Life Sciences teachers' use of discursive moves to establish dialogic discourse when teaching about the cell cycle

by

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Declaration

I declare that the dissertation, which I hereby submit for the degree Magister Educationis in November 2024 at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

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Ethics statement

With respect to people's values, rights, and dignity, this research was conducted in accordance with the University of Pretoria ethics committee, which granted ethical clearance prior to conducting this study. As such, all the participants in the current study consented to be part of the study before taking part in the research, which means that all the participants were well informed about all the research proceedings and their roles. Additionally, I used pseudonyms to protect the identities of the schools, teachers, and learners and maintain confidentiality. The participants were ensured that only the researcher and the supervisors would have access to the data obtained. This data is stored electronically on a password-protected drive. However, the study will be shared with the participants at their request. Finally, in acknowledgement of the other researchers who contributed to the current study, I used referencing.

Dedication

I dedicate this work to my family, who supported and encouraged me to persevere. My mother, Makhosazane Gloria Zondo and my father, Bhekabantu Albert Zondo who, taught me life values and being responsible.

Together with my siblings, my sister Slindokuhle Precious Zondo and Sbusiso Victor Zondo, they kept on encouraging me to work hard on this dissertation.

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“Ngith nje Mthiyane, Jandu ka Ndaba, Sokotshani, wena ka Vuma Ncase” (clan names).

And finally, to the Lord almighty, I am forever grateful. You have been so good to me.

Abstract

There is an agreement among science education scholars in South Africa and the world that establishing a dialogic discourse depends on how teachers ask questions and respond to learners' contributions. The purpose of this study was to investigate how Life Sciences teachers use discursive moves to establish a dialogic discourse when teaching the topic of the cell cycle in Grade 10 and the factors that influence the Life Sciences teachers' use of these discursive moves. Socio-cultural theory was used as the main theoretical framework and several constructs like teacher discursive moves from Tytler and Aranda's (2015) and Mortimer and Scott's (2003) frameworks of communicative approaches as a conceptual framework. Using a multiple qualitative case study, data was collected through classroom observations (video data) and video-stimulated recall interviews (VSRIs). The video data was analysed both inductively and deductively using an established framework, and data from the VSRIs was analysed thematically. Findings indicate a specific progression of discursive moves to establish a dialogic discourse. Interestingly, the findings differed in the length of dialogic interactive patterns when close-ended and open-ended questions were used to initiate a discussion. Factors that contribute to the use of discursive moves when teaching the topic of the cell cycle are presented and discussed. This study outlines some recommendations for in-service Life Sciences teachers' professional development and how initial teacher education programmes need to prepare Life Sciences teachers to understand the intricacies of establishing a dialogic discourse in Life Sciences classrooms.

Keywords: Authoritative discourse, dialogic discourse, discursive moves, cell cycle, Life Sciences teacher talk

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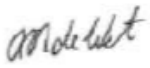

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List of abbreviations

CAPS	:	Curriculum and Assessment Policy Statement
Cl-Q	:	Closed-ended Questions
IA	:	Interactive Authoritative Discourse
ID	:	Interactive Dialogic Discourse
LFSC	:	Life Sciences
NIA	:	Non-Interactive Authoritative Discourse
NID	:	Non-Interactive Dialogic Discourse
Op-Q	:	Open-ended Questions

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CHAPTER 1: GENERAL ORIENTATION

1.1 Introduction to the Study

Communication in science classrooms is a requisite to facilitate the teaching and learning process (Mwelese et al., 2018). According to Murphy et al. (2020), talk in classrooms marks communication and can be found going on in most classrooms. The teacher can give a lecture or ask questions – teacher talk (Alkhouri et al., 2021), or learners can respond to the teacher's questions and instruction – *learner talk*. This means that regardless of the activity, talk is a principal mechanism (Tang, 2020) through which teaching and learning occur. Teacher talk is vital in science classrooms as it helps the teacher create a platform for the learners to engage in a dialogic discussion (Aranda et al., 2020), thus contributing to the learning process. Therefore, teacher talk plays a central role in facilitating learner engagement (Aranda et al., 2020) in the classroom and achieving specific goals (Bansal, 2018) during the teaching and learning process. Tang (2020) argued that teacher talk is the primary tool used by teachers as a mechanism to convey knowledge to the learners for teaching and learning to occur. Teachers can mediate the learning process through talk. In the current study, I define teacher talk as utterances aimed at instructing learners, explaining and asking questions and responding to learners' contributions during classroom interactions.

In theorising teacher talk in science classrooms, Mortimer and Scott (2003) developed a framework that characterises different teacher communication approaches. I describe these in detail in Chapter 2. The first approach is interactive, where the learners participate a lot. An interactive communicative approach can take an authoritative or dialogic form. The former occurs when the teacher welcomes scientific

ideas that are orderly and eliminates the ones that are not related to scientific knowledge. The latter occurs when the teacher explores different scientific ideas, and it involves the use of questions to probe the learners for more responses (Aflalo & Raviv, 2022; Mortimer & Scott, 2003). The second communicative approach is non-interactive and can also take two forms: non-interactive authoritative and non-interactive dialogic. In a non-interactive authoritative approach, the teacher does not encourage social interaction, and a single scientific view is introduced and embraced. In non-interactive dialogic, the teacher synthesises ideas and welcomes alternative and contradictory worldviews. These communicative approaches serve different purposes in science classrooms. For example, the non-interactive approach allows the teacher to convey the science content, and the interactive approach allows the teacher to involve learners in the learning process.

Studies in science education have conceptualised the above-described communicative approaches as discourses that can be established through teacher talk by arguing that some approaches allow for the construction of knowledge through the sharing of ideas (Soysal, 2020; Worku & Alemu, 2021). For example, in interactive dialogic discourse, many ideas are heard, allowing learners to engage with the content. Recently, there have been arguments that these discourses are determined by the teacher's purposive use of specific discursive moves (Murphy et al., 2020; Setiawan et al., 2021). Nonetheless, the preferred one is the dialogic discourse, although authoritative discourse is the most prevalent due to curriculum demands and the authoritative nature of science knowledge (Khoza & Msimanga, 2022; Lehesvuori et al., 2018). Therefore, when analysing science classroom interaction, showing how the teacher uses discursive moves becomes an area of interest.

Discursive moves are defined as the purposive primary tool employed by teachers to impart knowledge to the learners. Soysal and Tuzun (2019) defined teacher discursive moves as any form of verbal or non-verbal externalisation where the teacher aims to engage with the learners in a social context using verbal communication (Bansal, 2018; Soysal & Tuzun, 2019). As such, discursive moves include questions that aim to initiate a discussion during the teaching and learning process. Some literature argued that these discursive moves need to be accompanied by non-verbal strategies like the use of diagrams and models (Khoza & Makgata, 2024). In the current study, I define discursive moves in terms of verbal communication used by teachers to explain activities, give instructions, monitor the learners' understanding of content knowledge, and provide feedback to the learners. This definition means that discursive moves include how the teachers initiate interactions as well as how they weave the interaction by responding to learner contributions. Most research in science education investigating discursive moves is influenced by the famous Sinclair and Coulthards's (1975) Initiation-Response-Evaluation triad (IRE) approach. In this approach, the 'I' would be characterised as an initiation discursive move mostly in the form of a question that sparks a discussion inviting learner responses (R). The evaluating/feedback (E/F) would be feedback provided by the teacher that aims to weave a discussion based on learners' contributions at the 'R' level. Therefore, the teacher's use of initiations and responding to learner contributions become essential in establishing a specific discourse in science classrooms.

As argued above, to establish a certain discourse in science classrooms, the teacher needs to be mindful of the kinds of discursive moves used (Aranda et al., 2020). In

other words, the use of specific discursive moves determines the kind of discourse established in the classroom. For example, if a teacher only asks questions that require one-word responses from learners and does not probe, an authoritative discourse will likely emerge since authoritative discourse emerges when answers that are in line with scientific knowledge are sought. However, a dialogical discourse is also important to give learners a voice as well as using their prior knowledge to drive the lesson. Assuming that discursive moves are topic-specific, teachers need to be selective of the discursive moves employed to establish a dialogic discourse; one needs to intentionally make use of certain discursive moves that generate discussion during the teaching and learning process (Aranda et al., 2020). Moreover, the use of discursive moves is contextual in the sense that even though teachers are teaching the same topic, the teachers might use discursive moves differently due to the contextual factors inherent in specific schools. Although all the discourses are important, dialogic discourse helps learners to engage with the subject matter, thus exercising and developing their critical reasoning (Alkhouri et al., 2021), as learners think beyond the right and wrong answers. This is more than a necessity in science classrooms for effective teaching and learning (Mwelese et al., 2018). Given the role of dialogic discourse, in this study, I sought to investigate Life Sciences teachers' use of discursive moves to establish a dialogic discourse on the topic of the cell cycle in Grade 10.

1.2 The Topic of the Cell Cycle

Given the assumption that teacher discursive moves are topic-specific (Soysal, 2020), in this study, I investigated the teachers' use of discursive moves when teaching about the cell cycle. The topic of the cell cycle, as stipulated in the National Curriculum and

Assessment Policy Statement (CAPS), is taught in Grade 10 under strand one (Life at molecular, cellular, and tissue level) covered in the first term. This topic deals with how cells of multicellular living organisms, plants, and animals undergo the cell cycle, which is characterised by cell division (mitosis) and cell growth. When teaching the topic of the cell cycle, the focus is on cell growth, which occurs in three phases, namely, G1, S, and G2. Cells prepare for mitosis by replicating DNA material, and during mitosis, existing cells divide, forming two daughter cells that are genetically identical to each other and the parent cell. Some concepts that are taught in cell division (mitosis) include prophase, metaphase, anaphase, and telophase, which form the division of the nucleus, cytokinesis.

According to Manda et al. (2017), mitosis is one of the complex processes taught in Life Sciences, which requires learners to understand it fully rather than memorise the process (Mavuru & Pila, 2021). Both the preparatory stage and the actual cell division are quite challenging for the learners. The difficulty starts from linking knowledge from the cells and the actual mitosis concept, which is quite challenging to visualize. In the current study, my claim was that teachers' use of specific discursive moves to establish a dialogic discourse is of utmost importance to develop an understanding of concepts in the classroom to assist the learners in making sense of and envisioning cell division as it occurs. Previous studies have argued that numerous strategies have been carried out to assist learners in understanding the topic of the cell cycle. These strategies include team teaching or collaborative teaching, animation, quizzes, and game-based learning (Lham & Sriwattanarothai, 2018; Mavuru & Pila, 2021). Some strategies had a positive impact, while others were ineffective (Mnguni & Moyo, 2021). Quizzes and animations are some of the ineffective strategies (Alkhouri et al., 2021)

since they do not enable the learners to engage in a learning process through the sharing of ideas as recommended and contribute to the learning process (MacFadden et al., 2020). However, collaborative teaching and game-based learning challenge the learners to share their thoughts with the teacher and other learners, thus promoting learner participation. Learners' contribution to the learning process is rather important because when learners come to class, they already have their own references and individual experiences that affect their reasoning and understanding of the subject matter and thus should be considered. Therefore, I specifically investigated and analysed how teachers use specific discursive moves to establish a dialogic discourse when teaching this topic.

1.3 Motivation for the Study

In classrooms, regardless of the kind, discourse emerges and is important for the conveyance of the content knowledge to the learners and for the learners to contribute to building and acquiring this content knowledge. Murphy et al. (2020) conducted a study on the structure and content of discourse in South African schools and argued that the learners' ability to think critically is necessary and predicted by the nature of classroom discourse. However, Mwelese et al. (2018) stated that for the learners to make sense of the content knowledge, teachers need to be well-versed in ways to provide the necessary support through discourse. When the learners are motivated to develop and share their ideas and opinions, teachers engage the learners in ways that encourage classroom discussion, and the learners begin to regard classroom discourse as a basic part of the lesson (Mwelese et al., 2018), necessary for the learning to occur. As such, the South African science curriculum (Department of Basic Education [DBE], 2011) in use demands a transformation from traditional teaching

methods (teacher-centred) to teaching methods that encourage more active learner participation and learner engagement (learner-centred) (Gudyanga & Jita, 2019; Ramnarain & Rudzirai, 2020), which include discussion. Likewise, the National Curriculum Statement, R-12 Framework for science education implemented from 2012-2014, refers to classroom discussion and discourse as a requirement used to provide instruction in science classrooms. With such demands, teachers are expected to implement strategies that will promote learner engagement as per the demands of the new science curriculum (DBE, 2011), which calls for dialogic discourse.

In most South African schools, studies reveal that teachers still rely heavily on traditional teaching methods, which are teacher-centred practices (see Ramnarain & Rudzirai, 2020; Taole, 2020). They do this to deliver content knowledge, which, according to the discursive norms, leans strongly on authoritative discourse, although the developments in the new science curriculum state otherwise. According to Taole (2020), the use of this teaching method is influenced by the contextual issues such as overcrowding in most South African classrooms. Additionally, in essence, the selection of discursive moves vary, what one teacher uses is different from what another teacher would use based on the several factors that the study aims to reveal. However, such teaching practices deprive the learners of the opportunity to externalise their thoughts by sharing ideas and their understanding of content knowledge, as it limits the interaction (Meeran & Van Wyk, 2022), which is more than a necessity in teaching and learning science (Mavuru & Ramnarain, 2019), especially in topics like cell cycle. Such issues then compel teachers to use discursive moves in various ways to overcome the effect of the contextual factors. Additionally, some of the driving forces involve the demands of the South African curriculum, which require a high degree of

understanding of the content (Taole, 2020) and the skills to use the necessary and required discourse to yield better results in the teaching of science (Ramnarain & Rudzirai, 2020), which is still a challenge to some science teachers.

