words the force that C is exerting on A is also in that direction. So this one is the force because of A and this one is the force because of C. Do you see that? I am not sure whether we are together…

(26) Sipho: We are not.

(27) T: Alright, who is missing us? Right, 1, 2, 3, 4,5 (counting learners) lets go back and start afresh). Let us go back…

In turn 1, Mr. D shows that he appreciates what learners put on the board and explains to them why it is interesting. From turn 1 to turn 11, he was engaging with his learners. His engagement was on the science view (free-body diagram), thus, classified as an Interactive Authoritative approach. Turn 8 shows that learners were paying attention as they chorus "*repulsion*". Learners' utterances in turn 6 and 8 show that they were engaging with the activity although individually. More importantly, after the teacher's utterance in turn 11, learners start to have side-talks. This shows that they are thinking about what the teacher is engaging them in. The interaction from turn 12 to 21 shows learners' engagement as the teacher probes them.

Although Mr. S engaged with what two learners had drawn on the board, none of the two learners were asked to respond to questions he was posing in the interaction. In turn 23, he shifts from an interactive approach to a non-interactive approach. Mr. D starts to fully explain the free body diagrams that learners drew. He then notices that Lebo wants to defend her contributions and asks a question which Lebo doesn't answer (turn 19 -21). He then makes a decision of taking a non-interactive approach to explain what they were supposed to do (turn 23 & 25). His decision is influenced by learners lacking the necessary science language to articulate their understanding. For example, in turn 21, learners referred to the charge or object as 'running away' to denote repulsion.

*Learner understanding*

When the teacher shifted from an interactive approach, learners tried to follow what he was saying but they were unable to understand it. It seems like his Non-Interactive approach with the aim to equipping learners with the science knowledge did not help learners in grasping the content knowledge, learners alert him that they do not understand. One could argue that the inability of learners to understand is due Mr. D using the free body diagrams put on the board because after the second explanation, some learners were able to produce the following (which Mr. D marked correct):

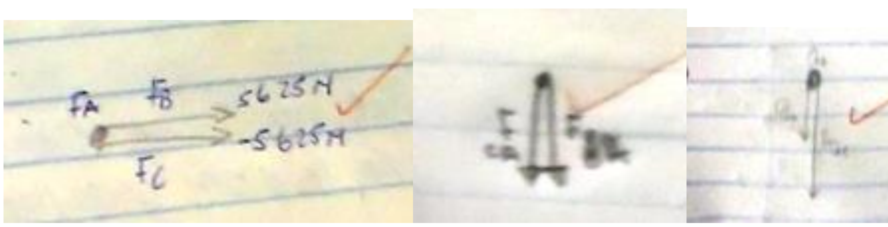


Figure 4.3: Learners' responses to demonstrate understanding of free body diagrams

*Linking teacher talk to learning*

In the above excerpt, we can see the domination of teacher talk. Morton (2012) found that although there is classroom interaction, the teacher is the one doing a lot of talking. Chapman (2006) argues that learners need to learn how to talk a about concepts (science) and it is up to the teacher to provide that particular platform where learners are given a chance to communicate their ideas. Wellington and Osborne (2001) also assert that when learners are engaged in talk, they learn to communicate through the language of science. In the excerpt above it seems that, Lebo does not want to continue talking: *"sir, it is fine"*. Mercer and Littleton (2007) say that learners are reluctant to voice out their contributions because they hold beliefs that teachers are always looking for the right answer. It can be true that evidence of learner understanding in Figure 4.3 resulted from the teacher re-teaching the concept again in a more transmittive way (turns 23 & 25). This was therefore in favour of the teacher's goals (Lyle, 2008) to clarify the concept of free body diagrams.

***Excerpt 4: Questioning and probing in Mr. N's class***

*Teacher talk*

This excerpt is taken from Mr. N's first lesson. After the introduction of electrostatics, the learner asked a question which led to Mr. N shifting his focus and talking about an atom. The aim here is show how the teacher uses questioning and probing to extract learners' conceptions before giving his final input.

| | | |
|---|---|---|
| *(1)* | T: | So,you got what he said. Should we be talking about a charged particle, we are talking about a scenario where the charges are unbalanced. Protons and electrons, positives and… |
| *(2)* | Ls: | Negatives. |
| *(3)* | T: | Should we have excess of negatives, what charge will we have? Excess means ? |
| *(4)* | Ls: | More |
| *(5)* | T: | More or Suplus of…then what is that charge? |
| *(6)* | Mog: | It is a negative charged |
| *(7)* | T: | Yes, a negatively charged particle. Does someone want to tell me what a positively charged object is? can someone please explain…Yes sir/ |
| *(8)* | Lelo: | When it is positively charged, it means that it has lost some of the electrons |
| *(9)* | T: | So, it has lost some of its electrons |
| *(10)* | Lelo: | Making the overall charge positive |
| *(11)* | T: | okay, we will come back to that…someone wants to talk… |
| *(12)* | Jabu: | There is surplus of protons |
| *(13)* | T: | Surplus of….? |
| *(14)* | Jabu: | Protons |
| *(15)* | T: | Somebody wants to try before I put in my input? Yes…try? |
| *(16)* | Mpho: | Sir…electrons are the ones that move ,when an atom, when a particle loses protons and has a surplus of electrons |
| *(17)* | T: | Okay, anyone who want to try something? Okay…what you need to know from today is that, the state of an objects whether it is positively or negatively charged is determined by electrons. You [Mpho] have put it correctly to say only the electrons move…only electrons can be transferred. Not positive, positives do not move. So, what does it mean to say, this is negatively charged? When we say that this is negatively |

> charged, we mean there is excess of electrons. When this is positively charged, what do you think it means? So, there is deficiency. Never talk about that using the positives. When we define whether this is negatively charged or positively charged we decide whether there is an excess of electrons and this is positively charged, why? Because there is deficiency. So, deficiency means there is surplus of protons but an explanation should refer to the electrons. So, these charges are…?

The kind of questioning here can be linked to the Interactive authoritative approach. The questions are based on the science principles and they are mostly close-ended questions. However in turn 17 it looks like he got what he wanted to get as he says "*what you need to know from today is that…"* Looking closely at his probing techniques, it can be argued that his desire was to extract learners' conceptions and work with them. In his consolidation talk in turn 17 of excerpt 4 he corrects some learners who perceive protons to be moving: *"Not positive, positives do not move".* Questioning combined with probing helped him to deal with learners' conceptions through non-interactive communication at the end.

*Learner understanding*

Following the above interaction in Mr. N's class, learners were given the worksheet based on the atomic structure and static electricity. As the teacher revised the worksheet with learners after 15 minutes, some learners seemed to have understood the idea of a charged object which they dealt with at the beginning of lesson 1 (See Excerpt 4). Specifically, in turn 17 of excerpt 4, Mr. N mentioned that only electrons can be transferred and later on, when he asked learners about the principle of conservation of charge they were able to state it:

| | | |
|---|---|---|
| *(1)* | L4: | Sir, the charge of a neutron is neutral or zero |
| *(2)* | T: | Yes it's neutral because it does not have a charge. Right, what is the principle of conservation of charge? |
| *(3)* | L5: | Charges cannot be destroyed nor created but can be… (inaudible) |
| *(4)* | T: | Right, there is no miraculous day where you will sit down and destroy a charge. The charge is neither be created nor destroyed. You can only?? |
| *(5)* | Ls: | Transfer |
| *(6)* | T: | Which charge usually, is going to be transferred? |
| *(7)* | Ls: | Electrons |

Learners were able to state that the only charge that can be transferred is electrons. The possibility is that they understood this earlier in the lesson from discussion on what it means to have a negatively charged object. Probably, as a result of the consolidation talk from the teacher, they were able to conceptualize the idea of transferring electrons only.

*Linking teacher talk and learning*

Scott and Mortimer (2005) associated the idea of probing with a dialogic discourse. Mr. N's utterances in the above excerpt may have been classified as probes but they don't make the whole excerpt an interactive dialogic one. The teacher asked for clarity. He shaped learners' ideas by asking as many questions as possible. Scott and Mortimer (2005) argue that teachers' communication choices are influenced by the teaching purposes and the nature of content. Therefore Scott and Mortimer's idea explains why the teacher reviewed learners' answers after gathering as much contributions as possible.

***Excerpt 5: Teacher shifts his focus and deals with learners' questions through interaction***

*Teacher talk*

At the beginning of Lesson 1, Mr. N was introducing electrostatics and getting learners to break down the word. He then shifted his focus because of one learner's contribution when they were defining the word 'static'. So, the significance of this excerpt is to show how the teacher attended to a learner's comment which ultimately led to whole class discussion and interaction.

*(1)* Dolly: Sir so, solid…(inaudible).
*(2)* T: Not quite because solid is a state of matter. How many states do we have?
*(3)* Ls: Three
*(4)* T: Three state, so can you identify them?
*(5)* Ls: Liquid, gas, solid
*(6)* T: So, are the charges solid or you are saying that they are in a solid?
*(7)* Mog: The charges are in a solid
*(8)* T: The charges are in a solid and they are not moving? So, stationary means these charges do not move and they do not flowing. So you can use all these but we actually have to understand what we mean by electrostatics.
*(9)* Jabu: Sir, an electron is a charge right?
*(10)* T: Yes
*(11)* Jabu: So, when you say charges do not move, the electrons do not move?

*(12)* T: The question is why is it so. Electrons only move when there is…when there is what? Let us put this aside. We are saying electrons flow when there is a push or a pull and usually this push or pull what do we call it?

*(13)* Ls: Force

*(14)* T: So, which force usually pushes this? emf. And what do we call it

*(15)* Ls: Electromotive force

*(16)* T: And this electromotive force is going to be there if there is what we call p.d

*(17)* Ls: Potential difference

*(18)* T: Potential difference. And this potential difference comes with the difference in charges? Positives and negatives.

In turn 1, Dolly is asking if the word 'static' in 'electrostatic' can be synonymic to solid. Since Mr. N asked them to break the word for their understanding, Mog sees 'solid' as having the same meaning with the word 'static'. One would expect that the teacher responds to learners and moves on with the lesson on electrostatics. Surprisingly, the teacher responds to the learner and evaluates his response by referring to his thinking: "*solid is a state of matter. How many states do we have?"* However, he doesn't end here. In turn 6: "*So, are the charges solid or you are saying that they are in a solid?"*. Mr. N teacher tries to understand the learner's conception so that he can make informed decision on how to help the learner. The teacher ends the discussion by summarizing what the word 'electrostatics' mean. His summary then led to another discussion on potential difference and whether the electrons are moving or not moving (turns 9-18). My point here is that if the teacher did not deal with Mog's conception, then there wouldn't have the summary that he made in turn 8. This then mans that Jabu wouldn't have asked the question in turn 9 which opened a class discussion even though the teacher remained focused on the science concepts.

*Linking teacher talk and learning*

Since Mr. N entertained the question which was not his focus, an interaction was opened. The interaction is dominated by question-answer play where answers are given in a chorus way. This triadic discourse functioned in the interest of the teacher as he was able to assess learners' content (Cazden, 1988). Lyle (2008) says that this is one form of rote learning. The teacher was on refreshing the minds by making the recall what they have learnt before. However, as time went, his question-answer strategy led to a whole class discussion around the concept of electrons. Therefore what Lyle calls recitation can open up a room for dialogic discourse provided the comments and/or questions from learners are more of contestation questions (Arguiar*et al.*, 2010).

***Excerpt 6: Mr. N gives learners a platform but still remains authoritative***

*Teacher talk*

The following excerpt is taken from Lesson 2. In this lesson, Mr. N was dealing with application of Coulomb's law and marking the work given previously. He asked one learner to come in front and lead them. The purpose of this excerpt is to show how the teacher gives learners a platform to engage with the subject matter yet remaining authoritative and acting as a facilitator. After the learner had solved the problem on the board, the teacher saw that there were mistakes and asked other learners to help her:

> "I was thinking you were going to help her grow there….there are so many mistakes that I see. She asked if she has done justice. We are not condemning but we are saying, there are standard ways. (Learners raising their hands). You can ask your friends to help you"

Learners started to voice out what they thought about what the other learner did on the board. Mr. N then helped them and facilitated the discussion after seeing no progress in their contributions.

| | | |
|---|---|---|
| *(1)* | T: | Right, to save time, if you put an 'f' like that you are talking about friction. You have to be careful. You don't have to be stylish. Write the big F for force. And then a 'newton' must be a Newton clearly defined. Write in a manner that it is a capital letter. Is that the answer? |
| *(2)* | Ls: | Yes |
| *(3)* | T: | Is that all? |
| *(4)* | Ls: | Yes |
| *(5)* | T: | Then please you have to revise your physics because a force is a vector and you cannot only have magnitude |
| *(6)* | Ls: | Direction |
| *(7)* | T: | So, what do you say? |
| *(8)* | Pan: | Sir, how I understand the way we calculate the electrostatic force, it is either you write repulsion… |
| *(9)* | T: | My friend don't tell how 'you'. Answer the question. This is a vector. Then what do you say? So, don't punish yourself telling us what you understand. What you understand is what it is. Yes sir… |
| *(10)* | Karabo: | It is attraction |

| | | |
|---|---|---|
| *(11)* | T: | So it is 112.25 Newton attractive. You put that there because you need magnitude and direction. Why do you think it is going to be attractive? Panashe |
| *(12)* | Pan: | It is because unlike charges repel…I mean they attract. So, these are unlike and they attract |
| *(13)* | T | Right, you realize how it was supposed to be done. How many of us did that? So, next time…it is very, very important |

While in turn 1 Mr. N directs them to what he is looking for,inturn 3 he is still asking for more. He takes an authoritative approach only to get the science correct. In turn 8, Pan responds the way he understands it and the teacher responds to him by saying *"My friend don't tell me how 'you'. Answer the question…"* (Turn 9). This shows his authoritative stance and making sure that learners give the correct answer. He reminds them in turn 13 that they should grasp how this is done.

*Linking teacher talk and learning*

Roth (1994) argues that engaging learners in a whole class discussion promotes dialogic discourse. In Mr. N's case, learners where able to argue with each other on presenting their views, the teacher wanted them to get the science story for the problem being solved. That is why in turn 13 he says they should learn how to do that next time. This is consistent with XU's (2009) finding that the nature of a topic can make a classroom not to be dialogic. Topics which are mainly based on calculations are interactive but they are not dialogic. The teacher is mainly interested in helping learners to get the calculations right. The main goal is on performing calculations and arriving at the correct answer. This results in procedural understanding of performing calculations mainly for exam purposes. There is no conceptual understanding since there is no engagement on the reason why something is being done in that manner.

***Excerpt 7: Mr. S uses questioning but in an authoritative way.***

*Teacher talk*

This excerpt is taken from Lesson 1 by Mr. S. The argument here was that the speed and net force should be zero for forces acting on a suspended ball.

1) T: Can I ask you a question to help you there? The force is acting on these balls. Are they at equilibrium?
2) Ashley: They are not…
3) T: So, there is a net force; you are saying?
4) Ashley: Yeah
5) T: If there is net force acting on these balls, what do you expect?

(Silence)

6) Hendrick: Repeat the question sir…
7) T: If the net force acting… (Inaudible), then what happens?
8) Hendrick: It accelerates
9) T: It accelerates…right? Did you see these balls accelerating?
10) Ls: Yes
11) T: Really? What is the meaning of accelerating?
12) Sizwe: There is force involved…

(Inaudible: learners talking to each other while Mr. S is talking)

13) T: and that force is also zero and if that force is zero?
14) Sizwe: Then it is zero
15) Ashley: And speed can also be zero sir

(Laughter from learners)

16) Ashley:Yes sir, speed can also be zero
17) T: Space?
18) Ashley: Speed. So there is speed there sir…
19) T: Yah, speed is zero. Acceleration is zero which means the net force is zero

Mr. S is using a question as a way to help learners solve the problem (turn 1). His question seems to have opened a whole class discussion. However, in the discussion, Mr. S takes an authoritative stance. This is evident in turn 15 when Ashley claims that speed can also be zero. The teacher's approach is classified as Interactive authoritative because Mr. S just accepts Ashley's answer instead of probing him and asking further questions. If Mr. S required Ashley to provide reasons for his claim, dialogic discourse could have been established. This could have led to argumentation where other learners can make their claims with supporting evidence. Since it was not what the teacher was trying to get them to, he just accepted the answer and continued talking.

*Linking teacher talk and learning*

The above excerpt was another interactive instance through questioning, yet authoritative. Questioning forms a large part of teacher talk because teachers want to test learners as well moving away from the transmission of knowledge. Traver (1998) argues that the level and quality of engagement is determined by teacher questioning. The teacher asked if the balls are at equilibrium and learners responded in multiple ways. The question was close-ended as seen from learners' responses. However an opportunity for modeling argumentation and dialogic discourse was missed as the teacher was not able to probe Ashley for more evidence. Furthermore this question could have been more divergent to allow multiple answers from learners (Martin & Hand, 2009). Mortimer and Scott (2003) say that teacher communicative approaches are influenced by the teaching purposes. Therefore, it can be argued that engaging learners in an argument was not the purpose of this interaction. However, it is through teacher mediation and learner responses that make a question more divergent.