Research on discourse in science classrooms has become more intense over the past years in South Africa. However, many of these studies have focused mostly on how discourse is affected by the scientific language (Mavuru & Ramnarain, 2019), language barriers, historical political effects (Chetty, 2019) and the teaching and learning setup. Although these studies have been able to show the importance of discourse and discursive moves employed by science teachers, the discourse types and specific discursive moves that bring about active learner participation and engagement studies, as per the curriculum requirements, are still minimal. As a result, several teachers encounter challenges in engaging learners in dialogic discourses (Gillies, 2020) since they lack knowledge of the working discursive moves and how to implement them. Therefore, my focus was on the use of discursive moves that establish dialogic discourse in the Life Sciences classroom.

1.4 The Research Aims and Objectives

Given the issues outlined above, this study aimed to explore how Life Sciences teachers use discursive moves to establish a dialogic discourse when teaching about the cell cycle. This aim was then broken into three objectives:

- ➢ To identify the nature of discursive moves used by Life Sciences teachers when teaching about the cell cycle

- ➢ To describe ways in which discursive moves contributed to the establishment of a dialogic discourse in a Life Sciences classroom when teaching about the cell cycle
- ➢ To discuss and describe what influences the kind of moves that the teacher uses when teaching about the cell cycle

1.5 Research Questions

The following main research question guided the study:

How do the Life Sciences teachers use discursive moves to establish a dialogic discourse when teaching about the cell cycle in Grade 10?

The above main research question was addressed by the following sub-questions:

1) What is the nature of discursive moves used by Life Sciences teachers when teaching about the cell cycle?
2) In what ways do the moves contribute to the establishment of a dialogic discourse in the Life Sciences classroom?
3) What influences the kind of moves that Life Sciences teachers use?

In the first research question, nature refers to the types or categories of discursive moves during the lesson to drive or channel the learners toward a dialogic discourse. The second sub-question is about understanding how the discursive moves were used. I mapped the sequence of the use of these discursive moves in dialogic discourse episodes so that I could make an argument on how dialogic discourse can be established through a specific sequence of moves. The third sub-question focuses on what influenced teachers to use specific moves. The term *influence* in the current

study speaks of where the employed discursive moves stemmed from. e.g. from the learners being confused or not fully understanding the question, teachers emphasising a specific point, or channelling the learners towards one particular scientific idea and teachers trying to challenge the learner to draw from their existing knowledge to build on it.

1.6 Research Design and Methodology

The methodology of the current study was guided by qualitative research and a case study. Qualitative research is concerned with obtaining an analysis of non-numeric data, and a case study design was employed in the research (Çakar & Şehmus, 2020). A case study is a strategy used to study a phenomenon within its context. Using the methodology mentioned above, I selected my data samples, and I was able to extract rich data that allowed me to understand the relationship between talk moves employed by teachers, their influences as well as their contribution to the development of dialogic discourse in science classrooms. As such, multiple cases were selected as the means to establish any relationships or similarities in the data obtained from all participating teachers. Data was collected through observations and video-stimulated recall interviews, which were transcribed verbatim and analysed deductively and inductively. The research adhered to quality criteria. Finally, observing decent, ethical values when conducting research is primary. Thus, ethical clearance was obtained prior to conducting the current research. These measures included applications for permission from both the University of Pretoria and the Mpumalanga Department of Education, submission of consent and assent letters to the selected schools and ensuring the use of pseudonyms in the write-up. The results of the study were then communicated to

the schools upon request and made available at the University of Pretoria in the form of a dissertation.

1.7 Summary of theoretical and conceptual perspectives

Generally, research that looks at interactions in science classrooms is grounded within the socio-cultural perspectives of learning. The theoretical framework that guided this study is Vygotsky's (1978) socio-cultural theory. This theory posits that learning is a socio-cultural process. This means learning is socially mediated through provision of tools by the teacher. In this study, the main tool is teacher discursive moves that prompt learners to co-construct knowledge. I also used a conceptual framework drawing from constructs like teacher discursive moves to ground the study. My assumption was that through the use of specific discursive moves, science teachers are able to establish a particular discourse – either authoritative or dialogic. My interest was on the establishment of a dialogic discourse. Therefore, the construct of discourses as conceptualised by Mortimer and Scott (2003) becae part of my conceptual framework. The framework is unpacked in Chapter Two.

1.8 Outline of Dissertation

In this introductory chapter, I linked the communicative approach and the concept of dialogic discourse. I then articulated the motivation for the study and the knowledge gap I have identified by debating international and local South African issues on the dialogic discourse and the curriculum. I then gave a brief description of unpacking the research questions of my study to be able to answer them. Finally, I provide a brief overview of all the chapters in the current study.

In Chapter 2, I will outline the literature review and provide a detailed description of the conceptual framework that guided my study, as well as a description of teacher talk, dialogic discourse, and communicative approach. The conceptual framework is well discussed, unpacking all its features. I also consider arguments from international research on the same concepts merging with arguments on the South African context for a better understanding of the research findings. Lastly, I discuss Vygotsky's socio-cultural theory in great detail as a theory that governs the study.

In Chapter 3, I describe the methodology that guided my study in detail, starting with the paradigm used for a better exploration and in-depth analysis of teacher discursive moves. Thereafter, I elaborate on the entire methodology that underpins the way my complete research is ingrained. Using methodological implications, I then convey how the teacher's discursive moves became my focus. Explaining the cases in the current study, I highlight how I decided on the specific cases, and how I worked with each of them in their context. Finally, the aspects of my data collection and analysis are explained in greater detail.

Chapter 4 presents how I analysed my data and how it helped me answer my research questions. I also provide different tools I used and explain how I used them to obtain segments of interest that show dialogic discourse for observation transcripts as characterised in the communicative approach as identified from the lessons. In this chapter, I also provide the interpretation of my results in terms of the nature of discursive moves employed by the Life Sciences teachers, as well as their influences and contributions to the establishment of dialogic discourse.

In Chapter 5, I provide a summary of the findings, including discussions of my study where I draw conclusions and make future recommendations. The limitations of the current study will also be outlined in this section, and recommendations for future studies will be made. The research questions are revisited and merged with the conceptual framework to set the guidelines for developments in establishing dialogic in science classrooms.

1.9 Chapter Summary

In Chapter 1, I gave an outline of the problem and the knowledge gap I have identified guided by the arguments in both international and South African contexts, as well as how I aimed to address this problem in the current study. I then briefly described the communicative approach and its role in dialogic classrooms or in interactive patterns. This description was merged with what the curriculum says about dialogic discourse. Lastly, I presented an overview of all that is discussed in all the chapters. The next chapter (Chapter 2) discusses the relevant literature in this study and the theoretical underpinnings of the study.

CHAPTER 2: LITERATURE REVIEW, THEORETICAL PERSPECTIVE AND CONCEPTUAL FRAMEWORK

2.1 Introduction

This chapter focuses on discussing the existing literature reviewed on discursive moves. My study focused on demonstrating a link between the nature of discursive moves used and the effect of these discursive moves on dialogic discourse when Life Sciences teachers teach about the cell cycle. As such, the literature reviewed aligns with specific patterns of discursive moves, specifically dialogic discourse, which can be more or less frequently used by Life Sciences teachers in science classrooms. This review is done by unpacking and closely looking at the contrast between authoritative discourse and dialogic discourse. The description will, therefore, outline and recognise the necessity of using specific discursive moves to engage learners in dialogic discourse to facilitate the teaching and learning process in science classrooms. The interactive pattern and communication are also described to create links and provide an understanding of how dialogic discourse is established. Thereafter, the conceptual framework that guided this study is discussed to demonstrate how I see the use of discursive moves and dialogic discourse fit together within the socio-cultural theory. I, therefore, also present the socio-cultural perspective as a theoretical underpinning theory of this study.

2.2 Teacher Talk

As previously indicated, teacher talk is a vital tool in science classrooms as it helps the teacher create a platform for learners to engage in an interactive discussion (Aranda et al., 2020), thus contributing to the learning process. Tang (2016) conducted a study on classroom discourse in Australia, Singapore and the United States, arguing

that talk is a primary mechanism through which teaching and learning of the subject matter occurs. In science classrooms, learners are mostly taught about science talk properly (Soysal & Soysal, 2024). However, learners also need to develop a scientific inquiry (Aranda et al., 2020; Rees & Roth, 2019). Teacher talk is one of the tools that can be utilised to help learners develop scientific inquiry (Aflalo & Raviv, 2022). Teacher talk provides learners with different ways to engage in academic conversations and discussions (Aranda et al., 2020), where they get to agree, disagree, add on, and transition the conversation. Therefore, teacher talk is the key to what is happening in the classroom.

Soysal (2019) conducted a study in Turkey, focusing on the effectiveness of teacher talk as a tool to facilitate the learning of science concepts. In his study, it has been argued that teacher talk can be used to present learners in a science classroom with an opportunity to interact and exchange scientific knowledge verbally. This finding was supported by a mathematics education study by Mwelese et al. (2018), who argued that the uniqueness of the teacher talk is determined by the interaction between the teacher and learners in a certain class where the teacher is facilitating, i.e. the responses provided by the learners and the kind of moves the teacher chooses to use, based on that particular lesson. The two studies – Soysal and Tuzun (2019) and Mwelese et al. (2018) – established that when learners are not as proactive and cooperative as in other classes, the teacher tends to ask more simple questions that require recalling factual knowledge to engage the learners. Another study conducted in Physical Sciences lessons by Aflalo and Raviv (2022) revealed that the responses provided by the learners might require the teacher to clarify the question, which will bring about a better understanding for the learners. When this is done the result is the

deepening of the conversation through responses by adding a few facts to it, challenging it, or disagreeing with it. In the study conducted by Soysal and Tuzun (2019), he argued that teacher-talk incorporates the pedagogical, instructional, and actions of a teacher; thus, one may say this is an indication that teacher-talk may be used as a teaching tool to aid in cooperative learning. Thus, when talk is used strategically in science classrooms, it can help teachers engage the learners in scientific thinking and inquiry-based learning to construct and build their content knowledge.

In the South African context, although minimal, previous studies done on teacher talk continue to show that teacher talk prevails as it possesses power and predominance as a teaching tool. For example, Mupfawa et al. (2021) conducted a study in three public schools in South Africa based on the analysis of discourse. The focus of this study was on analysing teacher talk to determine teachers' discourse when teaching genetic concepts. Their findings revealed that the use of language in science classrooms is a key factor, as are the challenges of proficiency associated with it. Moreover, findings in this study suggest that teachers focused on training the learners for the examination, indicating memorising. Murphy et al. (2020) discouraged this on the basis that it inhibits the learners' ability to be critical thinkers as science requires. It was further argued that teacher talk should be characterised by other instructional strategies that encourage learner involvement (Mupfawa et al., 2021). These other instructional strategies involve the use of representations for learners to visualise concepts (Khoza & Makgata, 2024). Through talk, involvement would grant the opportunity for the learners to speak scientific terms and gain meaning and comprehension (Buma & Nyamupangedengu, 2020).

Mudau and Netshivhumbe (2022) conducted a study in the Limpopo Province. This study revealed that Natural Sciences teachers still relied on authoritative discourse, which they argued limits learner-to-learner interaction and, thus, interaction with the subject content. Their study further alluded that teaching is highly influenced by the teacher's knowledge and thus, teaching strategies, which will, therefore, lead to the type of interaction and discourse employed. For example, if a teacher does not understand the role of talk as a pedagogical approach, then they are likely to resort to authoritative ways of teaching science. Nonetheless, teacher talk and limited interaction are still very common and primary in science classrooms. Teachers talking for an extended period and making use of complex scientific terms that learners cannot comprehend is among the primary reasons learners still view science as a foreign and difficult subject. As this hinders learner participation, it also shows the need for employing dialogic discourse in science classrooms.

Finally, a recent study conducted by Steinke (2023) also emphasises the use of spoken language in classroom discussions to promote effective scientific skills. In the study, it was argued that as the teachers engage the learners in classroom discussions, plenty of other challenges can be overcome. These challenges include misconceptions, confronting controversial issues through questions asked and lack of understanding (Relela & Mavuru, 2023), to mention a few. As the learners will be engaging with scientific terminologies, since science is a language of its own, their vocabulary is expanded (Khoza, 2024). However, teachers need to turn these challenges into opportunities to diversify and implement their pedagogical scientific language knowledge and delivery strategies (Khoza & Magadlela, 2025). For example,

an explicit appearance of a misconception during whole-class discussion signals an opportunity to drive learners into the correct scientific ideas through talk. Steinke (2023) further argued that the challenges mentioned above can be addressed through productive classroom discussion, where learners and teachers make use of the learnt vocabulary in relevant and specific context (new ref). Such interactions set out clear roles for learners' and teachers' engagement as well as their goals for engaging. In so doing, one can ensure that meaningful learning takes place, as the learners will also feel responsible for their learning process. Moreover, these productive classroom discussions revealed that learners took more turns to talk than teachers and asked more questions. In previous studies, this meant strong learner comprehension and critical thinking skills (Murphy et al., 2020).

Over the years, South African science education curricula have been reformed to improve the quality of content delivery and ensure that it prepares learners for the near future. However, research findings on teacher talk reveal that teachers lean on mostly teacher-centred (Murphy et al., 2020), interactive, and non-interactive authoritative discourse (Essien, 2021). According to Dube et al. (2020), this is influenced by several challenges encountered by teachers in science classrooms. These challenges involve the prescribed teaching time, which is not enough, overcrowding of classrooms, making them difficult to manage, and cultural and language barriers where learners struggle with science language and are thus challenged to express themselves and engage with the subject matter, to mention a few. Some of these challenges can be addressed and overcome with the proper development of skills and a variety of strategies teachers can use to support learners (Gudyanga & Jita, 2019).

Teacher talk is used across disciplines to help the learners navigate individual and specific content areas (Aranda et al., 2020), specifically in STEM education since the current focus is Life Sciences. As classroom discussions are initiated through talk, learners are therefore offered an opportunity to build their knowledge in different disciplines and make sense of the natural world. Chetty (2019) conducted his study based on literacy teaching in disadvantaged schools and revealed that learner engagement is the core of the learning process instead of the traditional teaching approach. Buma and Nyamupangedengu's (2020) study based on teacher education argued the significance of teacher talk as it enhances learner participation. They further argued that there is, however, minimal research on the nature of teacher talk practices that trigger heightened learner participation. Supporting this, in Shongwe's (2020) study on investigating patterns of mathematics talk in rural S.A. schools, he established that although talk is a useful tool, it is rather utilised to lecture and drill the learners, and this is an example of traditional teaching since the classroom is dominated by teacher talk. As a result, misconceptions are not addressed, and prior knowledge is not checked. Therefore, the traditional teaching method is not warranted since it deprives learners of the necessary skills they require to survive (Geyser et al., 2020). Nevertheless, teacher talk remains a principal medium in teaching and learning.

Lehesvuori et al.'s (2018) study on enhancing learner-centredness through dialogue was conducted and revealed that a learner-centred approach to teaching encourages active learner engagement thus, shifting from a traditional teaching approach (Gudyanga & Jita, 2019; Ramnarain & Rudzirai, 2020), that is entirely dominated by teacher talk. They further argued that teachers are orchestrators of classroom interaction, which is more than a necessity in science teaching and learning. Amongst

other reasons, this stems from science being a language that is not easy to comprehend when the learners are not encouraged to externalise their scientific ideas and knowledge through talk. Moreover, as necessary as it is to enhance learner participation, for the establishment of such results (learner active engagement and participation), one needs to plan the objectives properly before going to class and be guided by the plan throughout the lesson. If the aim is to engage learners actively in the teaching and learning process, the teacher talk becomes instrumental. As such, teacher talk and discursive moves in science can never be over-emphasised.

Based on the descriptions above on teacher talk, I gather in the current study that teacher talk is a purposely selected tool used by the teachers when conducting the lesson to facilitate and mediate the learning process. The selection varies as it is guided by proper planning and the goal the teacher aims to achieve at the end of the lesson. In essence, this cover giving instruction (Katili, 2020; Yildirim & Uzun, 2021), posing questions, providing feedback (Kang & Zinger, 2019; Mwelese et al., 2018), and following up on the learners' understanding, thus heightened interaction emerges (Khoza & Msimanga, 2022).

2.3 Interactive Patterns and Challenges

A lot of studies have been conducted on different interactive patterns that are driven by teacher talk and discursive moves following the basic level of classroom interactive patterns according to the Initiation-Response-Evaluation (IRF) model of Mehan (1979). This model involves teachers initiating a discussion by posing a question to invite learners to think in the classroom discussion; the learner responds, and the teacher provides feedback (Lehesvuori et al., 2018) to probe learners for more

responses (Rees & Roth, 2019). According to Worku and Alemu (2021), most classrooms exhibit a basic interactive pattern IRE/F (Initiation-Response-Evaluation/Feedback) for verbal exchange purposes. Research done reveals the use of interactive pattern IRF marks communication in classrooms and is thus regarded as a pattern that restricts dialogic interaction. According to Ahmad et al. (2020), the IRE/F pattern puts control on the teacher while it disempowers the learners. The study they conducted revealed that turn-taking that is displayed in the interaction was highly dominated by the teacher. These findings were supported by Yildirim and Uzun's (2021) study, as they argued that the IRE/F teaching pattern lessens learner talk and thus hinders critical thinking.

According to Mortimer and Scott (2003), the teachers use feedback to open chains of dialogic interaction; this is established by creating a sequential teacher-learner turn-taking use of the moves I-R-F-R-F or I-R-P-R-P-R-P. In this interaction, the learners' response is followed by a prompt (P) from the teacher. The prompt can be a follow-up question or even invite other learners to comment on the contribution. Bansal (2018) argued that frequent use of the F/P move in IRE/F/P perpetuates prolonged interactions since it encourages learner active participation and engagement. Active learner participation and engagement are characterised by the co-construction of knowledge (Kiramba & Harris, 2019), asking and responding to questions, and engaging in classroom discussions by sharing ideas (Yildirim & Uzun, 2021). However, it is not easy to achieve, although it is desired for meaningful learning (Mwelese et al., 2018). This is noticeable in the studies conducted in South Africa, although there have been initiatives set up to help teachers meet the curriculum needs to actively engage the learners in science classrooms (Dube et al., 2020).

Recent studies still reveal that there are challenges in achieving this goal. Teachers are still struggling with the skills of orchestrating classroom interactions through talk (Gudyanga & Jita, 2019) and discourse moves that will positively guide the lesson to dialogic interaction (Murphy et al., 2020). In the study conducted by Chetty (2019), cultural diversity also contributes to how the interaction unfolds in the classroom; thus, different patterns of interaction emerge in South African classrooms. These issues result in learners as well as teachers having different views of certain concepts and learners struggling to articulate their responses. Therefore, making authentic links to the curriculum in that setting puts a strain on the teachers. Considering the above-mentioned challenges, it is also evident that some teachers are still trying to understand what is expected of them (Chetty, 2019) and proper implementations that will prove positive with the curriculum reforms (Gudyanga & Jita, 2019). As a result, some teachers are struggling to move from a teacher-centred to a learner-centred approach, while others still employ both depending on the topic taught. Therefore, the strategies that are expected to be implemented in most South African schools appear inapplicable. Additionally, this is what drives the teachers to use teacher talk as the means to lecture (Mwelese et al., 2018) (teacher-centred approach) instead of engaging the learners in a discussion that allows them to share their thoughts.

Another contributing factor that compels teachers to utilise teacher-centred authoritative methods of teaching is the overcrowding of classrooms (Chetty, 2019; Taole, 2020). In the study conducted by Bessong and Ogina (2022) in Limpopo, they argued that unique strategies that focus on different learner needs are difficult to implement when the classes are overcrowded. The teacher needs to focus on other

aspects, such as managing the classroom in terms of even distribution of learning material and examination-oriented curriculum, among a few. Omodan and Mamaile (2024) also argued that teachers find it challenging to create a supportive learning environment that will engage the learners due to overcrowded classrooms. As such, teachers concentrate on content coverage rather than engaging learners with the subject matter. Therefore, the IRE interactive pattern is likely to emerge, where teachers evaluate the learners' responses and just carry on with teaching or move on to the next question. This type of interaction is said to limit dialogue in science classrooms (Essien, 2021). However, the use of feedback in IRF has proved to inspire dialogic interaction.

Naturally, discourse approaches lead to different outcomes in science classrooms. For example, authoritative discourse is used to transmit the authoritative science content, whereas dialogic discourse is used to engage learners regardless of the nature of their responses to questions. In the current study, the key focus was on the establishment of a dialogic discourse in science classrooms using different discursive moves, i.e., teacher talk. The reason for that was to support various aspects that guide the teaching and learning process, e.g., giving instructions, asking questions, and providing feedback centred around teacher talk (Rodriguez & Arellano,2018). Moreover, dialogic discourse aligns with science teachers 'essential nature and ability to guide learners in the learning process (Sandoval et al., 2021; Weninger, 2020). Through this guidance, learners are able to contribute to the teaching and learning process as opposed to being passive receivers of the science content.

2.4 Discursive Moves as Components of Teacher Talk and Drivers of Interaction Patterns

Discursive moves are any form of verbal or non-verbal externalisation where the teacher aims to engage with the learners in a social context using verbal communication (Bansal, 2018; Soysal & Tuzun, 2019). To characterise teacher talk, specific tools that drive interaction patterns must be used. Recent literature like that of Nennig et al. (2023) categorises discursive moves drawn from the initiation, response and feedback pattern that was first coined by Mehan (1979). Following this pattern, the teacher must ask a question to provide a platform for sharing ideas, in which the learners will engage by responding to the question, taking turns, and the teacher provides feedback.

2.4.1 Initiation Moves: Teacher Questioning

Initiation moves that are usually made at the beginning of the interaction episode are aimed at inviting learners into a discussion (Aranda et al., 2020; Buma & Nyamupangedengu, 2020). I describe how I defined an episode in the analysis section in Chapter 4. The teachers' initiation moves determine and influence the direction in which the discourse flows based on the types of questions asked and prompts provided through feedback (Aranda et al., 2020; Lehesvuori et al., 2018). For this reason, teacher questioning is regarded more than just a necessity in science classrooms; it is, instead, a requisite component of the classroom discourse (Ernst-Slavitt & Pratt 2017), thus allowing learners to contribute largely to the learning process (Kiramba & Harris, 2019). The types of questions chosen by teachers to use during the lesson influence the learners' cognitive development (Shongwe, 2020); hence, there is a need for mindfulness in choosing the right questions to use in class (Aranda et al., 2020). For instance, to initiate the discussion and ask what interphase

is, the learner responds, and the feedback provided by the teacher was, how can you tell if the cell is on interphase? The second question posed by the teacher as a means to provide feedback to the learners is an extended question, which encourages broader thinking from the learners, thus channelling their thoughts toward a specific idea (Boyd et al., 2019).

A study conducted by Buma and Nyamupengedengu (2020) indicates that teacher questioning has a huge contribution to shaping and promoting a dialogic interaction in science classrooms. They further argued that open-ended questions are types of questions that stimulate sharing of ideas, thus promoting dialogue-building in science classrooms. Their findings validate that open-ended questions are those that require deep thought processing and enable learners to engage in classroom dialogue by providing worldly responses. This is in support of the idea that when open-ended questions were posed, learners provided lengthy explanations and meaningful contributions to the lesson. Open-ended questions serve to prompt a conversation since they cannot be answered in one word (Khoza & Makgata, 2024). Furthermore, in a study conducted by Sandoval et al. (2021), the findings revealed that learners' responses to open-ended questions mostly show the teachers how the learners think, and thus, their cognitive level and growth get challenged (Soysal, 2019). Moreover, open-ended questions not only help facilitate interaction but also help learners improve their speech as they are challenged to construct longer sentences and air them. Active engagement in science classrooms is key to understanding what is being taught to the learners because this is when learners externalise their thoughts, confusion, and additions to understand the subject matter better.

Contrary to the above explanation, contemporary studies have revealed that questions that can be characterised by question-answer and true or false are regarded as closed-ended questions (Buma & Nyamupangedengu, 2020; Khoza & Msimanga, 2022; Sherry et al., 2019) since they limit learners' responses in classroom interaction. This type of questioning does not challenge the learners to think and voice out their concerns and confusions or even have suggestions on someone else's answer. The closed-ended question offers limited growth and collaboration (Ramadhani & Zainil, 2019) and does not seek to improve the learners' thought processes. The reason is that the answers provided by learners are factual and restricted, thus limiting classroom interaction. Due to these findings, one may say closed-ended questions limit the cognitive development of learners in science classrooms as it deprives them of active learning, interaction, and higher-order thinking. Nonetheless, closed-ended questions are still a necessity since they can start up a discussion, provided the teacher is flexible enough to make use of both types of questioning.

Teacher questioning in science classrooms helps guide the learning process when used to promote interaction through open conversations that are thought-provoking to the learners (Dohrn & Dohn, 2018). Questioning is the core of teaching as it is the central skill required from the teachers to elicit good responses and make the teaching effective. Teachers use different questions to obtain different results in the classroom, during the process of teaching and learning, and afterwards. The results desired may be to follow up and trace the learners 'understanding through participation, work out where to emphasise or repeat what has already been taught, check content knowledge, and assess. The learners also get the opportunity to merge newly acquired knowledge with existing knowledge and share their ideas in the classroom. Teachers

need to be trained on what types of questions to use and when to use them to ensure the effectiveness of teacher questioning and obtain the desired results.

According to Benedict-Chambers et al. (2017), understanding scientific content requires the practice of teacher questioning, which challenges learners' cognitive reasoning in developing conceptual understanding and curiosity. Despite the significance of teacher questioning, its effectiveness is aided by proper planning aligned with certain objectives that the teacher aims to achieve at the end of the lesson. Nonetheless, in a study conducted by Morris and Chi (2020) based on improving teacher questioning, they argued for the importance of promoting inquiry-based learning through questioning. This can be established through the use of constructive teacher questioning to promote discourse in science classrooms. Several studies have been conducted on teacher questioning; to review a few, Al-Zahrani and Al-Bargi (2017) used two types of questions to explain classroom discourse: display questions and referential questions. According to Ramadhani and Zainil (2019), display questions only require short answers from the learners, and such questions seek the learners 'knowledge. Alternatively, referential questions require more thought processing to generate lengthy responses from the learners. This type of questioning helps the teachers understand the learners' reasoning and opinions based on the topic being taught, e.g., what do you understand about the DNA replication process as it occurs in human beings? This is opposed to a display question, which is merely checking the learners' knowledge of the content but not necessarily understanding the content, e.g., asking where DNA replication occurs.

Research done by Morris and Chi (2020) on teacher questioning argued that poorly constructed and posed questions can negatively impact the learners and the knowledge-building process. Firstly, learners can take longer to respond while trying to make sense of the question; secondly, preventing learners from providing relevant answers, which implies that the questioning will not be able to play its intended role; and lastly, some learners will not respond to ambiguous questions, thus limiting the classroom conversation (Ahmad et al., 2020; Morris & Chi, 2020). Correspondingly, Aranda et al. (2020) stated that the types of questions the teacher selects during the lesson determine the kind of discourse established in a science classroom. Chen et al. (2017) categorised questions as closed-ended and open-ended questions. In their study, closed-ended questions are described as questions that have one correct answer, while open-ended questions have multiple answers. Open-ended questions increase the learners' thought processing since they require an understanding of content knowledge and application skills through the use of scientific language and externalising the ideas. This further generates classroom discussion as the teacher provides feedback, thus guiding the learning process to achieve certain objectives.