***Excerpt 8: Mr. S using Non-Interactive Authoritative approach***

*Teacher talk*

This excerpt is taken from Lesson 2 by Mr. S. The teacher asks learners what would happen to the force if the distance between charges is doubled. This excerpt shows that there are instances where interaction is suitable but due to some teacher pedagogical reasons, non-interaction authoritative approach is taken as important to convey certain concepts and procedures.

*(1)* T: How would the force change if the charges were as twice as far apart? So, instead of 10mm, it will be 20mm.
*(2)* Sdumo: The electrostatic force will decrease
*(3)* T: It will decrease or increase? But by how much? If you double the distance, what happens to the force?
*(4)* Sdumo: Constant…
*(5)* T: Right, you make this one…(Inaudible)
Silence
*(6)* T: So, let us take a generic approach on this one because you get questions like that in the exam paper. What happens if you double this one or if you half that one? What happens with the force? So…(Teacher solve the problem on the board and asks them to copy).

Mr. S poses a question in turn 1. In turn 2 Sdumo responds by saying that the force will decrease but he does not specifically indicate how it will decrease. Sdumo seems to have an idea. However, because of the teacher's decision, learners were forced to just listen and copy what is on the board. In turn 6, the teacher alerts them that they will get these kinds of questions in the exam but does not give them a chance to show how they would solve the problem. Instead, he employs a non-interactive approach by transferring what they should know as he says they should copy it in their books.

*Linking teacher talk and learning*

Similar to Mr. D, Mr. N's choices of communicative approaches based on the nature of science content, Mr. S chose to take a non-interactive approach looking at what he sees as best for learners. An authoritative approach was employed for curriculum reasons. The teacher knew that this kind of question was popular in examiners. Because of pressure to get learners passes the exam, he resorted to drill. Lyle (2008) argues that this kind of teaching does not promote conceptual understanding.

***Excerpt 9: Interactive Authoritative approach for deeper thinking***

*Teacher talk*

Authoritative approach was often used to engage learners and get them to think deeply through using leading questions. This excerpt from lesson 3 by Mr. S is a good example. It happened at the beginning of the lesson after Mr. S and learners dealt with the differences between the equations of the electrostatic force and gravitation force. They were now dealing with the similarity between these two equations.

*(1).* T: They are determined by similar equations. So, there must be something in common. There must be something in common. So, my question is that what is it that they have in common?
*(2).* Prince: One thing that is in common is that they are both for calculating forces between two objects
*(3).* T: Yes okay but…(inaudible)
*(4).* Ls: Huh?
*(5).* T: What do we know about those objects?
*(6).* Thembi: They are charged
*(7).* T: Not in the case of gravitational force
*(8).* Adolf: Sir, they are still, they are still…like they actually don't move…*eya* (yes)..
*(9).* Kate: Not always…
*(10).* Adolf: Like they are in one position…
*(11).* Prince: They are exerting force on each other…
*(12).* Adolf: Yes…they are like in one position
*(13).* T: Mmmmm…that is not necessarily always the case
*(14).* Prudence: Both these forces have distance
*(15).* T: Distance yes…

*(16).* Prudence: Yah, and I am from outside…(excited)
*(17).* T: The two of them exert a force on a certain distance. Meaning they don't touch each other. So that makes these forces what?
*(18).* Ls: Non-contact forces

Mr. S. posed a question for engagement in turn 1. Prince provides an answer which the teacher accepts but makes a comment to signal that it is not what he is looking for. In turn 5, he provides a leading question in order to direct them to the desired answer "*What do we know about those objects?"* Although the teacher's communicative approach is authoritative, he seems to be accepting every answer that a learner provides. For example in turn 13 he says that "*that is not necessarily always the case*". His feedback shows that what the learners say might be true (acceptance) but there is an answer that he is looking for and this answer is given by Prudence in turn 14.

*Learner understanding*

In turns 2 and 4, learners seemed to know what they were talking about. In other words, they were engaging with the subject matter. Mr. S and learners were only focused on the science content; they focused on one view of explaining things. Mr. S asks a leading question in turn 5. Learners then show that they are able to recall what they had forgotten in turn 18 when they can voice out that forces that act at a distance are non-contact forces. Recognition of forces being non-contact resulted from teacher's mediation of the recall process.

*Linking teacher talk and learning*

The teacher is taking an authoritative position because he wants learners to remember. Scott, Mortimer and Aguiar (2006) argue that classrooms in which the communication is authoritative are not prohibited; they simply show how the content relates to talk in the classroom. They say that it is sometimes important for the teacher to have authoritative position in a classroom so that the scientific content can be fully developed. Creating opportunities for learner participation and engagement in a dialogic learning environment will then make teacher to take a dialogic communicative approach which might still have the IA indicators.

### 4.5 Discussions on teacher talk and learner understanding

Communicative approaches used by different teachers influenced the forms of engagement in the classroom. All three teachers' lessons were dominated by interactive authoritative communication where the emphasis was on the science story. Despite this domination of IA communication approach, some parts of Mr. D and Mr. N's lessons showed evidence of dialogic forms of engagement. This is where learners' views were explored. This form of engagement allowed learners to influence the direction of the lesson (Scott & Mortimer, 2005). Through this dialogic engagement, learners showed understanding of the science concepts.

Learner understanding was also seen where learner questioning dominated. Although learners asked questions in a more authoritative way (based on the science story), it allowed them to involve themselves in a meaningful interaction. Brodie (2005) argues that learner questions can enhance participation. She says that it is not a bad thing to have the IRF/E triads. The triads can make learning meaningful if they are 'reversed'. So, the initiation is made by a learner as opposed to the teacher. The teacher will either respond to the question or ask other learners to do that. All three teachers' lessons showed this reversed triads. It was through these kinds of triads that learner participation and engagement was enhanced.

All three teachers seemed to use different forms of communication for different purposes. Mortimer and Scott (2003) argued that teacher communicative approaches are influenced by the lesson objectives. So, the teacher can open up an interaction to deal with learners' misconceptions or just to convey the science view. Some teachers may choose to engage learners in dialogue for different reasons (Scott, 2008). It was seen the three teachers' lessons interactive authoritative approach was used to just tell learners the science story while involving them. Although learners were involved, their answers or contributions were overlooked or ignored and this resulted in the IRF/E triads. In cases were interactive dialogic approach was emerging; teachers kept on going back to interactive authoritative approach. So, teachers were not able to make possible shifts between authoritative and dialogic communicative approaches.

### 4.6 Chapter summary

I started this chapter by presenting the results of teacher's interviews about the role of talk in their science classrooms. I then presented the results of teacher talk using the communicative approaches as outlined by Mortimer and Scott. These interpretations and discussions have provided some light on how teachers facilitate talk in their classrooms which might be as a result of their views about science teaching and learning. The results have shown that teachers are mainly authoritative in their classrooms yet interactive. Furthermore, the interactive approaches show elements of the triadic discourse which is mainly dominated by the question-answer form.

I then linked teachers' views to their classroom practices. Results have shown that teachers value constructivist teaching through the use of dialogic approach and interactions in their classrooms. However, some inconsistencies have been found between what they vocalize and what they actually practice in their classrooms. Teachers find themselves in a position where they want to employ more interactive approach, especially dialogic but because of how science content is, they are unable to do so. They are then compelled in some parts, non-interactive approaches and interactions which are of lower order. This then limits learner engagement.

Lastly, I provided nine excerpts as evidence of how the communicative approaches are employed in these science classes. It can be noted that from the excerpts, teachers facilitate talk through questioning, probing as well as transferring necessary information to learners. Although learners were encouraged to talk, teacher talk dominated the lessons because of the authoritative nature of the science content. In some these excerpts, I have also shown that there is some form of understanding that can be gleaned from teacher talk and the interactions that took place the teacher and learners. Some of this can be termed *learning* rather than *understanding* as it is difficult to measure understanding from teacher talk.

# Chapter 5: Conclusions and implications

## 5.0 Introduction

The purpose of this study was to understand how teachers facilitate talk in the classroom for learner understanding of science content. I did this by first looking at their views on classroom talk and looking at how that translates into their practices. My take was that teacher perceptions influence what they practice in their classrooms. The pedagogical decisions are highly dependent on the nature of science content and how they think it should be taught. I this chapter, I provide the summary of findings according to research questions which guided this study. I then deal with the limitations while reflecting on the process taken throughout this study as well as proposing what can be looked at in further research. Based on the research findings, I deal with implications for teachers and teacher education.

## 5.1 Summary of findings

I mentioned in Chapter 1 that this study is designed to understand the current teacher practices in science classrooms. Furthermore, I outlined the significance of teacher talk in learner engagement with content and how that can impact learner conceptual understanding. In this section, I summarize my findings according to my research questions. My research questions were:

1) What are science teachers' views on the role on classroom talk in understanding of content?
2) How do teachers facilitate classroom talk in their science classrooms?
3) What is the relationship between teachers' views of talk and their classroom practices?
4) What evidence of learner understanding of science content can be gleaned from the classroom interaction?

*RQ1: What are science teachers' views about the role of classroom talk in meaningful understanding of content?*

Four themes emerged from the interviews: teacher's role, learners' role, forms of communication and nature of school science content. The fourth theme (nature of school science content) seems to influence all other three and it seems to constrain teachers' pedagogical decisions. The nature of school science influences perceptions of teachers' role and the use of communicative approaches in the lesson. In terms of teachers' role, the main finding was that teachers view themselves as facilitators. However, from their elaborations, it can be deduced that they actually perceive themselves as mediators. This is evident when they talk about helping learners in solving science problems as opposed to just giving them 'tools' and letting them work on a science problem. The process of mediation is in line with the social constructivist theoretical framework employed in this study (Vygotsky, 1978).

All the three teachers mentioned the importance of interaction in science classrooms. They view interaction as a way of making knowledge accessible to learners with different abilities. On the issue of interaction, they viewed themselves as 'helpers' instead of sources of information. Although teachers believed that interaction and engaging learners in a dialogic discourse is important, Roehler, Duffy, Herman, Conley and Johnson (1988) suggest that their knowledge of establishing a dialogic discourse may be lacking. All three teachers prefer to use whole class discussion as a strategy after small group discussion. This is because of classroom management reasons. They feel that they might not reach to all learners. Teachers also mentioned that whole class discussion will not allow them to deal with learner contributions according to different learner abilities. This suggests that they would use Interactive Authoritative approach in teaching science. Galley (2001) found that teachers tend to have limited expectations of what their learners are capable of and therefore shy away from employing unfamiliar or difficult to manage strategies like whole class discussion. Yet, these may open up for dialogic discourse if managed carefully.

One of the teachers said that he believes that questioning is important in classroom talk. The other pointed out that talk is not only about exchange of words between the teacher and learners but is about working together in collaboration. This shows teacher awareness of their pedagogical decisions. All the three teachers emphasized the importance of interaction and classroom talk to promote critical thinking and help learners see the relevance and application of science.

*RQ2: How do teachers facilitate classroom talk in their science classrooms?*

Firstly, all the teachers facilitated talk through questioning. As part of questioning, collecting learners' pre-conceived ideas seems to be of importance to all three teachers. This is in line with constructivist approach of teaching science. However, the questions used at the beginning of the lessons are more of recall requiring learners to remember the science content learnt before. Morge (2005) asserts that this encourages memorization of concepts and theories. More importantly, the questions asked in the lessons resulted in triadic discourse. However, IRRRR…P/F chains were seen in one of the teacher's lesson. The chains are the ones which led to a more deep engagement interaction. Most of the triadic discourses limited learner engagement with the content. This is consistent with Cazden's (1988) conception that triadic discourse can result in learning of content but limiting learners' responses which may have opened up an engaging interaction.

The three teachers mostly used convergent and close-ended questions in the classroom. In these kinds of instances, learners were not able to provide different points of views objecting to someone's answer. Martin and Hand (2009) found that convergent questions mostly led to content based answers as opposed to a more dialogic discourse.

Secondly, teachers facilitate talk by using learners as teachers. This enables teachers to mediate discussions and facilitate talk. In all three classrooms, learners were used as teachers where they were allowed to go in front and solve some science problems. Teachers did engage in a dialogic discourse even where there was an opportunity and necessity. Scott *et al.* (2006) assert that teachers may not be aware of how to take a dialogic approach and how their authoritative stance limits learners' participation. It is therefore necessary to expose teachers to dialogic strategies so that they can move from a traditional triadic discourse to a more dialogic discourse.

*RQ3: What is the relationship between teachers' views and their classroom practices?*

In terms of the link between what teachers say about classroom and interaction, findings show the following points:

- Teachers said that they prefer group discussions but there was very little evidence of group discussion in their lessons. Instead whole class interaction was dominant. The inconsistencies on what teachers vocalize and what they actually practice is supported by Louca *et al.* (2004).Louca *et al*. say that what teachers vocalize may not necessarily determine their practices.
- Teachers said that they value the importance of interaction and engaging learners and the interaction seen in their classrooms. Most of their lessons were dominated by interactive authoritative communication. Tobin and McRobbie (1997) state that teachers are not aware of their views in relation to what they do in classrooms. More importantly, they are not aware of what dialogic discourse means therefore that they are unable to engage their learners in it. Due to teachers' authoritative stance, learners' engagement is limited. Jemenez-Aleixandre *et al.*, 2000) argue that the authoritative stance perpetuates learners' belief that only the right answer is needed, therefore learners become reluctant to make contributions.
- Teachers' views on the importance of classroom talk and interaction did not significantly influence and match their instructional practices. Instead, it seems as if their views on learners and the lesson objectives had a significant influence on the way they teach. They took an authoritative stance to match the content and lesson objectives
- Lastly, the employment of interactive approaches is influenced by beliefs and teacher experience. Teachers choose to use certain communicative approaches not just because they believe it works but because they have certain experiences where it was seen to be working.

*RQ4: What evidence of learner understanding of science content can be gleaned from the classroom interaction?*

Findings on the role of teacher talk and classroom interaction for learner understanding are summarized below:

- There is some evidence of understanding that can be seen from teacher talk and learner engagement.
- Teacher probes challenge learners and this has implications later on when they re-visit the concept. Learners who did not understand were challenged through probing and the use of the interactive chains (IRPRPRPRPR…F).
- The use of non-interactive authoritative approach promotes memorization of science principles and laws as opposed to understanding the reasoning behind those principles. However, understanding starts to emerge when the very same concept is explained again through an interactive approach collaboratively with the use of examples.
- Divergent questions used throughout interaction to allow multiple answers promote a more deep engagement with the content which may lead to understanding.

## 5.2 Limitations of the study

I now deal with some of the limitations of the study. The first limitation is concerned with sampling and number of participants. My research participants were three teachers and their science learners in an independent, intervention school. My focus on these three teachers limits generalization of findings. What these three teachers do does not reflect what other teachers do in other classrooms. Therefore generalization in this regard would be inappropriate. The findings *only* reflect these three teachers and their classrooms.

The study was based on a case study and it was qualitative. Although the findings provided an understanding on teachers' views and their practices and how they facilitate talk, the findings are to a limited context. The number of lessons observed was limited. A more extended observation would have provided more data to get a deep understanding of teacher talk and how interaction is facilitated. What teachers did when they were observed would not necessarily reflect what they do when teaching every concept.

Lastly, my presence in the classroom could have affected how learners engage with each other. The interaction could have been than usual. This can be due to learners wanting to 'please' the researcher. On the other hand, teachers could have deliberately chosen to teach in some way with the aim of helping me get 'rich data' for successful analysis. Therefore, if the study was to be repeated with the same teachers, it would yield different results because this is a qualitative study. Qualitative interpretations are influenced by the interpreter and contextual factors (Cresswell, 2003).

## 5.3 Further Research

The findings can be of value to the body of research in classroom talk and interaction. One of the things seen in teachers' practices is that they are not aware of what dialogic discourse actually entails. They see 'dialogue' as just interaction and letting learners talk to each other. Therefore, future research on classroom talk could look at how teachers engage learners in a dialogic discourse before and after a workshop. This could benefit teachers on how dialogic discourse is established. This could also help in clearly determining understanding of concepts by learners.

It was seen in some instances that it is not about learners' inability to talk and engage with each other as well as the teacher but it is about the language of teaching and learning as well as the language of science. Learners seemed to lack necessary words to articulate their thinking. As Lemke (1990) stated that language is a tool that facilitates interaction, it is evident that learners did not have this tool and this prohibited their understanding. Although there is a lot done on language, future research can look how the teacher facilitates talk in recognition of language demands. Furthermore research can be done to find out if teachers do have language competences because sometimes it is not about the inability of teachers but lack of competencies.

## 5.3 Implications for teacher education

I stated earlier that CAPS requires teachers to function as mediators while helping learners make sense of the content. Teachers need to start making possible shifts between interactive authoritative and interactive dialogic approaches. None of the discourses is more valued but there should be a balance between the two with the ability to shift from one to the other. However, teachers seem to find it difficult. Therefore teacher education programs and teacher workshops should focus on making teachers aware of the impact of their talk on learner understanding.

## 5.4 Personal growth

It is not, it has never been and will never be easy to carry out an educational research. Although it is not easy, putting thought in it transforms one and makes one see things in another perspective. This is what this study has done to me! This study has helped me as a teacher to see how a word or sentence could have major implications for learner acquisition of knowledge. Furthermore, the study has taught me to expect the unexpected! I have also learnt research skills like conducting an interview. From the interviews, I was able to see, for example where a probe was necessary and was not made and this had an impact on my data analysis

## 5.6 Chapter summary

This chapter was intended to conclude the whole study and summarize everything that is in this report. I started this chapter by dealing with the summary of findings. I did this by re-visiting the main ideas and findings emerging for each research question and linking that to what others have found in the past. I then outlined limitations of the study which were more methodological. I then dealt with implications for teacher education and stated that teachers should be taught how to establish a dialogic discourse in their classrooms. Teachers might value dialogue but if they are unable to engage learners in it, then their knowledge becomes useless to their pedagogical decisions. Lastly, I reflected on the research process and outlined my personal growth.

## References

Ada, N. A., & Okwu, E. I. (2001). Teachers' awareness of the role of improvised materials in science teaching. *Journal of Education*, *3* (1&2).

Aguiar, O. G., Mortimer, E. F., & Scott, P. (2010). Learning from and responding to students' questions: The authoritative and dialogic tension. *Journal of Research in Science Teaching, 47*(2), 174-193.

Alexander, R. (2000) *Culture and Pedagogy: International Comparisons in Primary Education.* Oxford: Blackwell.

Alexander, R. (2004). Still no pedagogy? Principle, pragmatism and compliance in primary education. *Cambridge Journal of Education, 34*(1), 7-32.

Anderson, L. W. (2004). Increasing teacher effectiveness ($2^{nd}$ Ed.). Paris: UNESCO

Barnes, D. (1992). *From communication to curriculum*.London: Sage Publications.

Barnes, D. (2008). Exploratory Talk for Learning. In N. Mercer and S. Hodgkinson (Eds.), *Exploring Talk in Schools* (pp. 1-12).

Boaler. J., & Brodie, K. (2004). The importance, nature and impact of teacher questions. In D. E. McDougall, &J. A. Ross (Eds.), *Proceedings of the twenty-sixth annual meeting of the North American Chapter of the International Group for Psychology of Mathematics Education, 2,* 773-782. Toronto, Ontario.

Boyd, M. P., & Markarian, W.C. (2011). Dialogic teaching: talk in service of a dialogic stance. *Language and Education, 25* (6), 515-534.

Brodie, K. (2005). *Learner contributions in Mathematics classrooms.* Paper presented at the Annual Conference of the Southern African Association of Research in Mathematics, Science and Technology Education Namibia.

Brodie, K., Lelliott, A., & Davis, H. (2002). Forms and substance in learner-centred teaching: teachers' take-up from an in-service programme in South Africa. *Teaching and Teacher Education*, *18*(5), 541-559.

Brownlee, J., Purdie, N. & Boulton-Lewis, G. (2001).Changing epistemological beliefs in pre-service teacher education students. *Teaching in Higher Education, 6* (2), 247-268.

Bryan, L. A. (2003). Nestedness of beliefs: Examining a prospective elementary teacher's belief system about science teaching and learning. *Journal of Research in Science Teaching*, 835-868.

Cazden, C. B. (1988). *Classroom discourse: The language of teaching and learning.* Portsmouth, NH: Heinemann.

Chan, K. (2003). Hong Kong teacher education students' epistemological beliefs and approaches to learning. *Research in Education, 69,* 36-50.

Chapman, O. (2006). Classroom Practices for Context of Mathematics Word Problems. *Educational Studies in Mathematics*, 62(2), 211-230.

Chisholm, L. (2005). The politics of curriculum review and revision in South Africa in regional context. *Compare, 35*(1), 79-100.

Chin, C. & Osborne, J. (2008). Students' questions: A potential resource for teaching and learning science. *Studies in Science Education*, 44, 1–39.

Chin, C. (2006). Classroom Interaction in Science: Teacher questioning and feedback to students' responses. *International Journal of Science Education, 28* (11), 1315-1346.

Chin, C. (2007). Teacher questioning in science classrooms: Approaches that stimulate productive thinking. *Journal of Research in Science Teaching, 44*, 815-843.

Creswell, J. W. (2003). *Qualitative, quantitative, and mixed methods approaches* (2nd Ed.). Boston: Pearson.

Cross, D. I. (2009). Alignment, cohesion, and change: Examining mathematics teachers' belief structures and their influence on instructional practices. *Journal of Math Teacher Education, 12,* 325-346.

Davidowits, B., & Rollnick, M. (2011). What lies at the heart of good undergraduate teaching? A case study in organic chemistry. *Chemistry Education Research and Practice, 12,* 355-366.

De Wal Pastoor, L. (2005). Discourse and learning in Norwegian multiethnic classroom: Developing shared understanding through classroom discourse. *European Journal of Psychology of Education, XX* (1), 13-27.

Department of Education. (2003). *The National Curriculum Statement Grade 10 – 12(Physical Science*. Pretoria: Department of Education.

Department of Education. (2011). *National Curriculum Statement Grades R - 12: Curriculum and Assessment Policy (CAPS) Physical Sciences*. Pretoria: Department of Education.

Driver, R., Asoko, H., Leach, J., Mortimer, E., & Scott, P. (1994). Constructing Scientific Knowledge in the Classroom. *Educational Research, 23*(7), 5-12.

Duit, R. (2002). Conceptual change—still a powerful frame for improving science teaching and learning. In *third European Symposium on Conceptual Change* (pp. 26-28).

Edwards, A. D., & Westgate, D. P. (1987).*Investigating Classroom talk*. Philadelphia: Falmer Press.

Feyzioglu, E. Y. (2012). Science Teachers' Beliefs as Barriers to Implementation of Constructivist-Based Education Reform. *Journal of Baltic Education, 11* (4), 302-317.

Furtak, E. M., & Ruiz-Primo, M. A. (2008). Making students' thinking explicit in writing and discussion: An analysis of formative assessment prompts. *Science Education, 92,* 799-824.

Galley, M. (2001). Gap exists over educators' expectations for minorities. *Education Week, 21(6)*, 10.

Halliday, M. A. K (1976). *Explorations in the Functions of Language*, London: Oxford: Blackwell.

Hatch, J. A. (2002).*Doing qualitative research in educational settings*. New York: SUNY.

Haworth, A. (1999). Bahktin in the classroom: The dialogic text. *Language and Education, 13* (2), 99-117.

Haynes, J. (2008). *Children as Philosophers. Learning through Enquiry and Dialogue in the Primary Classrooms.* Routledge: New York.

Hoadley, U. (2012). What do we know about teaching and learning in South African primary schools? *Education as Change, 16* (2), 187-202.

Houssart, J. (2012). Teaching assistants and intervention programmes in primary mathematics. *Proceedings of the British society for research into learning mathematics, 32* (2), 40-45.

Howell-Richardson, C., Christodoulou, A., Osborne, J., Richardson, K., & Simon, S (2009). *Exploring Science Teachers' Views of Teaching and Learning*. Paper presented at the British Educational Research Association Annual Conference, University of Manchester, 2-5 September 2009.

Jiménez-Aleixandre, M. P., Bugallo-Rodríguez, A., & Dusch l, R. (2000). "Doing the lesson" or "doing science:" Argument in High School Genetics. *Science Education* 84(6): 757–792.

Jones, M. G., & Carter, G. (2007). Science teacher attitudes and beliefs. In S. Abell, &N. Lederman (Eds.), *Handbook of Research on Science Education* (pp. 1067-1104). Mahwah, NJ: Lawrence Erlbaum Associates.

Kang, N. H.& Keys, C. W. (2000).*An Investigation of Secondary School Science Teachers' Beliefs About and the Practices of Hands-on Activities.* Paper presented at the annual meeting of the National Association for Research in Science Teaching, New Orleans, LA.

Leach, J., & Scott, P. (2003). Individual and Socio-cultural Views of Learning in Science Education. *Science and Education*, *12*, 91-113.

Lederman, N. G. (1992). Students' and Teachers' Conceptions of the Nature of Science: A Review of the Research. *Journal of Research in Science Teaching, 29* (4), 331-359.

Lemke, J. L. (1990). *Talking science: language, learning and values.* Norwood, NJ: Ablex Publishing.

Lichtman, M. (2006).*Qualitative Research in Education: A user's Guide*. United Kingdom: Sage Publications.

Lincoln, Y. S. & Guba, E. G. (1985). *Naturalistic Inquiry*. Thousand Oaks, CA: Sage Publications.

Lisanza, E. M. (2014). Dialogic instruction and learning: the case of one Kiswahili classroom in Kenya. *Language, Culture and Curriculum, 27* (2), 121-135.

Louca, L. Elby, A. Hammer, D., & Kagey, T. (2004). Epistemological resources: Applying a new epistemological framework to science instruction. *Educational Psychologist, 39*(1), 57-68.

Louca, L. T., Zacharia, Z. C. & Tzialli, D. (2012). Identification, Interpretation-Evaluation, Response: An alternative framework for analyzing teacher discourse in science. *International Journal of Science Education, 34* (12), 1823-1856.

Lyle, S. (2008). Dialogic teaching: Discussing theoretical contexts and reviewing evidence from classroom practice. *Language and education, 22* (3), 222-240.

Maclean, R. (1994). Language education, thematic studies and classroom learning: *A bakhtinian view. Language and Education, 8* (4), 231-250.

Manouchehri, A. (2007). Inquiry-discourse mathematics instruction. *Mathematics Teacher, 101*, 290-300.

Mansour, N. (2008). *Models of Understanding Science Teachers' Beliefs and Practices: Challenges and Potentials for Science Education.* VDM Verlag Dr. Mueller E.K.

Mansour, N. (2009). Science teachers' beliefs and practices: Issues, implications and research agenda. *International Journal of Environmental & Science Education, 4 (1),* 25-48.

Martin, A. M., & Hand, B. (2009).Factors affecting the implementation of argument in the elementary science classroom. A longitudinal case study. *Research in Science Education. 39*(1), 17-38.

Mavhunga, E. & Rollnick, M. (2013).Improving PCK of Chemical Equilibrium in Pre-service Teachers. *African Journal of research in Mathematics, Science and Technology Education, 17* (1-2), 113-125.

Maxwell, J.A (2005). *Qualitative Research Design: An Integrated Approach*. (2nd ed.). Thousand Oaks: Sage Publishers.

Maybin, J. (1999). Children's informal talk and the construction of meaning. *English in Education, 25* (2), 34-49.

McMillan, J. H., & Schumacher, S. (2010). *Research in education: Evidence-based inquiry* (7th Ed.). Upper Saddle River, New Jersey: Pearson Education, Inc.

McNeill, K. L., & Pimentel, D. S. (2010). Scientific discourse in three urban classrooms: The role of the teacher in engaging high school students in argumentation. *Science Education, 94*(2), 203-229.

McRobbie, C., & Tobin, K. (1997).A social constructivist perspective of learning environments. *International Journal of Science Education*, *19*, 193-208.

Menke, D. J., & M. Pressley (1994). "Elaborative Interrogation: Using 'Why' Questions to Enhance the Learning from Text." *Journal of Reading* 37, (8) 642-645.

Mercer, N., & Dawes, L. (2014). The study of talk between teachers and students, from the 1970s until the 2010s: *Oxford Review of Education, 40* (4), 430-445.

Mercer, N. (2008). The Seeds of Time: Why Classroom Dialogue Needs a Temporal Analysis. *Journal of the Learning Science, 17* (1), 33-59.

Mercer, N., & Littleton, K. (2007).*Dialogue and the development of children's thinking: A socio-cultural approach*. New York: Routledge.

Mercer, N., Wegerif, R., & Dawes, L. (1999). Children talk and the development of reasoning in the classroom. *British Educational Research Journal, 25* (1), 95-117

Morge, L. (2005). Teacher–pupils interaction: A study of hidden beliefs in conclusion phases. *International Journal of Science Education, 27*(8), 935-956.

Morrell, P. D., & Carroll, J.B. (2010*).Conducting Educational Research: A primer for Teachers and Administrators*. New York: Sense Publishers.

Mortimer, E. F., & Scott, P. H. (2003).*Meaning making in secondary school classrooms*. Maidenhead: Open University Press

Morton, T. (2012).Classroom talk, conceptual change and teacher reflection in bilingual science teaching. *Teaching and Teacher Education*, *28,* 101-110.

Nystrand, M. (1997).*Opening dialogue: Understanding the dynamics of language and learning in the English classroom*. New York: Teachers College Press.

Nystrand, M., Wu, L. L., Gomoran, A., Zeiser, S., & Long, S. (2001). *Questions in time: Investigating the structure and dynamics of unfolding classroom discourse*. New York: National Research Center on English Learning &Achievement.

Onwegbuize, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33* (7), 14-26.

Opie, C. (Ed.). (2004). *Doing educational research: a guide to first time researchers*. London: SAGE Publications.

Osborne, J. F. Eduran, S., & Simon, S. (2004). Enhancing the quality of argument in school science. *Journal of Research in Science Teaching, 41*(10), 994-1020.

Pajares, F. (1996).Self-efficacy beliefs in academic settings. *Review of educational research, 66*(4), 543-578

Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*, 62, 307-332.

Prewad, R. S (1992). Teachers' Beliefs about Teaching and Learning: A Constructivist Perspective. *American Journal of Education, 100* (3), 354-395

Richards, J. C., & Lockhart, C. (1996). *Reflective Teaching in Second Language Classrooms.* Cambridge: Cambridge University Press.

Riggs, I. M., & Enochs, L. G. (1990).Toward the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education, 74*(6), 625-637.

Roehler, L. R., Duffy, G. G., Herrmann, B. A., Conley, M., & Johnson, J. (1988). Knowledge structures as evidence of the 'personal': Bridging the gap from thought to practice. *Journal of Curriculum Studies, 20*, 159-165.

Roehrig, G. H., & Luft, J. A. (2004). Inquiry teaching in high school chemistry classrooms: The role of knowledge and beliefs. *Journal of Chemical Education, 81*, 1510-1516.

Rollnick, M., & Mavhunga, E. (2013). In search of the meaning of PCK: report of an international summit held in Colorado, USA in October 2012. In *Proceedings of the 21st Annual Meeting of the Southern African Association for Research in Mathematics, Science and Technology Education. Cape Town: SAARMSTE*.

Roth, W. M. (1994). Experimenting in a constructivist high school physics laboratory. *Journal of Research in Science Education, 31*, 197-223.

Scott, P., & Mortimer, E. F. (2005). Meaning making in high school science classrooms: A framework for analysing meaning making interactions. In K. Boersma, M. Goedhart, O. De Jong & H. Eijkelhof (Eds.), *Research and the Quality of Science Education* (pp. 395-406). Dordrecht, Netherlands: Springer.

Scott, P. (2008). Teacher Talk and Meaning Making in Science Classrooms: a Vygotskian Analysis and Review. *Studies in Science Education, 32* (1), 45-80.

Scott, P. Asoko, H. Driver, R., & Emberton, J. (2012). Working from children's ideas: Planning and teaching a chemistry topic from a constructivist perspective. *The content of science*, 201-220.

Scott, P., Ametller, J. Mercer, N., Staarman, J., & Dawes, L. (2007).*An investigation of dialogic teaching in science classrooms*. Paper presented at the National Association of Research in Science Teaching Annual Meeting.

Scott, P., Mortimer, E. F., & Aguiar, O. G. (2006). The tension between authoritative and dialogic discourse: A fundamental characteristic of meaning making interactions in high school science lessons. *Science Education, 90*(4), 605-631.

Simmons, P. E., Emory, A., Carter, T., Coker, T., Finnegan, B., Crockett, D., *et al.* (1999). Beginning teachers: Beliefs and classroom actions. *Journal of Research in Science Teaching, 36*, 930-954.

Shenton, A. K. (2004). Strategies to ensure trustworthiness in qualitative research projects. *Education for information*, *22*, 63-75.

Skidmore, D. (2006). Pedagogy and dialogue. *Cambridge Journal of Education, 36* (4), 503-514.

Solomon, J., & Harrison, K. (1991). Talking about Science Based Issues: do boys and girls differ? *British Educational Research Journal*, *17*(3), 283-294.

Stoffels, N. (2008). Why do teachers do what they do? In *Weber, E: Educational change in SA. Reflections on local realities, practices and reforms.* Rotterdam. South Africa.

Tiberghien, A., & Buty, C. (2007). Studying science teaching practices in relation to learning. Times scales of teaching phenomena. In R. Pintó & D. Couso (Eds.), *Contributions from* Science *Education Research, ESERA Selected Contributions* (pp. 59-75). Berlin: Springer.

Tobin, K., & McRobbie, C. J. (1997).Beliefs about the nature of science and the enacted science curriculum. *Science & Education*, *6*, 335-371.

Traver, R. (1998). What is a good guiding question? *Educational Leadership, 55*(6), 70-74.

Tsai, C.C. (2002). Nested epistemologies: Science teachers' beliefs of teaching, learning and science. *International Journal of Science Education*, *24*(8), 771-783.

Vygotsky, L.S. (1978). *Mind in Society: The Development of Higher Psychological Processes*, Cambridge, MA: Harvard University Press.