Benedict-Chambers et al. (2017) used four categories to explain teacher questioning: explanation questions, explication questions, science concepts questions, and scientific practice questions. Explication questions allow learners to elucidate using evidence about "what" happened in the investigation. When explanation questions are asked of the learners, they help them explain scientific facts using "how" and "why" questions. Learners respond to "how" and "why" questions, allowing them to share more in-depth descriptions of their understanding. Science concept questions provide a guide and training to the learners on how to use scientific language when responding

to questions in science classrooms instead of general language use. These types of questions help the learners think and communicate scientifically, thus developing the use of scientific language through sentence construction. Scientific practice questions support the learners' development of skills and knowledge during hands-on activities and other scientific practices.

The previously mentioned types of questions show a great deal of effectiveness in science classrooms and are thus necessary. Nonetheless, in the current study, I focused on how the interactions are initiated through questioning, categorised as open-ended questions and closed-ended questions. I explain closed-ended and open-ended questions using Chen et al.'s (2017) explanation. The teachers' planning of the right questions to use during the teaching and learning process, as well as afterwards, serves as a pedagogical function (Morris & Chi, 2020). The primary goal of teaching the learners is not to present the information to them; instead, teachers seek to help the learners gain confidence in what they already know by being able to explore, organise, extend, and integrate their knowledge. Therefore, teacher questioning is the most crucial component in helping teachers identify if the learners can construct their knowledge and bridge the knowledge gaps. According to Ramadhani and Zainil (2019), display questions were classified as closed-ended and referential questions as open-ended. This distinction is due to the findings that both display questions and closed-ended questions limit the learners' opportunities for responses, reasoning, and high thought processing. Nonetheless, such questions are still necessary for science classrooms as teachers can use them to induce discussion.

Previous studies on teacher questioning affirm that closed-ended questions can be advantageous in science classrooms because they can create a starting point, establishing whether the learner has knowledge of the content or not. Follow-up questions can then be open-ended, where the learners respond to the “why” and “how” to substantiate or provide a reason for their answers. The follow-up questions, which are open-ended questions, give learners an opportunity to revisit and reinvestigate the problem at hand and use high thought-processing skills to generate and construct their responses, thus improving the amount and quality of the classroom discourse in science classrooms.

As previously described, initiations are used to invite the learners into a discussion, and they vary in form. Many scholars who have researched the IRE/F patterns as they occur in science classrooms have exemplified and emphasised initiations used in the form of questions. This is the most common and evident initiation move employed in science classrooms. However, according to Nennig et al. (2023), initiations can occur through non-verbal and verbal cues such as posture, gesture, voice intonation and facial expressions. Khoza and Makgata (2024) found that instruction can also be used as an initiation move that guides the learners on what they need to be doing. The learners respond in a classroom setup to the above-mentioned forms of cues for a discourse to occur; therefore, they function as initiation moves. According to Feyzioglu and Güleç (2024), giving instructions that encourage discussions based on clarifying ideas with alternative perspectives enhances strong arguments and collaboration. Nevertheless, my current study focused on verbal utterances as initiations.

2.4.2 Feedback: Rejoinder Moves

Rejoinder moves have been previously defined as moves used by teachers to combine certain elements of talk in the classroom (Cian & Cook, 2018). Other scholars define rejoinder moves as a quick response that is used to shape the learners' understanding and answers. Correnti et al. (2015) referred to rejoinders as captured responses to the learners during the classroom discussion. These moves are used for different purposes, namely, eliciting and acknowledging, clarifying and extending the ideas (Khoza & Msimanga, 2022). By using these rejoinder moves, the teachers can provide feedback on the learners' explanations and questions (Aranda et al., 2020). The rejoinder moves that a teacher chooses to use aligns with the teacher's goal they want to achieve, thus channelling the learners toward that direction. Therefore, to characterise discursive moves, I drew from Correnti et al.'s (2015) framework for Analysing Teacher Moves (ATM).

Eliciting and acknowledging rejoinders involve eliciting further responses or restating a question, marking, acknowledging, affirming, and evaluating negatively. Teachers use this set of rejoinders category to shape the learners' responses through elicitation and acknowledge their contributions by agreeing. In the study conducted by Aflalo and Raviv (2022), eliciting and acknowledging rejoinders provide low-level feedback, e.g. affirming the learner's response by repeating the learner's utterance. They further argued that an interaction where the teacher focuses on eliciting correct answers is most likely to be more teacher-based, as the depth of learner understanding is disregarded. Similarly, Mangwiro and Machaba (2022) argued that in a mathematics classroom, learners show a lack of mathematical thinking when eliciting questions are used. In contrast to this, Khoza and Msimanga (2022) revealed that acknowledging rejoinders has the potential to intensify the classroom interaction, provided that the

learners also engage in the classroom discussion and the teacher responds by asking another question. Asking another question serve the purpose of eliciting learners' thinking (Aflalo & Raviv, 2022). This can also serve as an opportunity for teachers to see if learners have misconceptions on a certain topic or not. Thus, a way of evaluating learners' knowledge and skills.

Clarifying rejoinder moves are aimed at rephrasing the learners' responses. With clarifying rejoinder moves, the learners' responses are refined and aligned with scientific language (Khoza, 2023; Khoza & Msimanga, 2022). These rejoinders include requesting confirmation, requesting clarification, reframing questions, and revoicing. For example, in requesting clarification and revoicing, the teacher might have seen that learners struggle to put some scientific ideas using the science language or terminology. This would then serve the purpose of shaping learners' responses to questions to better their understanding of scientific concepts. Employing these types of rejoinders ensures the probing of the learners' understanding for further clarity to be achieved, as they range from simple confirmation to complex summarising of key points (Aranda et al., 2020). Buma and Nyamupangedengu (2020) argued that as learners are expected and asked to substantiate their answers, this could award better opportunities for learning. As such, one may say that clarifying rejoinder moves ensure a developed understanding of content knowledge and the subject matter. Furthermore, Buma and Nyamupangedengu established that the teachers occasionally use questions in response to the learners' utterances to discover if learners understand what they say. Similarly, Aranda et al. (2020) argued on teachers' use of learner responses to formulate more questions to escalate the discussion and deepen the understanding.

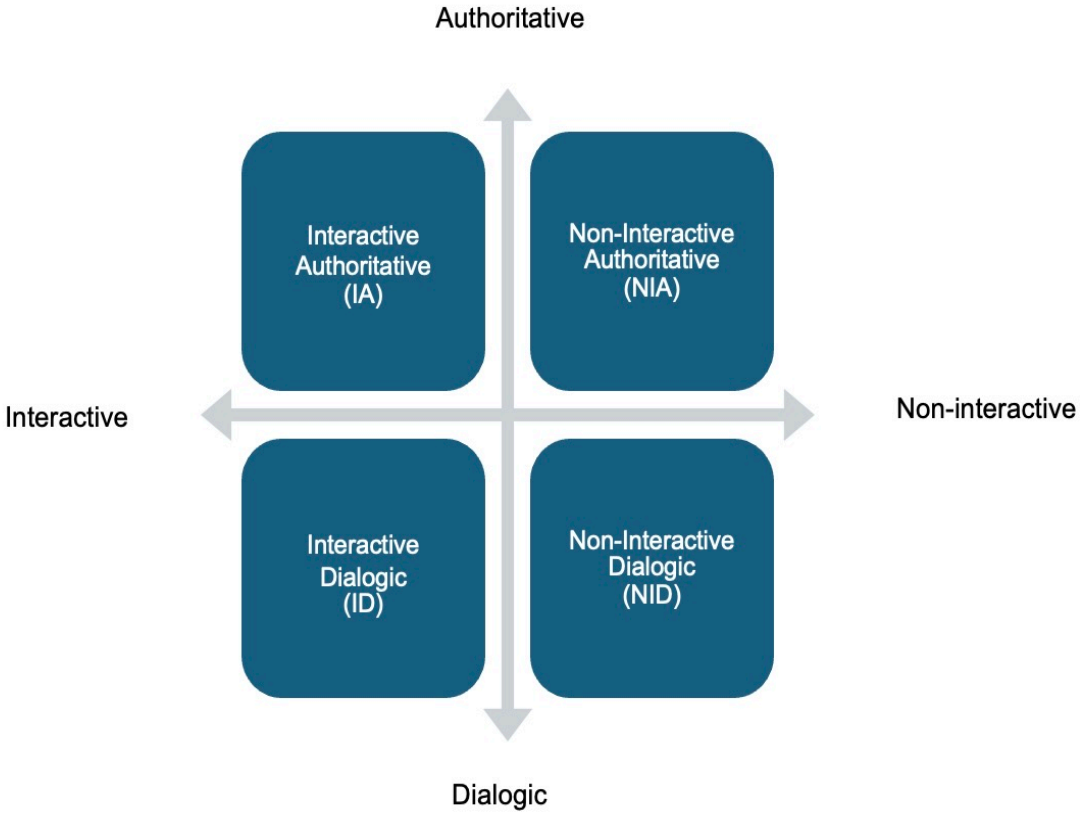
Extending rejoinders are aimed at challenging the learners' responses directly (Khoza & Msimanga, 2022) to help the learners ascent from recalling information and making use of their ideas. Extending rejoinder moves involves requesting elaboration, asking an extended question, canvassing opinion, challenging to extend ideas, and elaborating. According to Tytler and Aranda (2015), extending rejoinders challenges learners' cognitive reasoning to rethink their ideas and consequently deepen their understanding. According to Dorimana et al. (2022), reasoning is a skill that is necessary in a science class for the learners to engage learners in a discussion and thus take part in problem-solving. Furthermore, research has shown that engaging learners in reasoning expands their thinking, communication and listening skills (Nennig et al., 2023), which certifies learners' accountability and responsibility in the learning process as per the new curriculum reforms. Therefore, teachers must impart this skill by employing extending rejoinders. According to Mangwiro and Machaba (2022), this can be established by asking extended questions or requesting elaboration with a question. Similarly, Soysal (2020) argued that posing additional questions to the learners' responses can promote high-level reasoning (Mork et al., 2021). In my study, I employed Tytler and Aranda's (2015) framework to categorise teachers' discursive rejoinder moves to determine how dialogic discourse is established when teaching about the cell cycle. Specific use of sequence discursive moves can result in a certain discourse.

2.5 Science Classroom Discourse

Scholars who look at patterns of interactions in science classrooms define discourse as a cooperative construction of knowledge where teachers encourage learners to

share their thoughts, thus promoting meaningful interaction (Navaz, 2020; Setiawan et al., 2021). This definition highlights the significant role teachers play in teaching and learning in science classroom discourse. In the current study, I define discourse in terms of the communicative approach from Mortimer and Scott's (2003) framework.

Figure 2.1: *A Diagrammatical Representation of Mortimer and Scott's 2003 Framework*



Source: Mortimer and Scott (2003 p105)

In their framework, there are two main discourse dimensions that one can observe in a science classroom: interactive/non-interactive and dialogic/authoritative. The two main dimensions led to four categories: Interactive Authoritative (IA), Non-Interactive Authoritative (NIA), Interactive Dialogue (ID)& Non-Interactive Dialogue (NID) (see Figure 2.1). Non-interactive authoritative is characterised by no social exchanges between teacher and learner on a single scientific view. The teacher is, therefore, seen

as the main source of the science knowledge. In interactive authoritative discourse, verbal exchanges between the teacher and learners are exhibited. However, only scientific and well-ordered ideas are accepted and entertained by the teacher, and the ones not related to scientific knowledge are eliminated. Non-interactive dialogic is characterised by the teacher synthesising ideas and welcoming alternative and contradictory world views. The discourse here is called non-interactive because learners are not involved even though ideas that are not in line with the scientific views are acknowledged. Finally, interactive dialogic is concerned with social exchanges, and alternative points of view adding to the scientific point of view are acknowledged (Mortimer & Scott, 2003). In this discourse, the teacher seldom evaluates learners negatively and turns down learners' contributions.

Interaction in science classrooms is a requirement (Setiawan et al., 2021), and thus, it is essential to teaching and learning as it promotes learner contribution (Chen et al., 2017) and engagement with the subject matter, thus promoting development and a better understanding of scientific concepts. This gives science teachers an opportunity to shape and monitor the learners 'development (Boyd et al., 2019; Kang & Zinger, 2019) and understanding of science content knowledge since learners externalise their thoughts. According to Lefstein et al. (2020), the nature of discursive moves used by teachers during the teaching and learning process helps to shape how the learners think and process the newly acquired knowledge, thus being able to merge it with existing knowledge (Fang, 2021).

Many classrooms exhibit interaction in the form of authoritative interaction, which is often characterised by limited interaction (Navaz, 2020); since the teachers are drivers

of the interaction, in authoritative teaching, the interaction is limited. According to Wang and Ma (2019), authoritative discourse is characterised by the focus that is placed on the teacher's ideas and perspective. Teachers make use of interactive discourse to establish a common agreed-upon standpoint (Alkhouri et al., 2021) since it offers limited interaction between the teacher and learners. This results in learners becoming receivers of scientific content since their contribution and engagement to the subject matter are not deepened through the sharing of different ideas (Aflalo & Raviv, 2022). According to Fang (2021), this further limits the learners from constructing their own meaning since participation is not encouraged, thus undermining the role of prior knowledge. Prior knowledge is known to help learners develop their own understanding through self-inquiry as they merge what they already know with newly acquired knowledge (Fang, 2021). The different experiences learners come to class with must be confronted and redefined to usher the learners into the knowledge-building process (Alkhouri et al., 2021). This is then accomplished through the checking of prior knowledge, which forms the basis of the development of the learners' understanding of the subject matter, hence the necessity of drawing it from the learners. In such an interaction, the teacher aims to maintain control of the learners and the learning process (Alexander, 2020) by asking specific questions that stimulate recall. This method of teaching enables the teachers to deliver prepacked content knowledge and tends to channel learners to answers. As a result, the learners struggle to engage with scientific concepts and build up an understanding of those concepts. In the following case, authoritative teaching and its effects on science classrooms in the South African context are described.