Wallace, C., & Kang, N. (2004). An investigation of experienced secondary science teachers' beliefs about inquiry: An examination of competing beliefs sets. *Journal of research in Science Teaching, 41* (9), 936-960

Webb, N. M. (2009). The teacher's role in promoting collaborative dialogue in the classroom. *British Journal of Educational Psychology*, *79* (1), 1-28.

Webb, P., & Treagust, D. F. (2006). Using exploratory talk to enhance problem-solving and reasoning skills in Grade 7 Science classrooms. *Research in Science Education, 36*, 381-401.

Wellington, J., & Osborne, J. (2001). *Language and Literacy in Science Education*. Buckingham: Open University Press.

Wells, G. (2009). *The Meaning Makers: Learning to talk and talking to learn (*2nd Ed.). Bristol, UK: Multilingual Matters. .

Wells, G. (1999). Dialogic Inquiry: *Towards a Socio-cultural Practice and Theory of Education*, Cambridge: Cambridge University Press.

Wertsch, J.V. (1985). The social origins of higher mental functions. In J.V. Wertsch. *Vygotsky and the social formation of mind*. Cambridge, MA, Harvard University Press.

XU, L. (2009). Teacher Questioning as a Way to Open up Dialogue in the EFL Intensive Reading Classrooms in China. *Journal of Cambridge Studies*, *7* (4), 101-115.

# Appendices

## Appendix A: Interview schedule

Research question: What are science teachers' views on the role of classroom talk learner understanding of science content?

| Main Question | Follow up questions | Why is the information needed? |
|---|---|---|
| 1. How would you describe the role of a teacher in the science classroom? | ✓ What are some of the strategies that should be used in science teaching?<br>✓ Do you that there is a difference between teaching science and other subjects? Why?<br>✓ What are your goals in teaching science? | To obtain information about what teachers feel is their role and how they think a teacher should behave and do in a classroom<br><br>To obtain teachers' views of the difference between teaching science from teaching other subjects. |
| 2. Do you think that whole-class discussion is an important strategy in teaching science? Motivate your answer. | ✓ What role do you play in whole class discussion?<br>✓ What are your fears in using whole-class discussion in your science classroom? | To get teachers' views about the necessity of whole-class discussion and interaction in science classrooms. |
| 3. Explain the role of questioning in your science classroom. | ✓ What kind of questions do you use in your classroom? Why those kind of questions?<br>✓ How often do you ask | To obtain teachers' beliefs about the effects of questioning on learner |

| | | |
|---|---|---|
| | learners those questions?<br>✓ What prompts you to ask questions?<br>✓ What do you do with the answers that learner provide? | understanding.<br><br>To establish that questioning has an effect and drives whole-class discussion and interaction in science classrooms. |
| 4. What do you normally do to help learners understand the science content? | ✓ Do you consider your talk to have an effect on learner understanding of science content?<br>✓ Do you think involving all learners would help?<br>✓ Then how do you involve them all?<br>✓ How do you know that your learners understood the content taught besides giving them a written test? | To elicit teachers' prior practices in teaching to help learners understand the science content.<br><br>To get from teachers, if there are ways of assessing learners using talk and questioning besides written tests. |

Your responses are highly appreciated and will make significant contribution in this study. Thank you very much. I will see you when I observe your classroom. You are welcome to contact me for clarity on this research or your participation. Thank you Once again.

## Appendix B: Interview transcript – Mr. D

| stions and answers | Process Codes | Themes |
|---|---|---|
| Okay, thank you very much for agreeing to participate in this study. My research is about teachers' views on classroom talk and teacher facilitation of talk. So, I am going to ask you some few questions about your views on classroom talk for science teaching and learning and please try to answer them as fully as possible and you are free to stop me at any time for clarity. So, in answering these questions, I will be trying to answer research question 1 which says: what are teachers' views about the role of classroom talk in the teaching of science for learner understanding of science content. So, question 1for you is how would you describe the role of a teacher in a science classroom? | [1] teachers are there to help<br>[2]Learners should understand science principles | [1]teacher's role<br>[2]learners' function |
| Yahhhh…I would…[1]I think the role of a science teacher in a science classroom is to help the [2] learners to understand the science principles and apply them… | | |
| Okay, so is it only about helping then understand the science principles and applying them? | [3] teacher prepares learners for the future | [3]teachers' function |
| Mmmmmm….I think it can go beyond that if [3]learners are interest in the career that is related to science so it can make them to see whether they will enjoy the career in future, if they do enjoy the subject. | | |
| So, in other words, you only go beyond when there is….when there is interest in that field. You only go beyond what they need to know for that session if there is an interest? | [4]teacher prepares learners for the future | [4]teacher's role |
| I can yes, I can say no at the same time…. | | |
| Okay, why…?? | | |
| [4]At time it depends, you can explain a principle and a child might pose a question and you see | [5]teacher explains principle and its | |

| | | |
|---|---|---|
| that this question is also related to the career of that learner, in that situation, you need to explain beyond.<br><br>Okay, for the no??<br><br>[5]For the no, you explain the principle and explain its application in general.<br><br>In general?<br><br>(nodding)<br><br>Okay, so in explaining or teaching, what are some of the strategies that should be used in science teaching according to your understanding?<br><br>Mmmmm,…..strategies? I think the first strategy, [6]science is an abstract subject. [7]Sometimes it is very difficult for a learner to imagine the scientific things. So, the best one is to go with situation where there can be some [8]practicals that could be associated with that….well, these days there are simulations that can show the movement of electrons which you cannot show by doing a practical. So, at least if they say the electrons are moving in a circuit…so they can see the movement there at least to have a picture of what is happening.<br><br>So, in case where you don't have the opportunity to do some practicals (simulations) for certain concepts, like you say in the movement of electrons, what do you do? For that abstract nature of the content…<br><br>I think this is a tough question. [9]In theory, you can explain, draw diagrams and that's far you can go and if there is simulation then you can get to it and show what is happening.<br><br>Okay, so how….that is fine, you can explain but how do you explain? That is my interest….what are some of the things that you use when explaining? Do you ask them | function<br><br>[6] science as abstract;<br><br>[7] the difficulty of science;<br><br>[8] teaching strategies<br><br>[9]teaching strategies<br><br>[10]importance of prior knowledge<br><br>[11]involve learners<br><br>[12]Number of learners affects decisions | [5]teacher's role<br><br>[6] Nature of school science content<br><br>[7]nature of school science content<br><br>[8]teacher's role<br><br>[9]teacher's role<br><br>[10]communicative approaches (ID)<br><br>[11]Communicative approach (ID/IA)<br><br>[12]eacher's function |

| | | |
|---|---|---|
| questions, do you let them discuss, those kind of things… | | [13]Communicative approach (ID/IA) |
| Okay, first of all, you hear….you ask what do you understand by this….you [10]seek for their prior knowledge, their background knowledge on that principle, then you explain, after an explanation, you can give them group discussion to discuss or you can[11] just give them a question that they can work out s individuals and ask them to present their answers. | [13]Involving learners<br><br>[14]involving learners/teaching strategies | [14]teacher's role<br><br>[15]nature of school science content |
| Okay, what happens if their pre-conceived ideas do not match with what you want them to know. What do you do in that case? | [15] science as having lots of applications | [16]nature of school science content |
| Ehhhhhh……okay…[12].it depends now. Is it the whole class that has a misconception or is it just individuals…?? | [16]science as abstract<br><br>[17]science as abstract | [17]nature of school science content |
| Half-half, half of the class has a misconception about the movement of electrons and half of them seem to grasp the idea. | | |
| First of all, [13]I also involve other learners, that is why I say group discussion if not a group discussion, [14]I can rob other learners to say can you explain to other learners on how you understand so that they get different views. | | [18]learners' function<br><br>[19]learners' functions |
| Okay, ummmm do you think that there is difference between teaching science and other subjects? And why? | [18]Learners should enjoy the subject | [20]teacher's role |
| There is…there is a difference, [15]science…,has a lot of application and has a lot of imagination. Lets say…(inaudible)…from another subject. I am taking it to a perception which I had when I was a learner because I have not taught any other subject besides maths. There is a ….someone is talking about home language and someone is talking about science. I think there is much difference because in the science, we are talking about principles that at times are new that a person has never heard about them. | [19]Learners should be motivated<br><br>[20] teacher prepares learners for the future<br><br>[21]number of learners affect teacher decisions | [21] teacher's role |

| | | |
|---|---|---|
| Yet in languages it could be something that could be related to the environment, something that they see day to day but in science when we are talking about a concept, [16]they might have seen a kettle boiling water but what is happening there…,they might see a fern, they have seen a motor, they have not seen that. they just see the outside. So, [17]the principles are not some things that they see in a day to day basis.<br><br>Okay…how…??okay no, that is fine. What are your goals in teaching science? Some of the goals…what do you want to learn or to know at the end of maybe…there might be short term, medium and long term goals<br><br>[18]My first goal is for them to enjoy the subject. If they do enjoy the subject, then [19]I know that they will be motivated to know more and if they are motivated to know more, then[20] they may pursue or follow the career or at times they might not have the careers like accounting that has nothing to do with science but they will try their best because they enjoy it.<br><br>Okay…lets, thanks for that. Let us go to question 2 . Do you think that whole class discussion is an important strategy in teaching science?<br><br>Ehhhhh….it is a…I would say, [21]it depends on the size of the class first, secondly, you are able to help and deliver the same principle to everyone but the disadvantage is that you cannot get to everyone at the same time. You might pick some learners whose hands are down and some might feel offended because you haven't picked them or choosing them to speak.<br><br>So, how do you deal with that if the size of the class is…maybe you have 40 learners and you want to use discussion. How do you do that?<br><br>Ahhhh…eish[22]I think class discussion could be good if it is following group discussion…so | [22] group discussion than class discussion<br><br>[23]teacher talk less important after discussion<br><br>[24]teacher facilitates the talk<br><br>[25]learners should understand science principles<br><br>[26]teacher facilitate talk<br><br>[27]number of learners informs teacher decisions | [22]communicative approaches (IA/ID)<br><br>[23]teacher's role<br><br>[24]communicative approaches (ID/IA)<br><br>[25]learners' role<br><br>[26]communicative approaches<br><br>[27]teacher's role |

| | | |
|---|---|---|
| now you are saying: can you tell us what your group has said or what your group has found out. So in this case at least you are picking up on what that person has said on behalf of those four or five people…at least you getting as far as possible.<br><br>Okay in those group discussions or reporting back on what they have discussed in the group discussions, what role do you play in that manner?<br><br>(silence)<br><br>Both when they are still discussing in groups and when they are reporting back…<br><br>I think the [23]most important role is when they are discussing because when they have discussed, it becomes less important or less effective but when they are [24]discussing, moving around checking what they are discussing is correct…what they are processing what they are following is [25]right principles and applying right principles. When they are reporting back, at least you are sure even if they didn't do everything that they had to do…you have guided them otherwise, at the end, it becomes sort of corrections and helping. [26]That group discussion would be useless if they were discussing what is out of what is right.<br><br>You have shared some of your fears focusing whole class discussion…size of the class and all that. Can you elaborate more on that…some of the fears maybe…?<br><br>I think I have mentioned what I had to mention on the [27]fact that you may not get to everyone and you may frustrate learners that want to talk or being carried away by following certain learners…some learners would be shy to speak in front of the whole class but in a group, they can easily participate<br><br>Having talked about classroom discussion and | [28]Questioning as a lead; [29]learners should understand principle<br><br>[30]learners apply knowledge<br><br>[31]learners should understand principles<br><br>[32]Refers to relevance of science<br><br>[33]Learners should enjoy the subject | [28]communicative approaches (IA)<br><br>[29]learners' role<br><br>[30]learners' function<br><br>[31]learners' function<br><br>[32]nature of school science content<br><br>[33]learners' function/nature of school science content<br><br>[34]learners' function<br><br>[35]learners' |

| | | |
|---|---|---|
| whole class discussion, what do you think…. Explain the role of questioning in your classroom. Both your questioning and learners' questions when they question something after you have asked them a question. Let us start with your questioning. What is the role of that?<br><br>yah…mmmm…[28]the role of questioning is to lead them to [29]find out on certain principles…is to help them make their own investigations…it is to give them [30]lead to apply their own mind in finding out things.<br><br>Okay, then how do you question them? What kinds of questions do you use in order to do all the things you have talked about?<br><br>Hehehe…yah…it's a tricky question…this might depend on what I am talking about. If I am talking about the term, defining a term, there is nothing much but 'define a term'. They look for it themselves and then they present it. Lets say somebody [31]talks about a principle or a movement of motor 'describe how the motor moves, what makes it move". So, in the description, they have to look at principles, what is involved, what do you need to put in…correct, movement of magnetic field. So, they are describing but in that description, they need to look at all those principles.<br><br>So, how do you bring in the relevance of science in your questioning? You can just use any topic.<br><br>The relevance of science,revelent as…??<br><br>As being relevant to their everyday lives<br><br>[32]Like I have used the description of motor…in their to day life, they have used a fern, so if you tell them that fern that you are using at home uses a motor in it, that is when the use of a motor becomes relevant in their day to day lives<br><br>Okay, and that relevance, how does it affect the | [34]learners should understand principles<br><br>[35]learners should understand principles<br><br>[36]relevance of science<br><br>[37]importance of learners' prior knowledge<br><br>[38]relevance of science/teaching strategy | function/nature of school science content<br><br>[36]nature of school science content<br><br>[37]communicative approaches<br><br>[38]Communicative approach<br><br>[39]communicative approach (ID/IA) |

| | | |
|---|---|---|
| discussions that you have with them? Does it bring more discussion? Or what does it do to them? | [39]Question learners more; pose back questions | |
| If there is something that you bring related to their daily lives,[33] it brings some interest, it makes them to be more interested to see…okay I used this thing everyday but indie what is closed there, what is really happening? I think it sparks some motivation to [34]understand some principle more. | | [40]communicative approach (ID) |
| Okay, sparking some motivation…do you get more learners being involved….those learners who you think are not involved in the classroom, do you get them to participate? | [40]be open to every answer (dialogic discourse) | |
| Yah I think so, when you talk about something and you mention something that they use day to day, [35]because they would be talking about principles the you talk about the thing that they use day to day…you see face lightening. If you ask: do you know it vele? How does it work? Today we are going to discuss how it works…[36]so it makes them to know about something that they use in their everyday lives | [41]emphasizes being open to every answer | [41]communicative approach (ID)<br>[42]communicative approach ID |
| Then how often do you ask learners those questions? Do you ask them at the start of the lesson, in the middle, at the end to test? | [42] giving feedback to all answers | [43]communicative approach IA |
| [37]I think the most appropriate would be to say at the beginning but at times, you find that I mention it anywhere along the lesson when I have explained a bit of a principle. | [43]involve learners | |
| Okay so if you ask them in the middle of the lesson, what drives you to ask those questions.Do you go to class with prepared questions? | | |
| Like I said, in an ideal situation, [38]you mention that ‘today we are going to talk about motors. Do you know a motor, where do we use a motor?’ so that you bring them in on what they use in day to day basis. That is the most | [44] the abstract nature | [44]nature of school science content |

| | | |
|---|---|---|
| appropriate way…like I said at times, I come with principle and explain how it works and apply it…maybe mention one example and ask them to mention others | of science | |
| Okay, sometime you get learners who will answer and some give answers which are incomplete, some give answers which have errors, some give answers which are very correct and some pose questions based on your question. How do you deal with those things? | [45]considers talk similar to explanation | [45]communicative approach |
| Well, if it is question, any question that a learner asks, [39]I would pose it back and try to understand his or her level of understanding first so that when there is a response, it builds on what he/he understands first…so I am trying to push it back a bit and try understand the level she is asking on. If it is something I have been talking about, then I give it to the rest…maybe there are some who don't understand and may have the same question | [46]talk and teaching strategies | [46]communicative approach<br>[47]learners' function/ communicative approach |
| So, in other words, you can pose the question back to other learners? | [47]talk and teaching strategies | [48]communicative approach |
| Yes | [48]Teacher acts as a facilitator and guides learners | [49]teacher's role |
| Then what about the answers that they provide based on your questions? If they have errors, if they have…if they are incomplete | [49]Learners can be given information but not always | |
| [40]Usually if I asked for answers, I don't write one answer on the board. I would be open to as many answers as possible and then from that, I would (inaudible) | [50]learners should discover things for themselves | |
| So, these answers that you write, are you looking for science related answers or any answer…it can be outside the classroom, any answer that they provide? | [60]orals can work as a way of checking for understanding (talk) | |
| [41]I write all answers that they provide but if they were responding to a question, it means that that question will have a certain answer I | [61]pushing for exams and syllabus | |

| | | |
|---|---|---|
| just write any answer.<br><br>But do you deal with those answers that they provide?<br><br>[42]Yes…<br><br>How?<br><br>We talk about each answer. First of all, at times [43]I ask who is agreeing with this answer and I get the number of people agreeing with that certain answer. So, I see distribution of the principle on how they understood the concept. Then from there I say, those who have agreed with that answer, why do you say it is correct, those who don't agree, why do you it is incorrect. Then in that discussion, I bring on what I think it is correct.<br><br>Okay, what do you normally do to help learners understand the content besides discussion and questioning?<br><br>Like I said, [44]science is an abstract subject… I encourage them to use internet, if there are simulations to use, that would help and yah!...i think that is that…<br><br>Do you consider talk to have an effect on learner understanding of science content?<br><br>[54]Talk as explaining?<br><br>Yes, talk as explaining, questioning, the way you facilitate it. Does it have that much effect on their understanding?<br><br>I believe it does but it must be a blended kind of a situation.<br><br>Blended meaning?<br><br>Using other principle and… | [62]Test is always the key to check for understanding; pass/fail | |

| | | |
|---|---|---|
| Other strategies?<br><br>[47]Yes other strategies but obviously, you are there to help them, to guide them…[48]you are there to talk otherwise of you are there just walking and quiet…<br><br>So, in other words, when you say you are there to help them, you are not there to give them all the information?<br><br>[49]At times you don't have to give them, they must provide…<br><br>[50]And discover things for themselves?<br><br>Yes<br><br>And how do you know that your learners have understood the content besides giving them a written test?<br><br>Mmmmm….that one I think is difficult because without a written test, [60]oral questions, those are things that you can use…otherwise there is no-way. I don't think there is another way…[61]Unfortunately when we teach, we teach focusing on that they need to be able to answer the exam questions at the end….they must be able to express themselves on paper…that is unfortunate because some will understand and be unable to express themselves on paper…we teach, at the end of the day, if they are not able to express themselves on paper, this means they have failed.<br><br>Okay, thatk you sir for your time and I believe the responses will make a contribution in this study.<br><br>You are welcome sir…Thank you so much | | |

## Appendix C: Interview transcript – Mr. N

| Interview Turns | Codes descriptions | Theme |
|---|---|---|
| I: Thank you very much for agreeing to participate in this project. My research is about teachers views about classroom talk and teacher facilitation of talk. So, I am going to ask you some few questions about your views on classroom talk for science teaching and learning and I want you to try and answer them as fully as possible and you are free to stop me at any time for clarity. So, I have four questions in this interview schedule which are trying to answer the big question which says: What are teachers' views about the role of classroom talk in the teaching of science for learner understanding of science content. So, my first question is: How would you describe the role of a teacher in a science classroom? | [1]teacher pre-ambles basics<br>[2]teacher helps and guide learners<br>[3]teacher acts as a facilitator<br>[4]teacher helps and guides learners<br>[5]learners apply principles | [1]teacher's role<br>[2]teacher's role<br>[3]teacher's role<br>[4]teacher's role<br>[5]learners' role |
| T: Okay…right, the way I see the role of a teacher, one, is to actually [1]pre-amble the basics about a particular topic and the kind of a [2]guide the learners are able to get the answers… you kind of play the [3]facilitator role…you actually play a facilitator role where you actually create a learning environment and the situation they bring in, scenarios…that will actually [4]direct learners towards a scientific aspects and principles or anything related to that, so as to actually achieve the ultimate desire or [5]outcome that is to be inquisitive and also to be able to apply principles and rules and theorems in solving certain problems. | [6]teaching strategies | [6]teacher's role |
| I: Okay…so sir you talked about facilitating. How do you facilitate that? What are some of the strategies that should be used in science teaching? | | |
| T: Right, you try to make [6]demonstrations or you use experiments, assignments or research….I think so, or maybe | [7]science as a practical subject | |

| | | |
|---|---|---|
| worksheets | | [7]nature of school science content |
| I: And you talked about being….making them to be inquisitive, so is there any difference in teaching science and teaching any other subject like English for example, or EMS or Maths? | [8]teaching strategies | [8]teachers' role |
| T: Yah, I feel like…Science, maybe if I can just point out on languages…There should be differences as far as I am concerned because you find that language is more of a content but with science, [7]there is lot of practice and practicals. In essence, [8]science is a practical subject kind of hands- on subject…if learners are to understand anything, then it should be hands-on and then trying to find out ways of coming up with the solutions | [9] uses class discussion<br>[10]class size affects the decision<br>[11] group discussion than class discussion | [9]communicative approach<br>[11]communicative approach |
| I: Okay, my second question is do you think that whole class discussion is an important strategy in teaching science? | [12]class size affects teacher decision | |
| T: Yah…[9]it is but then the tendency is…yes it is as long as it is well monitored but if it is the whole class discussion, [10]the tendency is that you might find some learners who are not participating [11]I would rather split that into maybe smaller groups where you can move around monitoring and ensure that everybody is participating because if is it's a bigger group,[12] the tendency is that you find those who hide behind others and they might give a community answer like, yes we understand but there are certain people who don't. But narrow it down to individuals to smaller groups and you will find that each member will say something. | [13]involve all learners<br>[14]involve all learners | [13]teacher's role<br>[14]learner's role |
| I: So, if you narrow it, how do you act in that classroom? What is your role? | | |
| T: [13]My role there is to move from group to group, try to listen to the talk and [14]encourage each member to contribute. | [15]class size affects teacher decisions | [15]communicative approach ID/IA |

| | | |
|---|---|---|
| I: Okay, what are some of your fears in using whole class discussion in a science classroom since you said that you prefer to have smaller groups which you can monitor? | | |
| T: [15]My fear is that you might not be able to get to learners who are lagging behind because you find that the tendency is you always have very, very active members who are always giving responses and it means those one who are struggling tend to be left far behind and they might not catch up, so, I fear that the good learners will actually overwhelm others because then the other thing is if they have to do it as a group, the tendency is those who think their answers are weak might shy away and may not be given the opportunity to raise the concerns and that might de-growth understanding. [16]So maybe if you bring it down to smaller groups then it will also help them have some confidence to raise their answers… | [16] group discussion than class discussion | [16]communicative approach<br>[17]communicative approach IA |
| I: Can you explain the role of questioning in your science classroom? | | |
| T: [17]The role of questioning in my science lesson is ehhh… to actually make some recap and try to check if… what I have taught has been understood. So, generally I would pose or give a question then try to individuals, as many as I can to actually give a response from their side. Yes… so the question there…it helps me to check if what I have been teaching maybe have been understood and mastered and solidified. That will also help because at the end of the day if I discover that maybe a few can only answer then I could go back to scenarios and those who are willing can always help those who don't understand…maybe I might need to re-teach the topic. | [17]questions used to check understanding | |
| I: So what kind of questions do you use in your classroom and why those | | [18]communicative approaches |

| | | |
|---|---|---|
| questions? | | |
| T: Ehhh…[18]I try to have my questions starting from low order, to abstract level or questioning. The reason is that I need to make sure that whatever I teach and whatever I ask is to prepare them a [19]proper way as expected by the Department of Education knowing that in the examination, learners will be required to answer level 1 to level 4 questions. So, I should vary my questioning and the difficulty of the questions otherwise I will only ask questions that will not prepare them enough. So they should be able to answer questions from lower order going upwards and even abstract…(inaudible)…[20]subject grasping and then they should be able to approach the examination. | [18]questions vary with levels<br>[19]prepares learners for the exam | [19]teacher's role<br>[20]teacher's role |
| I: Ohk so, do you only ask questions related to the science content that you are dealing with at that moment or questions related to the everyday life and some things that they encounter outside the classroom? | [20]prepare learners for examination | [21]learner's role |
| T: Okay, science is that [21]kind of subject that gets people to be able to apply knowledge that they acquire to every everyday life. So, the subject itself pre-ambles a way to get there. So, [22]I should be able to ask a question in science that has got a context out there in their community, in the world, what they encounter everyday. Create a situation that will need a scientific approach to answer. So I don't always ask questions about what I would have taught. [23]I try to find an application scenario where the knowledge that they might have gathered can them be used later on. | [21]learners should apply knowledge/principles | [22]nature of school science content<br>[23]teacher's role |
| I: Okay, so how often do you ask these questions? | [22]relevance of science | [24]communicative approach IA |
| T: You mean in the classroom? | | |

| | | |
|---|---|---|
| I: Yes, in the classroom. How often do you question your learners?<br><br>T: Yah, I make sure that I ask every…[24]I have some intervals, after teaching for some time and after doing some things then I should make sure that there are questions for that particular thing that I have covered because if you take long or if the interval is long between the teaching and questioning, then you might loose them and you want to keep track that they are moving with you otherwise if you leave them far behind then you will not be able to retreat them and pick exactly where they have missed it. [25]So every time, there must be some check-points.<br><br>I: Okay, ehhh…What prompts you to ask questions? (silence)…Let's say you are teaching about Coloumb's law…on what grounds will you ask a question?<br><br>T: Usually, [26]I would ask a question basing it on the important aspect that I would have mentioned or covered. So, to ask them a [27]question is a way to consolidate that particular principle or that item that learners are expected to actually be able to show understanding, so, after I have actually taught especially I would say underline the point and break it and those terms….the major issues, I should be able to make sure that the…they actually be pointing it out that…what is the science around Coloumb's law like you pointed out that here they…(Inaduble)…because [28]remember it is only about passing their exams but for the growth of a person as a whole so that they are relevant to today's world.<br><br>I: Okay, so what do you do with the answers that learners provide? Lets say you ask a question about coulomb's law and one learner provides an answer that is correct or correct. What do you do with the answers? | [23]learners should apply knowledge<br><br>[24]questions to check for understanding<br><br>[25]have checkpoints for questioning<br><br>[26]question to check understanding<br><br>[27]question to consolidate<br><br>[28]relevance of science | [25]communicative approach IA<br><br>[26]Communicative approach IA<br><br>[27]communicative approach<br><br>[28]nature of school science content<br><br>[29]teacher's role |

| | | | |
|---|---|---|---|
| T: | Right ehhh… [29]I have actually encouraged them that there is no answer that is wrong. The only thing is that they answer they give might be irrelevant and might be answering the question that has been asked. [30]I actually try work around that to try and make sure that the child understands what the question demands because most of the time you discover that learners are able to…they might show that they understand the subject matter but then in their responses, they might have missed what the question demands. So,[31] I replay the question and point out on the important aspects within the question that they have to focus on… to zero their attention on and them hopefully, if we go over that again they usually come up with the correct response | [29]encourage learners to answer<br><br>[30]repeat the questions<br><br>[31]Repeat question to clarify it | [30]Communicative approach IA<br><br>[31]communicative approach IA |
| I: | So, do you usually redirect the question? let us say you ask a question and the learner gives you an incorrect answer or incomplete or an answer with errors. Would you direct the answer to another learner? Or how would you deal with that? If it has errors, misconceptions… | | |
| T: | [32]Usually, that would be the last thing to do but the first thing or best thing to do is to make [33]sure that the learner understands what they are responding to. Because if you redirect then you have shut the learner out and then as a result that learner might remain with a misconception. [34]So you rephrase the question and see how they answer, because at times, [35]we must take note in science that learners tend to give answers in such a manner that when we look at them, we have our own way of answering and times we might be… as teachers, you find that a learner gives a certain answer argued at a certain angle and because you have expected a particular answer we tend to say that it is not true and then maybe that is true. So, the best way is…if the answer that they have given does not satisfy my | [32]no redirection of a question to another learner<br><br>[33]repeat question (importance of talk)<br><br>[34]give feedback to answers<br><br>[35]accept all answers (ID) | [32]communicative approach IA/NIA<br><br>[33]teacher's role<br><br>[34]communicative approach ID<br><br>[35]communicative approach ID/IA |

| | | | |
|---|---|---|---|
| | expectation, then maybe I might have to look at my question, maybe my questioning is not proper. So I have to make sure that the question, I have to look at the question again and ask the same aspect that I am looking for differently because then if I say that it is wrong, and try someone, that means I have not helped that person because if the correct answer comes from the next learner then it means it means I have actually failed to help the first learner. I should help him, identify the problem and go back to the basics and try to come up with the solution and that will promote some…(inaudible) | [36]Contradiction/tension ID and IA | |
| I: | Okay, what do you normally do to help learners understand the science content? | | |
| T: | Right, for me, I usually, obvious [37]I would teach, and them bring some experiments and then give some exercises and them obviously the basics, if a learner is struggling, we always have some remedial work and interventions because usually, you discover that maybe as a group I would be not easy for the learner. And you can find some time and sit down with those who are struggling, go back to basics and go over the work with them and in the process, give some exercises and check… | [37] teaching strategies | [37]teacher's role |
| I: | So, do you think that your talk has an effect in your understanding? The way you engage with them does it have an effect on their understanding of content? | | |
| T: | Yah, I would say yes, I would say not quite. Why would a say yes? [38]I would say yes because some of the aspects are better understood by the learners when they have been explained because, at times, it is like you ask a learner to play a game and the game have some rules and none of the learners know the rules and then you ask one of them to be the referee and I guess there are bound to be some misconceptions.[39] So, now my | [38]talk is similar to explanation<br>[39]talk to clarify concepts – value | [38]teacher's role |

| | | |
|---|---|---|
| purpose of talking is to actually elucidate and try to derive some clarity in some suspect that I suspect my learners might be struggling in. so talk is really necessary. And in may cases, in the talk, you are not only talking but you are also giving direction and instructions as to which way we should go from here. [40]Even if you have to give a practical or an exercise, you still have to talk because you cannot always ask learner to get into the lab, get equipments and start doing the practical. That will be….because you are bound to lose the learners in the process. So the best way, I see, we have to talk though we might not need to talk all the time. We should also remember that it is them who should also practice talking so they can consolidate the terminology and the rest. Yes my talk is going to be necessary especially for clarity-seeking and when I have to come in and emphasize certain aspects. | learners talking<br><br>[40] Talk is similar to giving instructions<br><br>[41]Learners should talk more/involve learners | [39]communicative approaches IA<br><br>[40]communicative approaches IA/ID<br><br>[41]communicative approaches ID |
| I: So, in other words, you are telling me that involving all learners would help them understand? Talking to each other and interacting with each other…??? | | |
| T: Yah if they talk, then we still to be careful because learners might talk to each other and they only to have misconceptions and that is dangerous. Especially, you might have learners who are very active and they are willing to talk…what if they also have misconceptions and they explain to their fellow students….those misconceptions are consolidated as true faith. [42]That is why it is necessary at times to talk because we clarify some concepts so [43]that those who are able to catch the phrases then they will also be able to explain to others otherwise if all of them are blind, the one who is less blind is likely to mislead the more blind one. So, it is very necessary….remember you are the teacher there and you are there for quality control otherwise [44]I find it not so quite honest to ask a learner to teach | [42]talk to clarify concepts | |

| | | |
|---|---|---|
| another learner. What if they also have misconceptions? They will teach the learner as far as they also understand and not beyond and there might be some lack of wisdom in there…they might also be encopositated because letting them talk to each as a way of consolidation might be dangerous. [45]So we have to check-in….to see if whatever they are discussing we have to be involved into it. So that should if a learner decide to give an answer to another learners, you also get that so that you try and consolidate that so that facts are no lost there | [43]teaching strategies<br><br>[44]limitation of using learners as teaching aids | [42]teacher's role<br><br>[43]teacher's role |
| I: So, how do you know that your learners have understood the science content besides giving them a written test? | | |
| T: [46]Usually I would ask my learners to come forward maybe on a particular fun day and we decide that we are all going to teach each other and in that aspect I would have some learners….i would actually pick some learners and ask a learner to go in front and explain a certain context, I would select like we are dealing with Coulomb's law at random because I would ask a learner to go forward and tell us about Coulomb's law and I am listening them and I only get it when I think I need to add some value so that all learners for them to understand they must know that it is always guaranteed that…(inaudible)…so if you keep them on their toes because they will never know what I would ask them to. So we kind of play games around that so that everybody is ready and I would pick at random and ask one learner to stand in front and other learners must be asking and have to respond… | [45]involve learners<br><br>[46]teaching strategies | [45]communicative approach ID<br><br>[46]teachers' role |
| I: Okay, is there anything that you would like to say sir…about science teaching, how to teach science and classroom talk, science classroom talk…anything you want to share? | | |

| | | |
|---|---|---|
| T: Yah I am thinking, like science can be used,[47] it can be approached more like as a club, a club with members who are willing to come up with something new to outreach every other person who is out there and then that with respect maybe creating [48]a scenario where learners might try to come up with new ways of trying to solve some typical problems in the world of technology and let them play games which have aspects where somebody would come and present their findings about any aspect in science or any aspect related to what they would be covering at that particular time. [49]Perhaps not forget forgetting that whilst we are studying and teaching science, the tendency is that we tend to be narrowed down to the expectations from the department of education because that is the major issue. At the end of the day you must not forget that learners will be tested within certain limits but it would be very helpful if learners are open about their challenges and they are willing to explore some other avenues of maybe ohhh… even suggesting how a teacher can make a lesson interesting and how they feel they understand issues. [50]Certainly…yah we just have to engage learners as much as possible. Even if we have to talk we must forget that they also need to be heard. So, the talk….ehhh…combined with experimentation, research and every other thing… and they also have to play games where the[51] learners have to also present to others and they pretend to be teachers…mini-teachers teaching a particular topic. Or, you can slow consider whatever we are going to cover before starting with the topis…you allow learners who might have started to come and present what they have studied or you can even ask them to go and study that topic and tomorrow…or you can even make a time-table pick at random and after that you consolidate that<br><br>I: Thank you sir, your responses are highly | [47]approach science as a community of practice<br><br>[48]learners apply science skills<br><br>[49]Curriculum demands<br><br>[50]involve learners<br><br>[51]teaching strategies | [47]nature of science content<br><br>[48]Learners' role<br><br>[49]teacher's role<br><br>[50]communicative approaches |

| | | |
|---|---|---|
| appreciated and will make a significant contribution in the study and you are welcome to contact me for clarity on this research or your participation. Thank you once again.<br><br>T: Yes my pleasure sir | | |