Essien (2021) argued that authoritative teaching is used in most South African classrooms. With the cultural and language concerns in science classrooms, it is evident that learners' individual experiences are not being confronted, and it forms the basis of difficulties in understanding science concepts and content knowledge since most teaching and learning in rural classrooms occurs in authoritative settings. Furthermore, the prescribed time for the content subjects, as per the notional time allocation, is also an issue that inhibits the implementation of dialogic teaching, which is characterised by more discussions and learner engagement. Teachers usually feel the pressure of completing the syllabus as set by the DBE, thus leaving no room to explore learners' ideas through a dialogic discourse. Despite these factors, the above discussions on authoritative teaching reveal that science teaching calls for more attempts to shift (Ramnarain & Rudzirai, 2020) from authoritative to dialogic teaching (Mwelese et al., 2018). However, in some instances, the authoritative discourse proves convenient. This is because teachers are able to cover the content as stipulated by the department.

Nevertheless, Sherry et al. (2019) and Soysal (2020) argued that certain types of questions posed can help determine the discourse that develops in the classroom, whether it is dialogic or authoritative. Dorhn and Dohn (2018) established that authoritative discourse limits opportunities for learners to engage with the content, and closed-ended questions are the cause of this limitation (Chen et al., 2017). Similarly, Wang and Ma (2019) established that authoritative discourse does not engage learners' views and does not advance deep understanding. Nonetheless, Aflalo and Raviv (2022) argued that authoritative discourse can inspire a dialogic classroom where the teacher's authoritarianism is not as dominant. Expanding on this, Chen et

al. (2017) suggested that although authoritative discourse inspires dialogic discourse, teachers must adopt multiple roles to aid a dialogic classroom and suppress traditional roles that eliminate learner interaction and, thus, cognitive engagement. My study, therefore, focused mostly on interactive dialogic discourse. The assumption is that dialogic discourse can lead to improved learner performance as they would co-construct the science knowledge.

Mortimer and Scott (2003) defined a dialogic discourse as when the teacher accepts learners 'contributions regardless of whether these contributions conform to the scientific story or not. For the current study, I adopted this definition as I was concerned with studying the discursive moves employed to establish a dialogic discourse, which can sometimes draw from a scientific story. Teachers make use of interactive dialogic discourse to encourage both teacher-learner interaction and learner-learner interaction (Boelé, 2018), thus assisting learners to construct their knowledge through scaffolding (Truxaw, 2020). However, through dialogic discourse, teacher elicitations to prompt learners 'responses to questions and given instruction bring about the interaction between the teacher and the learners (Carpenter et al., 2020), thus supporting learner contribution and development in the subject matter (Aranda et al., 2020). According to Hennnessy et al. (2023), for learners to learn and understand science, they have to be inquisitive and engaged with the subject matter, which is established through dialogic discourse in science classrooms (Alkhouri et al., 2021). It is the most prevailing triadic discourse pattern IRF (Lehesvuori et al., 2018) that helps create opportunities for teacher-learner dialogue (Aflalo & Raviv, 2022) through shared discussions (Al-Adeimi & O'Connor, 2021). However, the nature of the "F" move employed in the triadic determines and shapes the classroom discussion.

Scholars who have researched discourse in South African schools, specifically where science education is concerned, reveal that collaborative dialogues are key to learning (Mwelese et al., 2018). The authors further argued that in such settings, the teachers provide proper activities and opportunities that focus the learners' attention through dialogue. In South African schools, however, there seems to be not enough such implementations (Murphy et al., 2020), especially in poorly resourced schools in townships and rural schools (Dube et al., 2020; Mavuru & Ramnarain, 2019). Teachers spend more time feeding the learners content knowledge that is new to them since most of these schools have a shortage of textbooks (Murphy et al., 2020). This makes it difficult for the learners to ask questions and provide well-constructed, lengthy responses to the knowledge they have just encountered since language is also a barrier (Mavuru & Ramnarain, 2019). In contrast to this, well-resourced schools (Hlalele & Mosia, 2020) are in line with the curriculum reforms that require learner engagement through dialogue to facilitate the teaching and learning of science. This alignment is possible due to the availability and use of resources such as textbooks, laboratory equipment, access to the Internet, etc. Such resources expose the learners to more information and, therefore, assist in improving the learners' science vocabulary in science language as they discuss their observations.

2.5.1 Dialogic Pedagogical Practice

Dialogic teaching is the most preferred, necessary, and effective way of teaching (Alexander, 2020) due to its nature of providing an opportunity for an authentic exchange of ideas, thus promoting the collaborative sharing of information in science classrooms. Through dialogic teaching, teachers have the opportunity to get insight

into where the learners are in terms of understanding and usher them to where they need to be. It is characterised by communication that gives multiple voices a space and a chance to share their ideas. According to Mwelese et al. (2018), with appropriate monitoring, dialogic discourse leads to proper learner engagement. In dialogic teaching, the learners' opinions and inputs are valued and used to promote a broader understanding of scientific concepts (Navaz, 2020), helping the learners to construct their knowledge as they engage with the subject matter during the interaction. The following descriptions are cases that support the necessity and significance of encouraging dialogic teaching in science classrooms. According to Alexander's (2020) findings on his 25 years of research in dialogic teaching, the research findings were conclusive that the use of dialogic teaching massively improves learner engagement. In his research, his focus was mostly on the teacher, where he established that teacher talk is critical in dialogic teaching. To support this claim, he argued that the teacher's ability to inhibit, prevent or encourage certain responses from the learners determines the nature of the pedagogy. As such, dialogic teaching is not just about transferring knowledge, it is also about negotiating and thus providing the learners with a certain degree of responsibility for what and how they learn. Following this, one may say that dialogic teaching helps meet all the integrities on how talk is best managed in classrooms, as the learners are awarded the chance to negotiate and discuss, thus building on their content knowledge.

A study conducted by Yildirim and Uzun (2021) in Turkey based on an overview of dialogic teaching and its impact on learning showed that dialogic teaching systematically triggers the learners' development in critical thinking, language, and participation. The teachers' ability to create a dialogic setting in the classroom gives

them a supportive role in the learners' process of constructing knowledge and advancing certain necessary skills in science, i.e., critical thinking, creativity, listening, and the quality of learner talk. The authors further argued that, through dialogic teaching, teachers and learners take turns to reason and negotiate their ideas to reach a common understanding. This collaborative engagement, therefore, leads to the co-construction of knowledge.

In A study conducted by Worku and Alemu (2021) in Ethiopia based on the implementation of dialogic teaching, they argued the importance of dialogic discourse in Science, Technology, Engineering, and Mathematics (STEM) education due to the reported and observed benefits it contributes to the curriculum. According to the authors, engaging learners as a means to enhance their understanding by taking part in classroom discussions and analysis and justifying their responses are a few of the benefits provided by dialogic teaching. Their findings revealed that some of the teachers lack awareness and the knowledge to implement dialogic teaching; thus, professional development in dialogic teaching is required.

The cases discussed above support all the motives to shift from authoritative teaching to dialogic teaching in science classrooms since it encourages more meaningful discussions (Gillies, 2020). According to Adams et al. (2020), dialogic discourse in teaching means being open to different perspectives, which Aranda et al. (2020) referred to as creating more open opportunities for the learners to share ideas and learn. Dialogic teaching has been put into practice over the years; however, more research is still required on the subject (Aranda et al., 2020), as most teachers still struggle with the proper skills (Mork et al., 2021) and thus encounter some challenges

in engaging learners in meaningful science classroom discussions. Based on how dialogic teaching supports and develops effective teaching, teachers need to be made aware of different strategies to choose from when there is a need, to achieve this. These strategies need to be learnt and modelled for the teachers to have a clear picture of what works and what doesn't, moreover, open a room for creativity. Although classroom discourse varies from class to class, Aranda et al. (2020) also argued that classroom discourse strongly correlates with how learners obtain knowledge. Furthermore, dialogic teaching is a condition in support of learning and is an effective instruction that promotes learner participation (Adams et al., 2020).

2.5.2 Factors that Influence Rejoinder Moves/Dialogic Discourse

Teacher professional knowledge is a concern in various education departments (Ogegbo & Gaigher, 2019) and countries (Mork et al., 2021); as a result, there are programmes put in place that ensure continuous teacher development (Bessong & Ogina, 2022; Dorimana et al., 2022). Scholars who have studied teacher professional knowledge argued that it encompasses different factors, including their content knowledge, instructional methods (Bessong & Ogina, 2022), skills (Mork et al., 2021) and other factors that warrant a conducive and effective learning environment. Professionally developed teachers can, therefore, corroborate effective and meaningful learning (Ahmad et al., 2020). This means, in my perspective and the context of this study, for the teacher to be able to create a dialogic discussion, they need certain skills that they obtain from different training programmes aimed at developing their professional knowledge.

According to Mork et al. (2021), the teachers' role in education as a whole and learning is very crucial and complex; hence, there is a need for ongoing professional development to sharpen their skills and content knowledge, to mention a few. This is a contributing factor to the learning process (Dorimana et al., 2022) and learner performance, i.e. the instilling and promoting scientific twenty-first-century skills. Furthermore, these skills are standard and recommended (Ogegbo & Gaigher, 2019) in the new science curriculum reforms, and they include critical thinking skills, collaboration and creative thinking, amongst a few. In contrast, teachers who lack professional knowledge in pedagogical knowledge and instruction may not know what is expected of them in the classroom (Bessong & Ogina, 2022) and, as a result, hinder the learning process. Therefore, the teacher's professional knowledge contributes largely to the classroom dialogic interaction, how it starts and how it unfolds.

Science curriculum reforms have emphasised the need for learner participation and engagement in science classrooms (Murphy et al., 2020; Steinke, 2023; Yang et al., 2021). This ensures learner-centred learning and thus improves teacher competency as well as the literacy of the learners (Relela & Mavuru, 2023; Steinke, 20223). Interactive classrooms have brought together information that is underlying to the surface, allowing the learners to share this information (Bessong & Ogina, 2022), which is crucial for learner development purposes. Teachers are the curriculum leaders (Mangwiro & Machaba, 2022) who play a huge role in meeting the demands of the school. Nevertheless, some teachers find themselves wondering and not knowing what their responsibilities are. This then puts a strain on the delivery of content as the teacher would struggle to encourage classroom discourse. Other teachers have the knowledge and the skills (Bessong & Ogina, 2022) to enforce

effective classroom discourse while others may not have these skills. It is, therefore, important for teachers to possess the skills of establishing a dialogic discourse in science classrooms.

The second effective factor in exercising curriculum reforms is the teachers' pedagogical content knowledge (PCK) (Arrigo et al., 2022), which holds a very high value and thus guides the learning process in the classroom, as both classroom activities and theory (Sedova & Navratilova, 2020) are guided by it. Nevertheless, (Mönch ch and Markic, 2022) argued that PCK is not enough to facilitate the teaching process that develops the learners' vocabulary and scientific language, to aid in classroom discussion (revision 2). As such, teachers who have scientific knowledge and appropriate classroom skills would ultimately be able to convey this knowledge to the learners (Akuma & Callaghan, 2018) through learner participation. It is also important to note that not all science teachers are well vested with content knowledge and pedagogical skills, and therefore, conveying the necessary and sufficient knowledge becomes questionable. This lack of skills hinders the knowledge-building process (Nennig et al., 2023), which should be facilitated for learners, which is paramount for the learner's development (Morris & Chi, 2020). PCK in this regard would help teachers to transform the content knowledge into forms that make it understandable to learners. In the case of establishing dialogic discourse, Khoza (2023) showed that for science teachers to respond to learners' contributions, they need to be able to quickly analyse the inherent messages carried out in these responses. This requires a strong content knowledge of the topic as well as how to maneuver through various concepts taught. Additionally, Khoza and Magadlela (2025) argued that teaching experience may also be one of the factors that contribute to how

the teacher understands the pedagogical practice incorporated with their knowledge and perception. This is because experienced teachers have more exposure and familiarity with how the questions are phrased in examinations. As such, it puts them at an advantage in terms of the areas to put emphasis on. Nevertheless, this does not guarantee versatile instructional methods, nor does it ensure or signify their scientific knowledge (Khoza & Magadlela, 2025).

Finally, research has shown that science teachers are often conflicted when it comes to teaching some topics in science as they contradict their religious beliefs (Relela & Mavuru, 2023) and those of the learners. Topics such as evolution are one of the topics in question, as is genetics (cloning). As a result, this would put a strain on the teacher in terms of the appropriate discursive moves to employ to establish a dialogic discourse without it getting chaotic from the cultural and religious belief perspective. This means that the nature of the topic taught contributes greatly to how and whether the teacher confronts learner contributions through using discursive functions. Nevertheless, the teacher still mediates the learning process, meaning that if there are hindering factors in conducting an interactive classroom, then the teaching and learning process becomes compromised.

Apart from teacher professional development, other contextual factors in education influence the teaching and learning process. These contextual factors may include community background, multi-cultural and multi-racial classrooms, diverse learner abilities and the school set-up (overcrowding) and curriculum, to mention a few. The communities in which the schools are located vary from rural to urban, whereas some would be populated by different violent groups (Mathebula & Runhare, 2021; Wolhuter

& van der Walt, 2020), i.e. social gangs (Sui et al., 2021). These social gangs infuse fear into the community as a whole and thus affect the schools' functionality, as the teachers would also be inferior to these social gangs (Sui et al., 2021). This affects the teaching and learning process negatively since teachers struggle to instil discipline in these learners (Mathebula & Runhare, 2021). Moreover, the social gangs can be gangrenous to their peers as well as the teachers, as there has been reports and studies done on the matter.