## Appendix D: Interviews transcript – Mr. S

| Interview turns | Code description | Themes |
|---|---|---|
| I: Thank you very much for agreeing to participate in this study, my research is about classroom talk and teacher facilitation of talk and I am going to ask you some few questions about your views on classroom talk for science teaching and learning. So, I want you to please try to answer them as fully as possible and you are free to stop me at any time for clarity. So…^ | [1]talk is not necessarily about SM | [1]communicative approach ID |
| T: Can I stop you now? | | |
| I: Yes you can. | | |
| T: What do you mean classroom talk? | | [2]teacher's role |
| I: In classroom talk I am looking at how…how you use sort of interactions, grouping in your classroom, so how you communicate with your students, like are you being authoritative, are you being dialogic? Are you giving them a chance to talk? That is what I mean. Does it answer your question? | [2]Teacher transfers knowledge<br>[3]teacher teaches skills<br>[4]teacher assesses learners what they have acquired | [3]teacher's role<br>[4]teacher's role |
| T: So, the classroom talk is the talk between teachers and learners… | | |
| I: Between teachers and learners… | | [5]teacher's role |
| T: Or between learners and learners? | [5]prepares learners for the future | |
| I: Both of them but specifically looking at you | | |
| T: So, but the talk must enable teaching? | | [6]learners' role |
| I: Yes | | |
| T: [1]Because the talk in the classroom is not necessarily about the subject matter. | [6]learners know nothing about science; curriculum demands | |
| I: Yah | | |
| T: But that is not what you mean by classroom talk | | [7]teacher's role/ |

| | | | |
|---|---|---|---|
| I: | No, that is not what I mean…With this interview, I am planning to answer: ‘what are teachers’ views about the role of classroom talk in the teaching of science for learner understanding of science content. I only have four questions in this interview and follow up questions. So, my first question is how would you describe the role of a teacher in the science classroom? | [7]teacher as source of knowledge<br><br>[8]teacher makes sure learners acquire knowledge | nature of school science content<br><br>[8]teacher’s role<br><br>[9]teacher’s role<br><br>[10]learners’ role |
| T: | Ehhh, [2]the role of a teacher is to transfer knowledge in the first place, [3]second place is to teach skills to the learners and then to [4]assess how the learners have acquired what has been taught and just teaching accordingly so that effectiveness can be maximized and [5]learners can be prepared for the future. | [9]teacher facilitates knowledge<br><br>[10]learners don’t know everything | |
| I: | Okay, If I may ask, what do you mean transferring knowledge? | | [11]teacher’s role |
| T: | What do I mean by transferring knowledge? | | |
| I: | Because you said the role of a teacher is to transfer knowledge to learners and to teach them skills | [11]knowledge should be transferred | |
| T: | The [6]learners come into the classroom not yet knowing what they need to know at the end of a term or a program, anyway, what they are required to know according to the curriculum | | [12]learners’ role<br><br>[13]learners’ role |
| I: | So, in other words…^ | [12]learners taught to think scientifically | |
| T: | So, [7]I have the knowledge and it is also in the textbooks and possible other sources and I must make sure that the learners acquire it. | [13]learners taught problem-solving skills | [14]learners’ role |
| I: | So, in other words what you are saying is that…^ | [14]learners apply knowledge | [15]learners’ role |
| T: | So, [9]I have to facilitate that | | |
| I: | So, what you are saying is that learners come to school as empty vessels without knowing anything? | [15]learners learn through practice | |
| T: | No, that is not what I am saying. [10]I am | | |

| | | | |
|---|---|---|---|
| | saying that they don't know everything that they need to know. They are not entirely empty vessels but on the other end, there is a lot that they don't know. So, yah…close to empty vessels…I don't have a problem when people say that it is like an insult that you refer to learners as empty vessels but just ask them some simple questions about science before teaching them and you will find that they is little that they know. [11]I have no problem with this analogy of empty vessels that needs to be filled. | [16]make learners complete | [16]teacher's role<br>[17]teacher's role |
| I: | So, I hear…do you think that there is a difference between teaching science and other subjects? In other words, would you teach science the same way you would teach English? | [17] teach learners problem solving skills | |
| T: | There is a difference in the sense that science is not just a knowledge subject. [12]Learners also need to learn how to think scientifically which among others[13] involves problem solving skills. [14]They need to be taught how to react to a new situation or a new problem, how to look for information to solve problems and how to combine bits and pieces of information to come to conclusions. So, those are skills. They cannot learn just by studying a test. [15]They can only learn through practice. I think it is the same thing with maths. I that is very… (Inaudible)…from other languages and history and geography. | [18]teach for conceptual understanding | [19]learners' role |
| I: | Can we say that you teaching science, you want to go and teach skills and that is your goal in teaching science? | [19]give learners exercises and challenges | |
| T: | No, that is not my goal. [16]My goal is to make learners complete, I can't make them scientists obviously but I want them to become conversant in science which involves skills. Bit in my time at Leap [17]I have emphasized the problem solving skills more because I felt that, that is where learners are lacking most. They have no problem with rote learning because if you ask them to state newton's second law, they will state it for you….every word in the right place but next if you ask them, can you explain what it | [20]difficult to get learners talk | [20]communicative approach IA |

| | | |
|---|---|---|
| means, then they are helpless. They can memorize things but they don't think about them. [18]That is why I have been trying to emphasize working on that aspect. | | |
| I: Okay, now, you were teaching the skills and not focusing on rote learning. How did you teach the skills? What are some of the strategies that you used to teach the skills? | | [21]communicative approach IA/ID |
| T: [19]By giving them lots of exercises and sometimes giving them what a call a challenge which is a problem that requires a bit more than a standard…like a higher level question, like level 4 question where they really need to do some serious think and ….yah find bits and pieces of information and combine it in the correct way and so on…but what I find is that it is very, very difficult to get them to do it. [20]Their response would be 'this is something we haven't done before' and if it is not explained to them then they are not required to do it and they wait for the teacher o give them a solution. And I have not, I my one and half year at leap, I have not found a method to break that impasse. I have not been able to make learners seriously use their brains and to…(inaudible). I even tried using rewards, like the first one who solves a problem gets a bar of chocolate. | [21]confirms whole class discussion as an important strategy<br><br>[22]identifies misconceptions through talk<br><br>[23]encourage all learners to talk | [22]communicative approach IA/ID<br><br>[23]communicative approach IA/ID<br><br>[24]teacher's role/ communicative approach IA<br><br>[25]communicative approach IA<br><br>[26]communicative approach IA/ID |
| I: Okay…that leads us to the second question where you talked about giving them exercises and helping them doing the exercise. So, my second question is 'do you think that whole class discussion is an important strategy in teaching science? | [24]prompt discussion, facilitate discussion<br><br>[25]rectify misconceptions in class discussion | [27]Communicative approach ID/IA |
| T: [21]Yes, I think it is because it helps you as a teacher to[22]indentify misconceptions and see where learners are going wrong and it is where learners can benefit from others' capabilities but it is important that you managed it well because what can easily happen is that you have some stars in the classroom that are always answering the questions and the rest are not really participating. [23]You must also appoint those who seem to be absent to join the discussion | [26]ask all learners questions<br><br>[27]encourage learners to | |

| | | |
|---|---|---|
| otherwise they wont benefit.<br><br>I: Okay, going back to management of whole class discussion, what role do you play in that whole class discussion? How would you manage it?what is your role in that classroom?<br><br>T: [24]To prompt the discussion and to make sure that it is about what I wanted it to be about also to help in the discussion and to[25] rectify misconceptions and to make sure that most learners are participating in the discussion<br><br>I: How do you encourage them to participate?<br><br>T: [26]By directing, pointing them and putting questions into that person and that person, and I make speaking to the whole as little as intimidating I can. So, I try to avoid making somebody feel stupid because they gave an incorrect answer. [27]Instead, I would encourage them..i don't know if I succeed but if somebody gives an answer I comment on it. I would say it is a good attempt, but have you thought it in this way or that way…<br><br>I: Okay thank you for that…Can you explain the role of questioning in your science classroom since you have been talking about whole class discussion, obviously questions would come through from the learners and from you going to the learners. So, I want you to explain the role of questioning in your science classroom. Both from you to the learners and from learners to you.<br><br>T: Okay, from me to learners, it is a [28]tool that I use often when I want to explain a new topic. I try to make learners understand the topic [29]by asking leading questions and force them to think about it.<br><br>I: What do you mean by leading questions?<br><br>T: Leading…for instance if I can give you a concrete example, the lesson about coulomb's law…then I want them to understand that understand that coulomb's | talk<br><br>[28]questioning as a tool to access prior knowledge; [29]ask leading questions<br><br>[29]direct learners towards the answer<br><br>[29]questioning as methods of teaching | [28]communicative approach IA<br><br>[29]communicative approach IA<br><br>[30]communicative approach IA |

| | | |
|---|---|---|
| law is not an isolated entity in science. It is related to other parts of the scientific knowledge. So, I ask them questions like: [29]looking at this equation, what does it remind you of? And the correct is that it looks like the universal law of gravity. So, I try to lead them to that answer which will lead them directly because it is not a difficult question. And I continue to ask about a force… (inaudible). That's a bit complicated so, I firstly ask what types of forces are there and obviously there should be some who knows that there are contact and non-contact forces.<br><br>I: Okay, so, is that the only questions that you ask them? Or maybe you ask them open ended, closed? Do you usually use open ended questions?<br><br>T: Uhmmm…I am not sure…<br><br>I: Okay lets continue…what prompts you to ask questions? What would have happened for you to ask a question?<br><br>T: I want to teach, so I should ask questions. It is my method of teaching<br><br>I: So, that is the only thing you ask questions for?<br><br>T: I am a teacher in a classroom and teaching is my purpose.<br><br>I: What do you do with the answer that a learner provides?<br><br>T: I will use it to explain to the class that it is correct and why it is correct and if it is correct, why is it not correct and why the thinking is wrong, which can help of course. And I would use it to ask questions. Ultimately, the aim is for the learners to arrive at the conclusions using the theory that they have learnt. So, I want learners to understand why electric force is directly proportional to the product of the charges and inversely proportional to the square of the | [30]use learners' answers to explain<br><br>[31]ask questions all the time<br><br>[32]learners should discover things for themselves<br><br>33emphasize the necessity of asking questions | [31]learners' role<br><br>[32]learners' role<br><br>[33]teacher's role<br><br>[34]communicative |

| | | | |
|---|---|---|---|
| | distance and that is through questioning. | | approach IA |
| I: | What you are saying is that questioning is the most important aspect in teaching and drives the whole lesson? | | |
| T: | [31]If I were to look upon what I am doing, I could be asking questions all the time… I am very rarely, just telling them this is the definition of that… | | [35]communicative approach |
| I: | So, you want them to discover things for themselves? | | |
| T: | I want them to discover the knowledge..yah | | |
| I: | What if the struggle to construct that knowledge? What do you normally do to help them understand that science content? So, lets say you give them an activity…. | | |
| T: | [33]Ask questions | [34]put the information in a question form | |
| I: | So, you keep on asking questions? What if….? | | |
| T: | If they are doing an exercise and they call me ask ask me…I am going to tell them do A, B and C, No, I can't…I would ask, what do you think would be the first stem…for instance lets say they were to calculate a force and they come and say DrStam, I don't understand and I see their paper is like…there is nothing written there. So, they haven't tried anything…then my question to them is 'what do you think should be the first step when you are dealing with a force problem?' And I go further until they come with an answer. And if they think there is a problem, then I tell them if you get a force problem, it is always advisable to draw a free body diagram and it helps you to identify relevant forces and also shows you the direction and then they can move on to the next step. [34]So, I am going to tell them to draw a diagram. I put it as a question to say what do you think should be the first step? I think they learn more than just telling them do A, B and C, more like giving them a | [35]questioning and talk impacts on understanding | [36]communicative approach IA |

| | | |
|---|---|---|
| recipe.<br><br>I: So, do you consider your talk and questioning to have an effect on learner understanding of science content?<br><br>T: I think it does, I am sure it does but….isay that because if it wasn't, then I would look for other methods. So, I use the method that I believe in.<br><br>I: Okay, other methods like?<br><br>T: Telling them everything…<br><br>I: Ohh…just lecturing?<br><br>T: Yes<br><br>I: Do you think this will work in making them understand?<br><br>T: Mmmmm<br><br>I: Do they understand or they would have just grasped the content?<br><br>T: Sometime it can also make them…because sometime I lose the audience because they don't know which direction I want to go with my questions. That happens some times. I think sometimes communication can break down if the learners lose track especially if the stuff is complicated. But it is not a big problem because when that happens, I realize and go back to start again and usually I put some extra steps in the reasoning and then I make sure that everybody can follow.<br><br>I: [36]So, in other words, it depends on how we construct our questions?<br><br>T: Yes, I don't write them down or anything like that…it is just my way of communicating and according to how the conversation develops because sometimes you can start on the assumption that they know. Only to discover that they don't know. Which means that you want to build on something that is not there. | [36]talk as a way of communicating ideas<br><br>[37]necessity of building on what learners already know<br><br>[38]asess learners through written test<br><br>[39]assess learners through talk | [37]communicative approach IA/ID<br><br>[38]communicative approach IA<br><br>[40]learners' role |

| | | | |
|---|---|---|---|
| | You have to go back to the point where you deal with the required knowledge. For instance, when it comes to electrostatics again, if in grade 10 they haven't been taught law of conservation of charge properly, and you discover that in grade 11, then you cant move on because some of the problems they have in their books assumes that they have that knowledge. [37]So you have to make sure that it is addressed so that you can continue with coulomb's law | | [41]teacher's role |
| I: | So, how do you know that your learners have understood besides giving them a written test? | [40]learners work on their own in exercises | |
| T: | [38]Well, a written test is very good and… | | |
| I: | Beside that…? | | |
| T: | Besides that, often my lessons, I give them a new topic, little bit of knowledge, the scientific knowledge. [39]So, I explain it to them and I give them some exercises to do. So, firstly that is the conservation between teachers and learners…I can pick up misconceptions or flawed reasoning…in the conversation, there is one thing that they can solve, informally assessed. Then, I give then exercises to do as a classwork and while they are doing that, I go around in the class and I look at what they are doing and if somebody needs help. That's also an activity where I can see if they understood the new topic | [41]use learners as teaching aids | [42]nature of school science content<br>[43]nature of school science content |
| I: | Okay, so, when you walk around, do you always encourage them to work together and help each other? | | [44]nature of school science content |
| T: | [40]Not really because sometimes I prefer them to work on their own because often if you allow them to work together, they end up talking about other things or somebody just sits and waits for the clever guy to answer the question and copies the answer. | | |
| I: | So, what happens when you see one who got the right answer and there are more learners who don't get it? Would you take one learner | [42]importance of visual | |

| | | |
|---|---|---|
| and ask him/her to help others? | aids in science | |
| T: Sometimes I ask the learner to explain using the whiteboard | [43]science is abstract | [55]nature of school science content |
| I: Not helping them individually? | | |
| T: No, helping them there….[41]you use learners as teacher's aids | | |
| I: Do you have anything to say related to what I have been asking you or anything to add on? | | |
| T: Ehhh…nothing | | |
| I: That's all that? Anything you want to share about teaching science..? | | |
| T: I think with science, [42]it is important to use visual means to aid the theory that you are explaining. [43]Otherwise, it becomes a very abstract subject. So, try as much as possible, practicals, demo experiments, sometimes use this very nice material available on youtube…so yah…I think that is also important because science is a practical subject which makes it different from mathematics. It makes it to be interesting for learners. I have noticed every time I want to do a practical, the learners are like…it brings a spark and makes learners to be motivated and that is very important | [44]make science relevant | |
| I: Okay, that you very…^ | [44]make science relevant | |
| T: [44]And…and try to link as much as possible what they are learning to their daily experiences. For instance if you are teaching gas moles, pressure and temperature and stuff, talk about car types…you know things that they use in their daily lives…those kind of daily experiences you can use to make science more alive for them. | | |
| I: So, you are saying that we cannot separate science from our everyday knowledge, what we do in everyday lives? | | |
| T: [45]No, we can't because we cannot escape | | |

| | | |
|---|---|---|
| scientific laws in everyday lives…how do you get the machine to fly is science, how do you get a car to drive is science…even cooking is science<br><br>I: Yah that's true. Thank you sir, your responses are highly appreciated and will make a significant contribution in this study. You are welcome to contact me for clarity on this research or your participation. And thank you once again.<br><br>T: You are welcome. I hope I helped you in your research to go forward because I am a researcher myself. I can understand the challenges that you are facing. Anyone who wants to research, I am always there to help<br><br>I: Okay, thanks sir. | | |