Teachers have aired concerns about heavy curriculum loads (Relela & Mavuru, 2023) that leave minimal room for a dialogic teaching approach. Scholars who researched dialogic teaching approaches (Worku & Alemu, 2021) argued that dialogic teaching is not practical in all classroom setups. They based their reasoning on the minimal supply of resources in some schools and overcrowding in others (Bessong & Ogina, 2022). These imbalances in the teacher-to-learner ratio and minimal resource supply weigh heavily on teachers who are expected to facilitate an equal supply of education and maintain control in class simultaneously. Moreover, according to Henderson (2021), as teachers are expected to facilitate dialogue, this can enhance learner talk during the discussion, thus, expanding their scientific vocabulary.

Cultural and racial diversity in one classroom is also one of the burning issues in education, which links largely to language constraints in science classrooms. Research on language in education (Márquez & Porras, 2020) revealed that learners, regardless of their language, may not be proficient in science talk (Aranda et al., 2020). Therefore, they require more opportunities to engage in science talk. Finally, some

learners tend to become less involved and less motivated to engage in classroom discussions, leading to the last factor, learner contribution and cognition.

In a science classroom setup, both teacher and learner contributions are a necessity to establish interaction (Buma & Nyamupangedengu, 2020; Dorimana et al., 2022; Nennig et al., 2023) and the learning process. According to Feyzioglu and Güleç (2024), the learners, contributions are guided by the teacher's contribution to the learning process, consequently shaping the classroom dialogic interaction. This is determined by how the learners are invited to the classroom discussion, which is the initiation of a dialogue (Nennig et al., 2023), as well as feedback provided by the teacher (Soysal, 2019), which has the potential to either maximise or minimise learner contribution (Ahmad et al., 2020). As such, learner contributions vary from simple, which are short and limited, to complex, which are lengthy, explanatory and descriptive. Open-ended questions (Navaz, 2020) are thought-provocative questioning that stimulates more contributions (Aranda et al., 2020) that are descriptive and lengthy (Navaz, 2020). Meanwhile, in closed-ended questions, learners respond with short and limited answers. These contributions then help the gauge the learners' understanding of content knowledge.

Nevertheless, Buma and Nyamupangedengu (2020) argued that the feedback provided by the teachers also has the potential to probe the learners for more elaborative responses (Aflalo & Raviv, 2022). Similarly, Mangwiro and Machaba (2022) argued that in mathematics, learners who have a mathematical mindset are more likely to bring explanatory and lengthy contributions in response to the teacher's questions. However, different questions contribute differently to how the learner

perceives and thus responds to those questions. Morris and Chi (2020) argued that learners may withhold their responses if the question is ambiguous. Despite the reliance on teacher questioning and feedback, the other factor that has the potential to limit or maximize learner contribution is learner cognition (Soysal, 2020). Some learners tend to be withdrawn and withhold their responses, while others actively engage during the lesson. This is based on numerous reasons, for example, misconceptions (Mönch & Markic, 2022), fear of not being able to express themselves due to language barriers (Olayemi & DeBoer, 2021), lack of confidence and the subject being stigmatised as difficult.

2.6 Theoretical Underpinnings: Socio-cultural Framework

Research on classroom interactions and teacher talk moves is usually grounded within the socio-cultural perspectives of learning. I used socio-cultural theory to ground my study. The Socio-cultural theory, developed by Vygotsky (1978) states that learning is a social process rather than an independent process. This means that learners rely on dynamic interactions with others to gain new knowledge (Verenikina, 2003), develop that knowledge taking into account the knowledge that they already have and finally obtain new ideas independently (Mahn, 1999). This theory further argues that learning is a gradual process that occurs continuously in an individual and is influenced greatly by social interactions and cultural factors (Verenikina, 2003). This, therefore, gives an overview of how cultural norms and social relations shape cognition and psychological processes (Seng, 1997). Scholars who have studied the cognitive development of learners strongly draw from the necessity of social interactions to establish knowledge construction and knowledge building (Murphy et al., 2020). This is also supported by the idea of learners socially engaging or collaborating (Aflalo & Raviv, 2022) with someone knowledgeable in the subject matter. This knowledgeable someone should

guide the learner's activities to facilitate the development. To look at the relationship between learning and learner development with a closer lens, the concept of Zone of Proximal Development (ZPD) (Mahn, 1999), scaffolding and mediation are analysed. These concepts are more concerned with the fact that cognitive development occurs because of the mediation of the surrounding environment (Verenikina, 2003), which influences the knowledge obtained as well as how the knowledge is obtained.

The zone of proximal development (ZPD) was described by Lev Vygotsky (1978, p. 86) "as the space that occurs between what learners can do independently and what the learners can do with the guidance of an adult or in collaboration with more competent peers". The people who can guide the learner's development are called the knowledgeable others. According to Vinson and Parker (2019), ZPD refers to the gap that exists between the actual development and the potential of a learner's development, guided by the knowledgeable other as learners engage in problem-solving to bridge this gap. This existing gap, in my perspective, can, therefore, be aided by mediation, which the teacher can provide during classroom discussions. As a result, one may say that the teacher plays a role as a mediator in the ZPD to help the learners bridge the knowledge gap. Moreover, this helps the learners to solve problems (Mahn, 1999) and engage with other learners socially (Verenikina, 2003) to exchange their ideas.

Defining the term mediation in a dictionary, "intervention and negotiating" are used, which one may say are more than appropriate terms used to suggest working together jointly to establish resolutions between the teacher and a learner. Scaffolding is described as providing supportive dialogue which directs the learners' attention toward

specific and key features of the lesson. Verenikina (2003) referred to this as the teachers' simplifying the learners' role but not the task at hand. Nevertheless, the teacher does not hand out answers to the learners; instead, they guide and support them (Seng, 1997) towards the correct answer and understanding of the content (Doolittle, 1999). Furthermore, when scaffolding, at some stage, the guidance can be withdrawn or enhanced (Bliss et al., 1996) depending on how the learner's development is progressing. Withdrawal of guidance is the means to promote independence in problem-solving (Mahn, 1999). I am therefore assuming that mediation and scaffolding promote and support social interaction among the learners as well as the interaction between the teacher and learners in the classroom. As stated by Shabani (2018), through mediation and scaffolding, the learners' abilities can be advanced. Thus, in the ZPD, one needs to mediate and scaffold using tools (Mahn, 1999). In my current study, these tools are assumed to be talk moves, which can be taken as discursive moves (Soysal, 2020).

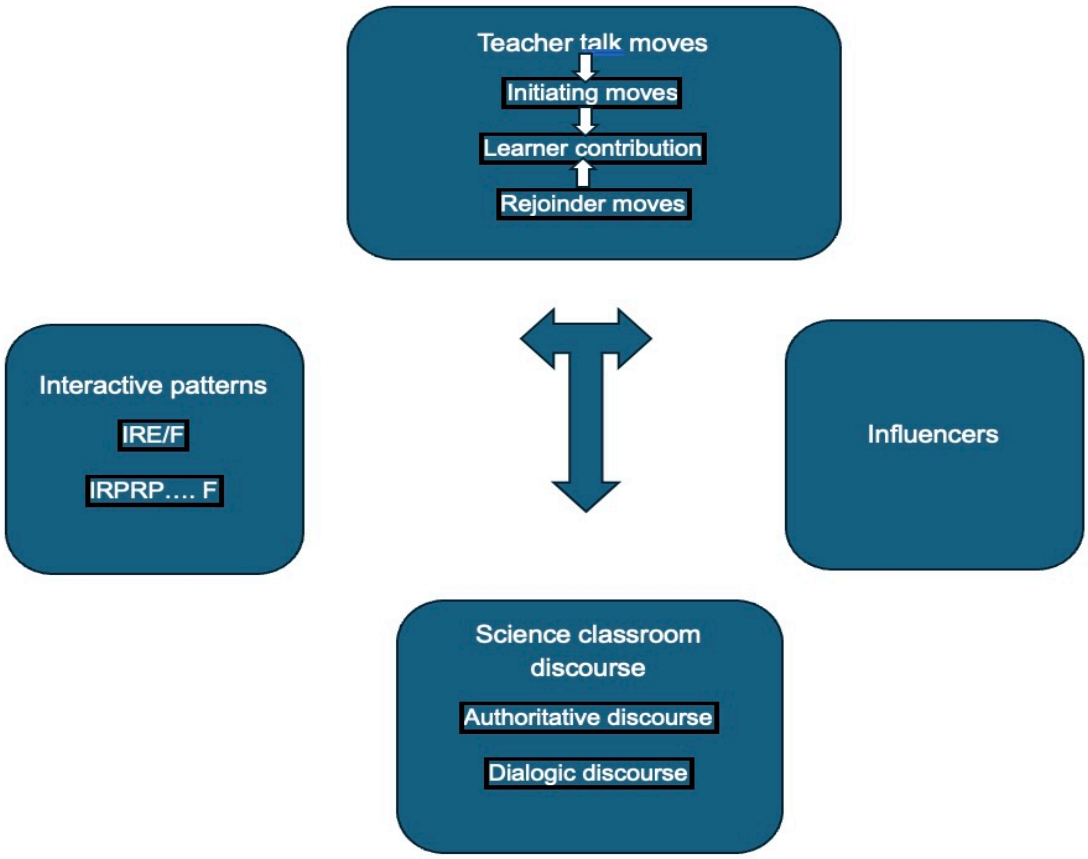
Previous studies have suggested that classroom discourse in science classrooms helps mediate, supporting the view that learning occurs first on a social plane. In this framework, the assumption was that there is an existing gap between the learners' development and the engagement in problem-solving, guided by the knowledgeable other, through mediation and scaffolding. Vinson and Parker (2019) described mediation as a process used by teachers to help develop the learners' understanding through dialogic discourse. During this process, the teacher also engages with the learners through dialogic discourse, and this influences learners' psychological functions (Soysal, 2019). Science teachers are therefore acknowledged as knowledgeable others since they guide learners using specific discursive moves,

guiding the learners to problem-solving and understanding of scientific concepts (Ebadi & Hatami, 2018).

2.7 Conceptual Framework

This study drew from Vygotsky's socio-cultural theory as it describes the development of an individual in a social plane through mediation and scaffolding (Vinson & Parker, 2019). Figure 2.2 demonstrates how the framework of the current study drew from specific concepts discussed in the literature review section, guided by the sociocultural theory of Vygotsky (1978). These specific concepts include talk moves (initiation and rejoinders), interactive patterns, classroom discourse and other factors that filter or amplify the interaction.

Figure 2.2: *Schematic Representation of the Conceptual Framework*



In Figure 2.2, the framework of my current study has three main components and influencers that serve as a bridge to establishing dialogic discourse. As previously indicated, several factors in a science classroom influence how the learners contribute to the classroom discourse. These factors serve as a bridge to the interlinking of the three main components of my conceptual framework. The first main component is teacher talk moves. Talk moves are a form of discursive moves that are used in the classroom to engage learners (Soysal, 2020) in social interaction (Verenikina, 2003). These social interactions are meant to help the learners learn or build their knowledge in line with the sociocultural theory. The socio-cultural theory emphasises the exchange of ideas for learning to take place. Considering that the learners still have a huge room for development where the knowledge gap exists (Mahn, 1999), the adult is required to assist the learners in bridging this knowledge gap, known as the ZPD. In the ZPD, one needs to mediate and scaffold using tools. In this study, these tools are assumed to be talk moves, which can be taken as discursive moves (Soysal, 2020). Teacher talk, using specific discursive moves, has become an important tool in the mediation process (Shabani, 2018). To characterise discursive moves, I drew from Correnti et al.'s (2015) framework for Analyzing Teacher Moves (ATM). The authors studied teacher moves in classroom discussions, focusing on initiation moves (moves employed to invite learners to a classroom discussion) and rejoinder moves (where teachers provide feedback on the learners' responses). This framework suggests that teacher moves can be categorised as initiation and rejoinder moves. According to the ATM framework, initiation moves are used by teachers to start a discussion of a new concept, thus beginning a new line of enquiry. Of the two categories, closed-ended questions mostly do not award learners the opportunity to provide differently structured answers. In contrast, open-ended questions gave the learners flexibility when

answering those questions (Aranda et al., 2020). In this component, initiation moves influence rejoinder moves, which are guided by the learner's contribution.

Rejoinders refer to the feedback provided by teachers to the learners' responses aiming to elicit and acknowledge, clarify, and extend (Correnti et al., 2015). Eliciting and acknowledging, which is the first category, helps the teacher shape the learners' responses and acknowledge their contributions. Examples of such moves include eliciting further responses or restating a question, marking, acknowledging, affirming, and evaluating negatively. The second category involves revoicing or paraphrasing to deepen learners' understanding (Correnti et al., 2015). Examples of such moves include requesting confirmation, requesting clarification, and reframing questions. In the third category, extending, learners 'knowledge is expanded by challenging learners' ideas and thought processes. Examples of such moves include requesting elaboration, asking an extended question, canvassing opinion, challenging extended ideas, and elaboration. Tytler and Aranda's (2015) framework was used to characterise rejoinder moves. From the above-mentioned rejoinders, acknowledging rejoinders and clarifying rejoinders are used to help in shaping the learner's responses; the eliciting rejoinder, on the other hand, prompts and elicits the learners for more responses, thus creating a medium where more ideas are externalised. As such, rejoinder moves determine whether dialogic or authoritative discourse is established in a science classroom as the learner contributes by engaging in the discussion.