## Appendix E: Example of transcribed lesson

| Turns | Interactive patterns | Communicative approach |
|---|---|---|
| **<u>Lesson 1, double period, 50 min each</u>** | | |
| T: Right, good afternoon good people | | |
| Ls: Afternoon sir… | | |
| T: Like I said, we want to look at our chapter, our new chapter as the | | |
| term is beginning and we want to look at electrostatics. So, I say that the | | |
| topic is electrostatics. Is the word correct? So, we can then try to analyse | **I** | |
| this because we are saying electrostatics is a word that has two words. If | **R** | |
| you split this…right lets try, how would you want us to split this? | **F** | |
| L: Static.. | | |
| T: So, you want me to cut it there, and that and that (breaking | **R** | |
| ‘electrostatics’ into ‘electro’ and ‘statics’) There is part 1 of it and part…? | **I** | |
| L: two | **R** | |
| T: What is the meaning of this word [electro] or where do you thing | **E** | |
| is derived from? | **R** | |
| L: Electricity | **P** | |
| T: So, you are saying that, you have a feeling that the meaning | **R** | |
| of…it has to do with what? Electricity | **E/I** | **IA** |
| L: Electricity | | |
| T: So, in electricity, usually, what is it that it is the main story there? | **R** | |
| L: Charges… | **F** | |
| T: So, you are dealing with what? Some charges. So we want to | **R** | |
| believe that when we hear charges, it has to do with electricity. Right, | **P** | |
| what do you think this one is derived from [static]? | **R** | |
| L: Motion | **P** | |
| T: Emotions? | **R** | |
| L: Motion | | |
| T: Yes, motion it has to do with motion. Since this is static, what do | **E** | |
| you think it means? | **I** | |
| L: Stationary | **R/I** | |
| T: You are saying it has to do with what? Stationary. Which other | **R** | |
| word do you think might mean that? Any other word that you think might | **P** | |
| substitute stationary | **R** | **ID** |
| L: Still | **P** | |
| T: Somebody says still…and you cant move when you are still so | **R** | |
| you are ‘not moving’ or you are motionless | **F** | |
| L1: Sir so, solid…(inaudible).. | | |
| T: Not quite because solid is a state of matter. How many states do | **I** | |
| we have? | **R** | |
| L: Three | **F/I** | |
| T: Three state, so can you identify them? | **F** | |
| L: Liquid, gas, solid | | |
| T: So, are the charges solid or you are saying that they are in a | **R** | |
| solid? | **P** | |
| L2: The charges are in a solid | **R** | |

| | | |
|---|---|---|
| T: The charged are in a solid and they are not moving. So, stationary | **E** | |
| means these charges do not move and they do not flowing. So you can | **R** | |
| use all these but we actually have to understand what we mean by | **I** | |
| electrostatics. | | |
| L3: Sir, an electron is a charge right? | **R** | |
| T: Yes | **I** | |
| L3: So, when you say charges do not move, the electrons do not | **R** | |
| move? | | |
| T: The question is why is it so. Electrons only move when there | | **NIA** |
| is…when there is what? Let us put this aside. We are saying electrons | **E/I** | |
| flow when there is a push or a pull and usually this push or pull what do | | |
| we call it? | | |
| L: Force | | |
| T: So, which force usually pushes this? emf. And what do we call it | **R** | |
| L: Electromotive force | **F/I** | |
| T: And this electromotive force is going to b there if there is what | **R** | |
| we call p.d | **F/I** | |
| L: Potential difference | **R** | |
| T: Potential difference. And this potential difference comes with the | **F/I** | |
| difference in charges? Positives and negatives. What do we call the | | |
| negatives | **R** | |
| L: Electrons | **E/I** | |
| T: What do we call the positives | **R** | |
| L: The protons | **P** | |
| T: So, if there is an imbalance in terms of numbers then we have | **R** | **IA** |
| potential difference. But from lower grades, we understand what potential | **P** | |
| difference is. So, we are dealing with discrepancy in terms of the numbers | **R** | |
| of positives and negatives. Should there be this potential difference then | **E/P** | |
| the electromotive force will push their electrons. For now, when we deal | | |
| with electron studies, we are talking about those electrons but where are | **R** | |
| there electrons? We say they are in this material snd these electrons are | | |
| particles of matter. Do you think that there are electrons on the dest that | **P** | |
| you are writing on? On a metal? | **R** | |
| Ls: Yes | **F** | |
| T: So,the electrons are there because the basic particle of building | | |
| matter is… an? | | |
| L4: Atom | **E** | |
| T: Atom and what are the sub-atomic particles? | | |
| Ls: Protons, electrons, neutrons | | |
| T: So, those are the basic sub-atomic particles. An atom and its sub- | **I** | |
| atomic particles. How do you draw an atom? It is cyclic…and what do I | **R** | |
| have in the middle? Its this and that…and what do we call these | **P** | |
| Ls: Shell, orbit level | **R** | |
| T: So, you can simply put it as orbital and what do I find here | **P** | |
| Ls: Electrons | | |
| T: And what do I find in the middle? | **R** | |
| Ls: Protons, neutrons | **P** | |
| T: And what do they form? | **R** | |
| L: Nucleus | **P** | |
| T: They form what we call nucleus. So, our story is about these | **R** | |

| | | |
|---|---|---|
| electrons and about these protons. Right now you know that you have | **P** | |
| those electrons and protons on those desks but those charges are | **R** | |
| stationary. If I may ask, is everything around us charged? | **P** | |
| Ls: Yes, No | **R** | |
| T: Right somebody says yes and somebody says no. If yes, what is | **P/E** | |
| the answer. | | |
| L5: When something is charged, it means there surplus or excess of | | **NID** |
| electrons whereas when it is not charged, the electrons and protons are | | |
| equal so it nuetralises. | | |
| T: I think he needs some encouragement. | | |
| Ls: (clapping hands) | | |
| T: So,you got what he said. Should we be talking about a charged | **I** | |
| particle, we are talking about a scenario where the charges are | **R** | |
| unbalanced. Protons and electrons, positives and… | **E** | |
| L: Negatives. | | |
| T: Should we have excess of negatives, what charge will we have? | | |
| Excess means ? | | |
| L: More | **I** | |
| T: More or Suplus of…then what is that charge? | **R** | |
| L1: It is a negative charged | **F/I** | |
| T: Yes, a negatively charged particle. Does someone wants to tell | | |
| me what is a positively charged object? can someone please | **R** | |
| explain…Yes sir/ | | |
| L5: When it is positively charged, it means that it has lost some of the | **P** | |
| electrons | | |
| T: So, it has lost some of its electrons | | |
| L5: Making the overall charge positive | **P** | |
| T: okay, we will come back to that…someone wants to talk… | **R** | |
| L2: There is surplus of protons | **F/P** | |
| T: Surplus of….? | **R** | |
| L2: Protons | | |
| T: Somebody wants to try before I put in my input? Yes…try? | **I** | |
| L6: Sir…electrons are the ones that move ,when an atom, when a | **R** | |
| particle loses protons and has a surplus of electrons | **P** | |
| T: Okay, anyone who want to try something? Okay…what you need | **R** | |
| to know from today is that, the state of an objects whether it is positively | **F** | **IA** |
| or negatively charged is determined by electrons. You [L6] have put it | | |
| correctly to say only the electrons move…only electrons can be | **I** | |
| transferred. Not positive, positives do not move. So, what does it mean to | **F/P** | |
| say, this is negatively charged? When we say that this is negatively | | |
| charged, we mean there is excess of electrons. When this is positively | **R** | |
| charged, what do you think it means? So, there is deficiency. Never talk | | |
| about that using the positives. When we define whether this is negatively | **R** | |
| charged or positively charged we decide whether there is an excess of | **R** | |
| electrons and this is positively charged, why? Because there is deficiency. | | |
| So, deficiency means there is surplus of protons but an explanation | | |
| should refer to the electrons. So, these charges are…? | **I** | |
| Ls: Stationary, motionless, not flowing | | |
| T: Not flowing but they are there. The question is, how do you make | **R** | |
| them to be there? That is going to come. So, who started all these? There | | |

| | | |
|---|---|---|
| is a man called Coulomb. So, he is the person who specialized in studying | **F/I** | |
| these charges. So, when we are dealing with electrostatic we are dealing | **R** | |
| with charges that are not flowing, still…Right? | | |
| Ls: Yes… | **F/I** | |
| T: There is something that he said that we can put in the form of | **R** | |
| words. What did he say? | **F** | |
| Ls: The electrons…. | **I** | |
| T: One person please… who wants to talk? Lerato you want to | **R/P** | |
| talk….yes because this question is directed to you. You happen to be in | | |
| this classroom and we asked you a question. What did he say, what is | **R** | |
| Coulomb's law? | | |
| Lerato: Coulomb's law stated the force of attraction exerted by one | **E** | |
| charge at another charge is directly proportional to the product of the | **R** | |
| charges and inversely proportional to the square of the distance between | **P** | |
| them (reading from textbook). | **R** | |
| T: Do you think you understand what it means? Try to explain what | **P** | |
| you derive from that…what is he saying? In your own words, in your | | |
| own visuals. Visualize this try to understand what he means. | **E** | |
| Silence | | |
| T: Because you are saying, he says that two charges will do what? | **I** | |
| Exert. So what is to exert? | **P** | |
| L6: Push | | |
| T: Pull or push…so, they exert a force one ach other. One moment | **R** | |
| there might be pulling and the next moment there might be…? | **F** | |
| Ls: Pushing | | |
| T: So, how many charges are we dealing with here? | **I/P** | |
| Ls: Two charges | | **IA** |
| T: Where are these charges? | | |
| L4: In an object… | | |
| T: In a object but we are dealing with a charge, remember I can | **R** | |
| consider an object but the story might lie with a charge. Yes sir…? | **P** | |
| L4: Can I ask? Are these charges not in the electric field? | **R** | |
| T: Electric field is something else. As you are saying that a 'field'. | **E/I** | |
| For you to push, it means something that you are pushing should be | **R** | |
| within the reach. What is a force by the way? | **I** | |
| Ls: It is a push or a pull. Can you push something without touching it | | |
| Ls: No… | **R** | |
| T: So, we need to establish something in general that a force can be | **P** | |
| 1 of 2. A force can be…what is that? | **R** | |
| Ls: Contact force | **P** | |
| T: And?? | **R** | |
| Ls: Non-contact | **E** | |
| T: We definitely need to know what we are dealing with. If we have | | |
| to push a book across a table? Can you push a book without touching it? | **I** | |
| Ls: No | **R** | |
| T: So, for you to apply a force which is a push or a pull, you must be | **P** | |
| in contact. But look at you…we can drop you from the 10th floor but what | **R** | |
| will happen is that you are going to rise and go to heaven (laughter). | **P** | |
| What will happen if you are so excited that you jump out of the balcon | **R** | |
| and hope to live…will that happen?. | **R** | |

| | | |
|---|---|---|
| L: No. | **P** | |
| T: You will be pulled by the force of gravity. Can you see it, does it | **R** | |
| have to be in contact with you? | **P** | |
| Ls: No… | **P** | |
| T: So, we say gravitational force is a non-contact force | **R** | |
| L7: But sir microscopically, you can push it without.. (inaudible) | | |
| T: That would be very, very, very incorrect and impossible. I can see | **I** | |
| what you are really saying…without touching, but crouching a little bit, | **R** | |
| but…that wont work because the force to push that book, the minimum | **R** | |
| you can apply is how much? | **R** | |
| L5: Just to overcome the force of friction | **F** | |
| T: Just to overcome friction. Any other force beyond friction, what | **R** | |
| do we call.. (inaudible)..So what simply means is that if you push the | **P** | |
| book with force beyond its frictional force, the book will just move and in | **R** | |
| what velocity? | **P** | |
| Ls; Constant velocity | | |
| T: What is the change in velocity? | **R** | |
| Ls: Zero | **P** | |
| T: Zero. Therefore the second law says m is equals? | **R** | |
| Ls: (Inaudible) | **P** | |
| T: So, the book does not… (inaudible) Thank you Lerato. | | |
| Someone's hand was up...yes ladies first | **R** | |
| L8: So, sir the gravitational force is the only force that is non-contact? | **P** | |
| T: That is not true…that is not true…we will use her to give us | **R** | |
| another force is non-contact. Right the question has been asked so give us | **P** | |
| the answer. Which other force exert on an object without touching? Think | **R** | |
| about something. Go back to grade 10 | **P** | |
| L8: Normal force | **R** | |
| T: That is not true because you cant have a normal force if the | **E** | |
| bodies are not in contact | **I** | |
| L9: What is the questions sir? | **P** | |
| T: The question is, she says that gravitational force is the only one | **R** | |
| which is non-contact. The answer we said no and we want to find out if | **P** | |
| there are others and I wanted to her to try. Go back to grade 10. What did | **R** | |
| we learn in grade 10 that is related to the physics? When we talk about | **F/P** | |
| the earth and even drew certain lines around the earth. What were we | | |
| talking about? | **R** | |
| L10: something like magnets | **I** | |
| T: Yes, so what force is that? | | |
| Ls: Magnetic foece | **I** | |
| T: And we are dealing with another non-contact force. What is that? | **R** | |
| L5: Electrostatic force | **I** | |
| T: Electrostatic force. The particles do not necessarily need to touch. | | |
| But if the particles do touch what is the distance between them? | **I** | |
| Ls: Zero | **R** | |
| T: That is not true | | |
| L5: The distance is greater than zero | | |
| T: It is greater than zero but what is it? | **R** | |
| L9: Sir it is the distance between, from the center of that ball to the | **R** | |
| center of another ball | **P** | |

| | | |
|---|---|---|
| T: So, we can say the distance is radius plus radius because we | | |
| measure the distance from the center. Distance wil never be zero. It will | **R** | |
| never be zero because of we then have to apply Coulomb's law in | **P** | |
| mathematical form…what does it say mathematically? Mahlatse?? | **R** | |
| Mahlatse: (giving the formular) | **P** | |
| T: Can we identify what each variable there represents? Right | **R** | **NID** |
| Tisetso, you can pickl | **E** | |
| Tisetso: N stands for force | | |
| T: Stands for force measured in what units? | | |
| Tisetso: Newtons. Any other pick?MrVillo? | | |
| Villo: K stands for Coulomb's constant. | **P** | |
| T Are there units for Coulomb's constant? | | |
| Villo: MmmmNewtons per minute squared… | **P** | |
| Ls: Minutes?? (Laughter) | | |
| T: Someone feels there is something wrong and we want to know | **R** | |
| what that m stands for | **P** | |
| Ls; meters | **R** | |
| T: Meter squared per Coulomb squared | **P** | |
| L3: Sir, here ba re (*they say*), it stands for charged particle | | |
| T: Yes, that particle is charged | **R** | |
| L11: Q. It is the charge | **P** | |
| L12: r squares…it is the distance between the two… | | |
| T: It is r squared | **R** | |
| L12 Radius squared | **P** | |
| T: It is not radius squared. We are trying to identify the variables | **R** | |
| here. What is this one? | **P** | |
| Ls: r | | |
| T: It is r not necessarily trying to include the squared. You can say r | **R** | |
| squared trying to explain it but we are saying the variable used there is r. | **P** | |
| What does r represent? | **R** | |
| L12: Distance between the set of two objects | **P** | |
| T: What are these objects that we are dealing with here? | **R** | |
| L12: The charges | **P** | |
| T: Yes, the charges. So r stands for the distance between the charges | **R** | |
| that we are talking about. And what is the unit for these charges? | **I** | |
| L12: It is measured in meters | | |
| T: In meters. What if the distance comes in millimeters? | | |
| Ls: You convert | **F/E** | |
| T: Why do you think it is advisable to convert? | | |
| Ls: SI unit | | |
| T: So that you use the SI units and what is that | **R** | |
| Ls: Standard international units | **P** | |
| T: So, past that people, we should be able to apply this [Coulomb's | **R** | |
| law] to solve certain problems. Questions? | **P/F** | |
| L4: Sir, if you are dealing with three objects…, charges do you still | | |
| use this [Coulomb's fomula]?? | **I** | |
| T: My friend, what are you dealing with about those charges? | **E** | |
| L4: Force | | |
| T: And what are these things? They are…? | | |
| L4: Charges | | |

| | | |
|---|---|---|
| T: And you are dealing with force. That involves what? A force that | | |
| involves charges. For you to be able to solve those problems, whose law | | |
| applies here? | | |
| Ls: Coulomb | | |
| T: And what did he say? | **I** | |
| Ls: (learners calling out the formula) | **I** | |
| T: If I may borrow from the universal gravitational law, what does it | **R** | |
| say? | **F** | |
| Ls: (calling out the formula) | **R** | |
| T: Now, if I may ask you, can you identify objects around here? | **I** | |
| Lets talk about the solar system | **R** | |
| Ls: The planets? | **F/I** | |
| T: Yes give me some planets | | |
| Ls: Pluto, | **R** | |
| T: One person please | **F/I** | |
| T: Yes | **R** | |
| L: Neptune | **I** | |
| L: Jupiter | **R** | |
| T: So, why am I doing this, I want to help this brother of mine to | **I** | |
| help him understand it now and forever. All these bodies in the solar | **R** | |
| system have their central reference point. And what is that? | **I** | |
| L: The sun | **R** | |
| T: the sun…all of them. Does the sun revolve around the earth or | **I** | |
| they revolve around the sun? | **I** | |
| Ls: They revolve around the sun | **R/I** | |
| T: So here there is mars and here there is Jupiter. Do you think that | **R** | |
| mars exert a force on Jupiter? | **F/I** | |
| Ls: Nooo, Yesss | | |
| T: When you are dealing with physics, put them aside. Even if the | **R** | |
| question says suggest, don't ever try to write something that has got | **P** | |
| nothing to do with science. Whatever question they put…what do you | **R** | |
| think what is your opinion, you still apply the physics. So, you might say, | **P** | |
| I might not know if they exert a force on each other but according the | | |
| universal gravitation law, this is the story, therefore they exert a force on | **R** | |
| each other. Don't worry about how you feel and don't say | **P** | |
| "ahhhh….10000 km, I don't think so", So what is the universal law of | **R** | |
| gravitation? | **P** | |
| Ls: (shouting the formula) | **R** | |
| T: Okay, let us say that on a Cartesian plane, we have five charges | **F/P** | |
| and all these charges are of the same type. Five charges on a Cartesian | | |
| plane placed any how. What do we know in science about like charges? | | |
| Ls: They repel | **R** | |
| T: Like charges?Lesego | **P** | |
| Lesego: Repel | **R** | |
| T: And unlike charges attract. But if these charges are on the same | **E/I** | |
| Cartesian plane, is there any distance between any two of them? | | |
| Ls: Yes | **R** | |
| T: If charge one has a distance between charge two and charge two | **E/I** | |
| has a distance with charge 3. Charge one, charge two, and charge 4 and | | |
| the likes??/…. Do you think charge one exrt a force on charge two? | | |

| | | |
|---|---|---|
| Ls: Yes | **I** | |
| T: Do you think Q1 Exert a force on Q3? | | |
| Ls: Yes | | |
| T: Do you think Q2 exert a force on Q3? So, if you have more forces, will they still exert a force on each other? What is a force? | **R/P** | **I**D |
| Ls: Push or pull | | |
| T: Does it only have one identification of two? | | |
| L5: Two | **F** | |
| T: What is it then? | | |
| L5: Magnitude | **R** | |
| T: Magnitude and? | | |
| L5: Direction | **F** | |
| T: So, have you ever, in your life where more than two forces interact? How did you find the resultant force? | **R** | |
| T: (Inaudible) | **I** | |
| Ls: (Inaudible) | **F** | |
| T: So, that is how you are going to approach it. Not necessarily to say I have given you the procedure. So donkey one and two pull in opposite directions and there is this donkey and you need to find their individual contributions. You can decide, to use what? One? To find the resultant? What can you use? | **R**<br>**E/I** | |
| L4: Head to tail | **R** | |
| T: What else? | **P** | |
| L4: Decompose | **R** | |
| T: Any other? By construction. So, if there is more than two charges, you can still work that out because between any two charges there is a force. | **P** | |
| L5: So, if the charges are perpendicular? | **I** | |
| T: Even if they are not perpendicular, you still use Pythagoras after decomposition. Remember there is not only one way to solve these. There are other ways. But we are saying, do you have an idea about what you need to do when you are given three charges? Don’t worry, we will come to that when the time comes. For now, I want you to go through something that I have prepared for you. It is just to =touch on some things that I think may help us. I am going to give you 10 Minutes to work on this. | **R/E** | |
| The teacher handed out the worksheet which mainly dealt with basics of the atom, law of attraction and repulsion, and charges. The teacher moved around the classroom but did not give help to learners. The worksheet took learners 11 minutes to complete | | |
| T: I just want your general knowledge and what you already know | | |
| T: Swap your papers. Quickly let’s go through that… Who wants to read the first question? | **I** | |
| L1: The outer (inaudible).. are not tidely bound to the atomic nuclei | **R** | |
| T: Nuclei meaning many nucleuses… | | |
| L1…They are free to roam in the material. Such material are good……… | **R** | |
| T: Good what? | **I** | |
| L2: Conductors | **R** | |
| T: Good conductors. It means that those electrons are free. They are not tidely bound. What can you say about such materials which have | **E/I** | |

| | | |
|---|---|---|
| tidley bound electrons? They are? | | |
| L3: Insulators | **R** | |
| T; Insulators. What is the charge of the following? Electrons | **E/I** | |
| Ls: Negative | **R** | |
| T: Protons | **E** | |
| Ls: Positive | **R** | |
| T: Neutrons? | **I** | |
| Ls: Neutral | **R** | |
| T: Like charges?? | **I** | |
| Ls: Repel | **R** | |
| T: And opposite charges attract. Are they getting ticks there? | **E/I** | |
| L4: Sir, the charge of a neutron is neutral or zero | **R** | |
| T: Yes its neutral because it does not have a charge. Right, what is the principle of conservation of charge? | **E/I** | |
| L5: Charges cannot be destroyed nor created but can be… (inaudible) | **R** | |
| T: Right, there is no miraculous day where you will sit down and destroy a charge. The charge is neither created nor destroyed. You can only?? | **F/I** | |
| Ls: Transfer | **R** | |
| T: Which charge usually, is going to be transferred? | **P** | |
| Ls: Electrons | **R** | |
| T: Electrons. What part of an atom is positively charged and what part is negatively charged? Which one is positively charged? | **E/I** | |
| Ls: Nucleus | **R** | |
| T: What part of the atom is positively charged and what part is negatively charged? | **I** | **IA** |
| L6: Nucleus is positively charged… | **R** | |
| T: What part of an atom…?? | **P** | |
| L5: The center… | **R** | |
| T: What part of an atom? What were you going to say about a proton? Because a proton is part of an atom. An atom and its sub-parts. These sub-parts are then can be referred to as particles. The word particle comes from a part. So, it is an atom and its sub-atomic particles. So which part of an atom is positively charged? | **E/P** | |
| Ls: The proton | **R** | |
| T: The proton. And negatively charged? | **E/I** | |
| Ls: The electrons | **R** | |
| T: Because if you say the nucleus is positively charged, yes agreed but that is too wholesome because in the nucleus, what do we find? Protons and ? | **E/I** | |
| Ls: Neutrons | **R** | |
| T: Are neutrons charged also? So, why should the neutrons that we say are neutral be part of the nucleus because the nucleus…remember the nucleus is constituted by charged and uncharged particles but you tell me that the nucleus as a whole is positively charged. Yes, it can be but the thing is there are other 'charges' which are not charged. You get that now?? | **E/I** | |
| L4: Why is it that the neutrons are neutral but they don't… (inaudible) | **I** | |
| T: You are saying the neutrons are?? | **R** | |

| | | |
|---|---|---|
| L4: Neutral<br>T: But then you saying suddenly they can have a charge?<br>L4: (Inaudible)<br>T: Right…<br>L4: Sir if I rub this (rubbing a pen on his hair)…these neutrally charged…<br>T: Neutrally charged? There is nothing like neutrally charged. It is you are saying this empty bottle is full of water. Listen please. Just help him develop his point<br>L4: Electrons are attracted to the protons in a neutral object and a negative object is attracted to the positive (using two pens to illustrate)..the positives sir…why is it in a nucleus, the negatives….the neutral… (Inaudible)<br>T: Right…<br>L6: I think what he is trying to explain is that the neutral object has charges which are equal in a sense that it makes it to be neutral and all the forces just cancel each other.<br>T: The forces cancel each other?<br>T: Maybe what you are saying is likely to be true (responding to L4) but the question is how positives can and positives be in one…<br>L3: Isn't it that the neutrons have both positives and negatives whereas the positives with the neutrons are equal to the protons<br>L4: Can you explain that?<br>L3: The negatives in the neutrons are equal to the positives in the nucleus. So, …<br>L4: So, the neutrons in the nucleus have less positives?<br>L3: No, the neutrons…isn't it that the neutrons have a negative and a positive so an atom that is not charged has the same amount of protons You understand? The neutrons are equal to…<br>*To deal with the discussion, the teacher used the analogy of girls and boys…* | **R**<br>**P**<br><br><br>**I**<br><br>**E**<br><br><br>**R**<br><br><br><br><br>**R/E**<br><br><br>**P**<br>**E**<br><br>**I**<br><br>**P**<br>**R**<br><br>**P**<br>**R** | |

## Appendix F: Wits Ethics Clearance

**Wits School of Education**

27 St Andrews Road, Parktown, Johannesburg, 2193 Private Bag 3, Wits 2050, South Africa. Tel: +27 11 717-3064 Fax: +27 11 717-3100 E-mail: enquiries@educ.wits.ac.za Website: www.wits.ac.za

12 June 2015

Student Number: 461653

Protocol Number: 2015ECE013M

Dear ClimantKhoza

**Application for Ethics Clearance: Master of Science**

Thank you very much for your ethics application. The Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate, has considered your application for ethics clearance for your proposal entitled:

**Exploring the nature of teacher talk and its role in student understanding of science content**

The committee recently met and I am pleased to inform you that **clearance was granted**.

Please use the above protocol number in all correspondence to the relevant research parties (schools, parents, learners etc.) and include it in your research report or project on the title page.

The Protocol Number above should be submitted to the Graduate Studies in Education Committee upon submission of your final research report.

All the best with your research project.

Yours sincerely,

Wits School of Education

011 717-3416

cc

## Appendix G: Information letter – Principal

**LETTER TO THE PRINCIPAL**

DATE:

Dear:

My name is Hlologelo Climant Khoza. I am a postgraduate MSc: Science Education student in the School of Education at the University of the Witwatersrand.

I am doing research on Classroom talk: Exploring teacher talk and its role in learner understanding of science content. My research involves Grade 11 Physical Science teacher and his/her students. I will be video-recording three lessons where the teacher is teaching a science topic. The lessons will be video-recorded for the entire period. The reason for video-recording the lesson is that this study is qualitative and I am looking for a detailed analysis of talk and how the teacher facilitates that. The video-recordings will give details of non-verbal activities in the classroom. Observations of the lessons will not disturb the running of the lessons in any way. So, I will not participate in the lessons. At the end of each lesson, I will collect some test which test their understanding of the content covered at that time.

The reason why I have chosen your school is because I am familiar with the schools and has smaller classes for good analysis of the teacher talk.I am inviting your school to participate in this research on the nature of teacher talk in science classrooms. This research may benefit the school in that your staff may adopt some classroom talk to explain some science concepts.

The research participants will not be advantaged or disadvantaged in any way. 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 names of the research participants and identity of the school will be kept confidential at all times and in all academic writing about the study. Their 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. I look forward to your response as soon as is convenient.

Yours sincerely,

SIGNATURE

NAME: HlologeloClimantKhoza

ADDRESS: 24 Queens Road, Argyll House, Parktown, Johannesburg

EMAIL: climantkhoza@gmail.com

TELEPHONE NUMBERS: 0848734928

**APPENDIX H: INFORMATION LETTER AND CONSENT FORM – TEACHER**

INFORMATION SHEET TEACHERS

DATE:

Dear

My name is Hlologelo Climant Khoza and I am an Msc: Science Eduactionstuden in the School of Education at the University of the Witwatersrand.

I am doing research on Classroom talk: Exploring teacher talk and its role in learner understanding of science content. My research involves you as a grade 11 Physical science teacher and your learners. I will be observing some of your lessons where you will be teaching any science topic. The lessons will be vide-recorded. The reason for video-recording the lesson is that this study is qualitative and I am looking for a detailed analysis of talk and how the teacher facilitates that. The video-recordings will give details of non-verbal activities in the classroom. Observations of the lessons will not disturb the running of the lessons in any way. So, I will not participate in the lessons. I will also be interviewing you on your views and opinions of classroom talk and interaction.

The reason why I have chosen your school is because I am familiar with the schools and has smaller classes for good analysis of the teacher talk. I was wondering whether you would mind if you can participate in the study by allowing me to video-record your lessons and interview you.Your name and identity will be kept confidential at all times and in all academic writing about the study. Your 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.

You will not be advantaged or disadvantaged in any way. Your participation is voluntary, so you can withdraw your permission at any time during this project without any penalty. There are no foreseeable risks in participating and you will not be paid for this study.

Please let me know if you require any further information.

Thank you very much for your help.

Yours sincerely,

SIGNATURE

NAME: HlologeloClimantKhoza

ADDRESS: 24 Queens Road, Argyll House, Parktown, Johannesburg

EMAIL: climantkhoza@gmail.com

TELEPHONE NUMBERS: 0848734928

Teacher's Consent

Please fill in and return the reply slip below indicating your willingness to be a participant in my voluntary research project called: Exploring the nature of teacher talk and student understanding of science content.

I, ________________________ give my consent for the following:

I **Permission to observe you in class**

I agree to be observed in class. YES/NO

**Permission to be audiotaped**

I agree to be audiotaped during the interview YES/NO

I know that the audiotapes will be used for this project only YES/NO

**Permission to be interviewed**

I would like to be interviewed for this study. YES/NO

I know that I can stop the interview at any time and don't have to answer all the questions asked. YES/NO

**Permission to be videotaped**

I agree to be videotaped in class. YES/NO

I know that the videotapes 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 do not have to answer every question and can withdraw from the study at any time.
- I can ask not to be audiotaped, photographed and/or videotape
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign______________________________ Date____________________________

## APPENDIX I: INFORMATION LETTER AND CONSENT FORM – PARENT

INFORMATION SHEET PARENTS

DATE:

Dear Parent

My name is Hlologelo Climant Khoza and I am an MSc: Science education student in the School of Education at the University of the Witwatersrand.

I am doing research on Classroom talk: Exploring teacher talk and its role in learner understanding of science content. My research involves your child who is attending at Leap Science and Maths School. I will be observing some lessons where the teacher is teaching your child science concepts. The lessons will be vide-recorded. The reason for video-recording the lesson is that this study is qualitative and I am looking for a detailed analysis of talk and how the teacher facilitates that. The video-recordings will give details of non-verbal activities in the classroom. Observations of the lessons will not disturb the running of the lessons in any way. So, I will not participate in the lessons. I will also take some tasks that learners write to see if they understood the content.

The reason why I have chosen your child's class is because he/she is attending at the mentioned school and doing Grade 10 which is the class I am interested in for this study. It is not only your child who will be observed but all the Grade 10 students.I was wondering whether you would mind if you can allow your child to be observed and video-recorded while he/she is being taught.

Your child will not be advantaged or disadvantaged in any way. S/he will be reassured that s/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 this study.

Your child's name and identity 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 help.

Yours sincerely,

SIGNATURE

NAME: HlologeloClimantKhoza

ADDRESS: 24 Queens Road, Argyll House, Parktown, Johannesburg

EMAIL: climantkhoza@gmail.com

TELEPHONE NUMBERS: 0848734928

Parent's 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 teacher talk and its role in learner understanding of science content

I, ________________________ the parent of ______________________

| **Permission to review/collect documents/artifacts** | **Circle one** |
|---|---|
| I agree that my child's small test can be used for this study only. | YES/NO |
| **Permission to observe my child in class** | |
| I agree that my child may be observed in class. | YES/NO |
| **Permission for questionnaire/test** | |
| I agree that my child may write a test for this study. | YES/NO |
| **Permission to be videotaped** | |
| I agree my child may be videotaped in class. | YES/NO |
| I know that the videotapes 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 my name and the name of my school will not be revealed.
- he/she does not have to answer every question and can withdraw from the study at any time.
- he/she can ask not to be audiotaped, photographed and/or videotape
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____________________________ Date___________________________

## APPENDIX J: INFORMATION LETTER AND CONSENT FORM – LEARNER

INFORMATION SHEET LEARNERS

DATE:

Dear Learner

My name is Hlologelo Climant Khoza and I am an MSc: Science Education student in the School of Education at the University of the Witwatersrand.

I am doing research on Classroom talk: Exploring teacher talk and its role in learner understanding of science content. My investigation will involve you as a Grade 11 learner at this school. I will be observing some lessons where the teacher is teaching you any science concept/ topic. The lessons will be video-recorded by me. The reason for video-recording the lesson is that this study is qualitative and I am looking for a detailed analysis of talk and how the teacher facilitates that. The video-recordings will give details of non-verbal activities in the classroom. Observations of the lessons will not disturb the running of the lessons in any way. So, I will not participate in the lessons. At the end of each lesson, I will collect the task you completed that would be based on the content covered that day.

I was wondering whether you would mind if you can participate in this research. I need your help with observing you when you are taught in classroom and video-recording you during the lesson. 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. Also, if you decide not to be video-recorded, I will make sure that the video-recorder does not reach you.

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 project.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

NAME: HlologeloClimantKhoza

ADDRESS: 24 Queens Road, Argyll house, Parktown, Johaneesburg

EMAIL: climantkhoza@gmail.com

TELEPHONE NUMBERS: 0848734928

Learner Consent Form

Please fill in the reply slip below if you agree to participate in my study called: Exploring teacher talk and its role in learner understanding of science content

My name is: ________________________

| **Permission to review/collect documents/artifacts** | **Circle one** |
| --- | --- |
| I agree that my test can be used for this study only. | YES/NO |
| **Permission to observe you in class** | |
| I agree to be observed in class. | YES/NO |
| **Permission for questionnaire/test** | |
| I agree to write a test for this study. | YES/NO |
| **Permission to be videotaped** | |
| I agree to be videotaped in class. | YES/NO |
| I know that the videotapes 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 do not have to answer every question and can withdraw from the study at any time.
- I can ask not to be audiotaped, photographed and/or videotape
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____________________________ Date___________________________