The second component is science classroom discourse, which can either be authoritative or dialogic. It is the use of certain moves that can determine which type

of science classroom discourse is established. Authoritative discourse is characterised by limited interaction or restricted by the teacher (Navaz, 2020) and only accepts one scientific view (Alkhouri et al., 2021), or dialogic, where the teacher accepts learners' contribution despite their adherence to the scientific story (Mortimer & Scott, 2003). As per the science curriculum requirement for the teacher to engage the learners with the subject matter and participate in the classroom discussion, authoritative discourse does not meet this requirement. Authoritative discourse supports teacher-centred learning, which deprives learners of enough opportunities to engage with the subject content and collaborate, as well as for the teacher to build their knowledge (Fang, 2021). As such, in authoritative discourse, interactions are limited, as is the room to mediate and scaffold to help the learners construct and build their knowledge. As there is a very limited range of answers, the room to negotiate the proposed answer to reach a common ground also shrinks. In authoritative discourse, there may be an exchange or sharing of ideas, but it is not to a great extent. Previous studies reveal that teachers can make use of authoritative discourse but not rely on it as it resembles lecturing. Consequently, the ability and the opportunity to help the learners bridge the ZPD is compromised. This requires the teacher to be able to identify what the learner can do independently and what assistance they need to do what they cannot do on their own. Through interaction, they develop the ability and knowledge to solve problems.

According to Scott et al. (2006), dialogic discourse is most preferred in science classrooms to facilitate learning with meaning to the learners. If managed properly, dialogic discourse can lead to a deeper level of teacher and learner interaction (Alexander, 2020) as well as an understanding of the subject matter. In a dialogic classroom setup, the negotiation of meaning during the interaction should be based

on the construction of knowledge (Truxaw, 2020). Nonetheless, this form of classroom discourse is very rare in science classrooms. Therefore, teachers need to be furnished with skills to facilitate dialogic discourse in science classrooms since an advanced use of teacher talk is expected. Seeing that in dialogic discourse, learners share or have authentic ideas (Aflalo & Raviv, 2022), they do not necessarily have the correct answers that the teacher expects. The teachers facilitate such interactions in science classrooms through the use of teacher talk as a tool to guide the learners into constructing and building their knowledge (Alkhouri et al., 2021). Therefore, teacher talk that encourages dialogic discourse helps meet and address the needs of new curriculum reforms that enforce engaging learners in a discussion. This means that learning occurs in a social plane and through the help of an adult or the knowledgeable other, who in this case is the teacher, who mediates and scaffolds (Truxaw, 2020) to ensure the learner is guided and supported properly to learn.

The third component is that interaction in science classrooms is necessary (Setiawan et al., 2021); as such, interactive patterns are patterns that unfold during classroom discussions between a teacher and a learner, e.g. IRE/F (initiation, response evaluation/ feedback) and IRPRP (Initiation–Response–Prompt–Response–Prompt). In these interactive patterns, the teacher invites the learners into a discussion, using the initiation move (I), a question. The learners then respond (R) to the question, and the teacher evaluates the learners' responses or provides feedback (E/F). Another interaction that can be observed in a science classroom is when the teacher initiates the discussion with a question, a learner responds, and the teacher prompts the learners to increase learner attentiveness and engagement (Chen et al., 2017). It should be noted that the teacher in this interaction, according to the sociocultural

theory, is the knowledgeable other, as they are the ones who guide the learner's development and prompt the learners for more responses. In the process, teachers are mediators and help the learners by scaffolding (Truxaw, 2020) between the learned content and the learner. The teacher uses teacher talk as a tool to employ discursive moves in the form of initiation and rejoinder moves. These discursive moves help to shape the learners' understanding of the subject matter and, thus, development. Moreover, this learning is more learner-centred and as such, the teacher manipulated the interaction to engage the learner to talk in the classroom discussion (Yildirim & Uzun, 2021).

2.8 Chapter Summary

This chapter provided insight into the literature, theoretical underpinnings and the conceptual framework that guided my study. I reviewed the literature on teacher talk as a tool that is used to promote active learner engagement with the subject matter. Most of the research reviewed identified how different teachers in different regions employ strategies to bring about dialogic discourse through teacher talk. In the South African context, however, minimal reports have been made on the research findings, and some of the studies of this nature have been conducted in Mathematics and Physical sciences.

As such, very little is known at this point on the talk moves and the type of discursive moves that encourage dialogic discourse in Life Sciences classrooms. I positioned my study on Vygotsky's sociocultural theory because I wanted to find out how teachers use teacher talk as a tool to encourage active learner participation and learner engagement, to bring about dialogic discourse to further assist the learners in constructing their knowledge. Firstly, unpacking how teacher talk is used as a tool to

promote social interaction between the teacher and the learners. Secondly, the implications of teacher talk are employed to mediate and scaffold the learner's construction of knowledge in science classrooms, through the zone of proximal development (ZPD). Finally, the discursive moves employed through teacher talk mark authoritative and dialogic interaction between the teacher and the learners in science classrooms, as well as the factors that influence the use of specific rejoinders. In the next chapter, I describe the research design and methodology that guided my study.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

In the previous chapter, I discussed the relevant literature reviewed and the conceptual framework that underpinned the current study. In this chapter, I give a detailed descriptive follow-up on the information provided in Chapter 1 on the research design and methodology. The research design and methodology used to carry out this study are therefore presented in terms of a detailed description of the research paradigm and research approach, a research design that underpinned this study, and the data collection methods extracted from it. Therefore, here I provide an explanation of why I view my study as interpretive qualitative case study research. Furthermore, the research site, sampling, data collection, data analysis, and quality assurance are discussed. Ethical considerations and issues of quality assurance are also discussed in this chapter.

3.2 Research Paradigm

Paradigms are purposefully used by researchers as a theoretical plan according to the research work (Alhoussawi, 2023, p. 109) to describe the research best (Pervin & Mokhtar, 2022) and carry out meaningful research. As such, research questions and objectives can be explored based on the research paradigm employed. Paradigms range from positivist to post-modernism. Since the in positive paradigm data is in numbers and thus objective, post-modernism governed by subjective explanations of specific individuals, (Kestel & Korkmaz 2019), the current study is guided by an interpretivist paradigm. As opposed to the positive paradigm, which is objective and where reality is measured in values and quantified (Rahi, 2017). Since the data collected is in the form of numbers, thus based on statistics and evidence (Alharahshe

& Pius 2020). And the post-modernisms governed by subjectivity, explanations, and the interests of specific individuals. This paradigm holds the belief that learning and knowledge gathering, in reality, occur through social interaction (Pervin & Mokhtar, 2022), with teacher talk being central to the construction to guide instead of the teacher's individual opinion or view being used. In the current study, I wanted to understand the nature of discursive moves used by teachers through talk to bring about a dialogic discourse in Grade 10 Life Sciences classrooms. The rationale behind this paradigm is that it describes how human beings interpret the world in which they live subjectively to make meaning of it (Kivunja & Kuyini, 2017; Nomazulu, 2018) and how a human mind can obtain knowledge of the world. This paradigm has helped me as a researcher analyse and develop an understanding of the nature of teacher discursive moves used by Life Sciences teachers in the classrooms. This understanding is due to applying the interpretivist views on the interpretations of the meaning that humans attach to their actions, guided by the assumption that the meaningfulness of the research findings is dependent on the interpretation of the researcher. Therefore, the interpretivism paradigm requires a close analysis of data that discloses the meaning of the findings while showing how this meaning configures to generate observable outcomes.

3.3 Research Approach

This study followed a qualitative research approach, which is an approach that seeks to explore and understand the meaning the individuals and groups ascribe to human and social problems in depth (Creswell & Creswell, 2017), as well as the interpretation of written information (Flick, 2013). Since qualitative approach is concerned with non-numeric data and gathers participants' behaviors and experiences (Creswell & Creswell, 2017). In qualitative research, the complex social world of human and the

dynamic of their experiences explaining questions about meaning is provided. Thus, the collection and analysis of non-numeric data is done to understand concepts, opinions, and experiences. As qualitative research has an orientation on day-to-day events (Flick, 2013), teachers were observed teaching as they were using different teacher discursive moves. Moreover, qualitative research requires rich, thick and in-depth descriptions of how people interact and behave in their existence. As such, the richness and thickness of the data drew from the diversity of participants as per the contextual factors inherent in a school and other factors such as experience, gender, age etc. while the depth was established through the quotations asked to each teacher. This research approach, therefore, served as a thorough guideline in conjunction with an interpretive paradigm, which enabled me as a researcher to explore how reality is interpreted in a social and interactive context through flexibility in the use of classroom observations and video-stimulated recall interviews (Berg, 2017).

3.4 Research Design

There are many research designs associated with the qualitative approach; these include grounded theory, phenomenology, narrative research, ethnography, and case study (Creswell & Creswell, 2017). In designing my study, a case study design was employed in the study (Çakar & Şehmus, 2020), which is a strategy used to study a phenomenon within its context (Abutabenjeh & Jaradat, 2018). Classrooms possess these characteristics as the teaching and learning are transitional and topic-based; such specific instances can be understood using case studies. In my current study, I explored teacher talk to understand its role in teaching and learning further. As a result, the focus was mostly on the teachers, although this was investigated through teacher-

learner interactions of dialogic discourse. These interactions were captured to extract data on teachers' and learners' utterances using data collection techniques and classroom observation, to determine what teachers said and how it was said, as well as video-stimulated recall interviews to discover why they did it in that specific way. As findings from case studies cannot be generalised and in consideration of the teachers' use of discursive moves differently to cater for different contextual factors inherent in a particular school, this study provides insights into the multiple cases explored of the possible use of teacher talk as a tool to establish dialogic discourse.

Case studies can be explanatory if they are aimed at causality and study data at both broad and shallow surfaces to get an in-depth understanding of the phenomenon. Descriptive research begins with a descriptive theory and is aimed at describing a phenomenon that is reflected in the data. In the exploratory case study, the research forms a baseline for further studies, which does not necessarily take into account in-depth factors. The case study design allows for single or multiple case studies. Single case studies are concerned with one bounded case to be illustrated; in this type of case study, a researcher selects one person or a single group to study (Coombs, 2022), while multiple case studies refer to the selection of multiple cases to compare cases, as the means to establish relationships, common patterns or similarities or both (Coombs, 2022). My study was an exploration of multiple case studies (Creswell & Creswell, 2017) since the cases selected in participating teachers share common features of the use of discursive moves differently, although teaching the same topic. Grade 10 Life Sciences teachers were the cases investigated as they delivered lessons on the topic of the cell cycle using discursive moves. Learners' responses were taken into consideration since they were part of the lesson, and they contributed

to the unfolding of the dialogic discourse. As my study was interpretive, I sought to understand the relationship between talk moves employed by teachers, their influences, and their contribution to the development of dialogic discourse in science classrooms. Thus, a case study design assisted me in strongly examining the nature of discursive moves used by Grade 10 Life Sciences teachers when teaching about the cell cycle within a more detailed context. This assisted me in obtaining rich, thick descriptions and an understanding of how the teachers established dialogic discourse through the use of discursive moves (Berg, 2017).

3.5 Research Site and Sampling

This study was conducted in poorly resourced schools in Mpumalanga province, in Gert Sibande district, Msukaligwa 1 and 2 circuits. The four selected schools in which data was collected follow the South African Curriculum Assessment and Policy Statement (CAPS). Sampling refers to the selection of specific and relevant data sources from which data is collected to address the research objectives (Moser & Korstjens, 2018).

To be able to address research objectives, one needs to be able to select information-rich cases. According to Shaheen and Pradhan (2019), selecting information-rich cases enables the researchers to conduct a thorough and in-depth study. Information-rich sources are cases where one can learn about many issues and obtain more data (Nomazulu, 2018) from conveniently available schools willing to participate in the study. The participating individuals in the current study were selected using purposive and convenient sampling (Nair, 2019). According to Adeoye (2023), in purposive sampling, the researcher purposefully selects the participants based on familiarity with and suitability to the topic being studied. Convenient sampling is concerned with

selecting participants who are easy to find and get in touch with. The purposive convenient sampling was an advantage to my current study as it was less expensive and flexible but still allowed room for in-depth analysis. I worked with four Grade 10 Life Sciences teachers who were selected from four public schools (one teacher in each school). The selection criteria for selecting the teachers were: The teachers must have Life Sciences as a major subject, they must be currently teaching Life Sciences, and have a minimum of three years teaching experience in Grade 10 Life Sciences. The selection criteria for schools were the school had to be an under-resourced public secondary school, offering Life Sciences as a subject and compelling teachers to rely solely on teacher talk. The selected schools were in the cluster that I was leading. Because of the exposure and constant engagements with these schools' Life Sciences teachers, I was able to gain an understanding of the functioning of the school in terms of periods and the scheduled time to teach the specific section (cell cycle) of mitosis as well as whether they were well resourced.

Table 3.1: *Teacher Profiles*

Teacher pseudonyms	**Schools**	**Age group**	**Teacher qualifications**	**Other subject taught**	**Number of years teaching**	**Number of years teaching Life Sciences**
Elijah	A	45-55	Bed	Mathematical literacy	20	18
Kol	B	25-30	Bed	Natural Sciences	7	7
Cami	C	30-35	Bed	Natural Sciences	9	9
Mary	D	25-30	BEd Hons	Creative Art	4	4

Table 3.1 represents the profiles of all the teachers and schools sampled to be participants in my current study. School A is a multi-racial school that has a minimal supply of resources. School B is a disadvantaged school that is poorly resourced, and both Schools A and B are quantile one schools. School C and School D are MSTA schools, although they are still in quantile one, meaning they are offering Mathematics, Science and technological subjects. As a result, these schools are at an advantage of being sponsored by different organisations. The sponsors, amongst a few resources, have provided mobile classes (containers), laboratories with the necessary equipment, and Smartboards. Nevertheless, not all classes are equipped with Smartboards. As such, in Life Sciences classes, these resources were not available and, as such, not utilised. Additionally, this would mean that teachers do not necessarily exercise their skills of using certain resources. There are limiting factors that cause teachers not to be able to use the few available resources. For example, having a minimal number of resources which are prioritised for the Grade 12 classes. Secondly, the limited number of resources requires teachers to put in extra time to expose the learners to these resources, and the issue of having overcrowded classrooms in these schools hinders that.

Out of all four schools, only School A had a minimal number of approximately 35 learners in class. All the other schools (B to D) had more than 50 learners in each class. Overcrowding in the classroom has been debated in previous studies as a hindering factor that prevents the facilitator from attending to learners' individual needs. It has been further debated that, in overcrowded classrooms, teachers tend to rely mostly on traditional teaching methods that do not encourage, for example, the exchange of ideas and hands-on activities in science classrooms. Which is the primary

and number one recommendation in curriculum reforms. School A, which had the lowest number of learners in the class and an experienced teacher, showed lengthier and more in-depth discussions compared to other schools. One may say that this stems from Elijah's ability to engage with all the learners, read them when they are lost, or when they understand the concept. In Schools B to D, however, their recorded interaction was very limited, which can be linked to the fact that teachers struggle to engage with the learners individually and confront their contributions based on the large number of learners in one class. All the participating teachers have degrees in teaching, except for Mary, who has a Hons degree. In the current study, the teaching qualification did not have a huge contribution. Elijah, Kol, and Cami also teach other subjects within the science discipline, which gives them an opportunity to expose the learners to scientific skills in their lower grades. It is only Mary who teaches a subject outside of the scientific discipline. As a result, in the current study, it is evident that the teachers are also able to instil some of the scientific skills required from the learners in other subjects and emphasise these skills in Life Sciences as some are relevant. Teachers have established this in the form of prior knowledge. In contrast to this, Mary's creative arts teaching does not allow her room and opportunity to guide the learners to scientific skills in lower Grades; she relies on other teachers for this.

3.6 Data Collection Methods

The methods used to collect data refer to tools used by the researcher to conduct a research study (Bazeley, 2020). In my study, I used two data collection tools, namely classroom observation and video-stimulated recall interviews as described below.

3.6.1 Classroom Observations

Classroom observations are defined as the action of watching a teacher in the classroom teaching (Saldaña, 2021). This means mainly getting inside the classroom to look at and listen to what the teacher and learners are doing, and therefore, observations serve as the suited method to explore experiences and their meaning. There are four types of classroom observations involved: firstly, the observer as a complete participant, where the researcher conceals the role of an observer. Secondly, the observer is a participant; in this type of observation, the role of the researcher is clear and known. Thirdly, the participant is an observer, and the researcher (observer) plays a secondary role in the research. Lastly, the researcher is a complete observer, where the observer does not participate in the study (Nyimbili & Nyimbili, 2023). There are advantages and limitations to each of the different observation types listed above. During observations, the presence of the researcher might have a negative impact, causing the participants to alter their behaviour. Resulting in the researcher having to extend the period of observation, to gain thorough and natural behaviour from the participants, which can be time-consuming. Observations also allow the researcher to capture visible or social interactions, but none of the cognitive processes, to account for and reason why they say what they say (Scott & Medaugh, 2017). Additionally, during classroom observations, only the current events are captured, what happened prior as well as afterwards is not captured although it has an impact on the current events. To address or aid these limitations, I did not rely on just one method of data collection; I also made use of video-stimulated recall interviews. Additionally, to ensure the natural behaviour of the participants, I did three observations in each class for an hour to ease the unfamiliarity of my presence during classroom observations.

In the current study, I was the complete observer, and I did not direct the teaching process or the classroom situation. I observed the teachers carrying out the lesson on the topic of the cell cycle; the lessons were conveyed via video and audio. Multiple classroom observations were conducted to capture the everyday actions and reactions of the participants in the learning environment. Having observations recorded on the video also helped authenticate the information obtained from the video-stimulated recall interviews during the data analysis process. During classroom observations, a video recorder was used to record all the lessons. According to Berg (2017), recorded observations allow the researcher to access data for transcribing and analysis of the data obtained. The recorded classroom observations assisted in capturing the teachers' utterances and actions while teaching about the cell cycle, as well as the learners' responses when they responded to the teachers' utterances because the current study focused on utterances, not actions. The topic of the cell cycle, which is part of the topic of mitosis, is expected to be taught for two weeks following the CAPS document, and classroom observations were made until the completion of the topic. The plan was to observe a total of three lessons per teacher, which would have resulted in a total of 12 lesson observations. However, due to unforeseen circumstances, Kol from School B had to relocate to a new school and Elijah, a teacher from School A, had to be away from school for a period of two weeks. As a result, I was only able to observe two lessons from Elijah and Kol. For Cami and Mary, three lessons were observed for each teacher, which amounted to a total of ten observations. Arrangements were made with teachers for flexibility and the ability to collect data in each school without the clashing of periods. Two teachers were observed in the first week, and the two remaining teachers in the second week. Due to multiple classroom observations, the participating individuals appeared to provide

more natural performance and data, thus providing the researcher with more authentic data. The teaching videos were transcribed verbatim for analysis. I provide a table showing the lessons observed, the duration of the observations, and the sub-topics below.

Table 3.2: *Lesson Observation Summary*

Teacher	Lesson 1 sub-topic	Duration	Lesson 2 sub-topic	Duration	Lesson 3 sub-topic	Duration
Elijah A	Introduction (Chromosomes and cell cycle)	1hr	The cell cycle	1hr	-	-
Kol B	Introduction (Chromosomes and cell cycle)	1hr	The cell cycle and importance of mitosis	1hr	-	-
Cami C	Introduction (Chromosomes and cell cycle)	1hr	The cell cycle	1hr	Importance of mitosis and cancer	1hr
Mary D	Introduction (Chromosomes and cell cycle)	1hr	The cell cycle	1hr	Importance of mitosis and cancer	1hr

Table 3.2 above shows how all four participating teachers segmented and taught the topic of mitosis. As shown in Table 3.2, each period was allocated an hour as per the notional time allocation. Evidently, the first and second participating teachers were not observed for the entire duration of the topic due to unforeseen circumstances. Teachers C and D, however, were able to teach until the third day. However, on the last day, there wasn't much to be done; it was more about treating activities to shape learners' responses better. Moreover, it is important to note that as per the CAPS document (Department of Basic Education, 2011, p. 26), an entire topic should be

taught for a duration of two weeks, which amounts to eight hours as per that notional time allocation. Nevertheless, the participating teachers only taught it in three hours at most. Some of the hours were dedicated to assessments by the teachers.

3.6.2 Video-Stimulated Recall Interviews

Video-stimulated recall interviews are conversations that occur between the researcher and the participants to follow up on certain ideas and to make sense of them (Vidhiasi, 2018). This data collection method is most common and convenient when conducting qualitative study because it allows the researcher to understand events from the participant's perspective, and the teacher's explanations are linked to the lessons. As such, this accounts for the teacher's perspective of how the classroom interaction unfolds. Moreover, Swit et al. (2024) argued that VSRIs enable the researcher and the participants to negotiate an understanding and meaning of the situation. They further argued that contrasting other methods of data collection, such as questionnaires, clarification of questions and certain information can occur during the conversational engagement (Nel, 2022). As such, this data collection method enables eliciting the teacher's reflection on the chosen aspects by the researcher. For these purposes, VSRIs proved to be suitable and beneficial to the current study as they enabled the collection of rich, in-depth data (Creswell & Creswell, 2017), as the Life Sciences teachers who participated in the study watched and reflected on their interactions with the learners (Nguyen & Tangen, 2017) that were captured during classroom observations.

Video-stimulated response interviews were used to address the third research question (What influences the kind of moves that Life Sciences teachers use?). which

speaks to what motivated the discursive moves that the teacher employed during the lesson. It was conducted after the preliminary analysis of the videos and audio obtained during a classroom observation. This means that the construction of the interview questions (see Appendix B for the interview protocol) was based on the preliminary findings from the analysis of transcripts obtained for the video-recorded observations. Therefore, the interview questions generated were specific to the findings of the analysis; however, the questions revolved mostly around the teacher's thinking about the usage of specific moves at different points of the lesson. For example, why did you ask this question? Why did you phrase this question like this? You did not respond to the learner here; why? Did you ask the same question in other classes? Moreover, the VSRI questions were aligned with the dialogic episodes extracted from the preliminary analysis of data obtained from classroom observations. The VSRI was audio-recorded and transcribed verbatim for data analysis. Each participant had approximately 30 minutes to complete the interviews. This data collection method thus assisted in understanding the use of teacher discursive moves when teaching about the cell cycle from participants' perspectives. Video-stimulated response interviews also contributed to the authentication of data obtained from classroom observations. Transcripts from the VSRIs were analysed to generate themes. The generated themes were also developed from pre-determined themes from my framework and literature review.

3.7 Data Analysis

Data analysis in research refers to the process of studying data obtained to make meaning of it (Bazeley, 2020). The data that is being analysed is studied from any angle (Pandey & Pandey, 2015) to explore all the possible facts. Analysis of data

obtained in research enables the researcher to discover how much was known before the study, determine relationships or lack thereof (Pandey & Pandey, 2015) with other empirical studies and finally provide explanations on the research topic to draw conclusions based on the findings. In this study, I analysed two data sets. A cross-case analysis was employed to compare the findings. A cross-case study is a method in qualitative research used to compare any similarities or differences and present findings from different cases for the development of new explanations (Mays & Pope, 2020). In classroom observations, teachers were teaching the same subject and the same topic; however, the employment of discursive moves showed different trends, which I compared to establish which noticeable trends resulted in a dialogic discourse in different classes. In the video-stimulated interviews, I narratively looked at some of the factors influencing discursive moves in a single case and then compared that to the other case, thus making it a cross-case. The narrative analysis, which is thematic in nature, helped me analyse individual transcripts and do a cross-case analysis. In the findings section in Chapter 4, I present these as themes.

3.7.1 Analysis of Transcripts (classroom observations)

Coding refers to the process of transforming collected data into a set of meaningful and cohesive categories. Coding helps summarise or reduce data and re-present data, thereby providing a systematic account and deliberately facilitating analysis of the captured phenomenon (Bazeley, 2020). Codes are thus short phrases and words generated by the researcher (Saldaña, 2021) that hold the specific meaning of verbal information. There are two types of coding involved in the coding process: inductive and deductive coding. Inductive coding is also referred to as open coding, which starts from scratch, where codes are created based on qualitative data. According to Vears

and Gillam (2022), inductive coding is commonly used in small-scale studies aimed at finding the meaning of the data collected. Deductive coding starts with a predefined set of codes to assign those codes to the new qualitative data obtained. In my current study, the classroom observation data were transcribed word for word to do preliminary analysis prior to conducting VSRI.

During the preliminary analysis, I invited my supervisor to code the teacher utterances, and the codes were discussed accordingly, thereby leading to an agreement on the coding process. We were looking for dialogic discourse segments or episodes in each lesson observed. After identifying the dialogic episodes, I constructed the VSRI protocols as per the dialogic episodes identified for each teacher (see Table 3.2). Accordingly, teacher moves were analysed deductively by coding them and characterising them as initiation moves and rejoinder moves. Characterisation of initiation moves was influenced and drawn from the literature reviewed in the current study. The initiation moves were coded for whether the questions were open-ended or closed-ended (see Table 3.1). Tytler and Aranda's (2015) framework was used to code for the rejoinders, where broad categories and sub-categories of rejoinder moves were attached and linked to the relevant teacher utterances. For clear details on how this framework was utilised, see Chapter 4, Section 4.3.1. The analysis employed was, therefore, deductive coding for both teacher utterances and learner utterances, as the learner utterances' contribution influenced the teachers' utterances. Although the unit of analysis was based on the teacher, learner utterances were coded to provide the context for the teacher's utterances. Since my main focus was on the development of dialogic discourse, I observed and identified episodes that displayed a dialogic discourse to map the interaction and progression of the discursive moves used during

teaching and learning to identify emerging patterns. Therefore, the dialogic episodes became my study's primary unit of analysis.

Table 3.3: *Teacher Utterances Analytical Framework*

Teacher moves	Broad category	Sub-category	Abbreviated
Initiation moves (types of questions)	Open-ended questions/	–	Op-Q/
	Closed-ended questions		Cl-Q
Rejoinders	Eliciting and acknowledging rejoinders	Eliciting further responses/ restating a question	EFR/ Res-Q
		Marking	Mar
		Acknowledging	Ack
		Affirming	Aff
		Evaluating negatively	Ev- N
	Clarifying rejoinders	Requesting confirmation	Re-Co
		Requesting clarification	Re-Cl
		Reframing question	Re-Q
		Revoicing	Rev
	Extending rejoinders	Requesting elaboration	Re-E
		Asking an extended question	AE-Q
		Canvassing opinion	Can-Op
		Challenging to extend ideas	CEI
		Elaborating	Ela
		Present scientific views	Pre-Sv

Table 3.4 above represents the analytic framework that I drew from Tytler and Aranda's framework (2015). I saw it fit to use this framework in the current study as it showed the role of teacher talk moves to achieve dialogic discourse, from initiation moves to the rejoinder moves of the initiation rejoinder feedback pattern, as it gave specific indicators to characterise teacher utterances. During the analysis process, when I was doing deductive coding, initiation moves were characterised as open-ended questions or closed-ended questions. Initiation moves are moves used by teachers to invite learners to participate in the learning process to bring about the dialogic discourse and, therefore, occur at the beginning of a new enquiry (Mudau & Netshivumbe, 2022). Following the discussion, the teachers' utterances were then characterised as rejoinder moves, as there was a continuation of the enquiry. The rejoinder moves listed above in broad categories also have sub-categories. When I was doing the coding, I used both categories, starting with the broad category, and then, based on the role of the rejoinder move, I linked them to the relevant sub-categories. The usage of the above-mentioned indicators, now referred to as codes, appeared similar for more than one dialogic discourse episode; however, they served different purposes in each case. As a result, the use of codes assisted me in focusing on extracting the nature of discursive moves used by teachers to establish the dialogic discourse in science classrooms, which is the first research question. For the second research question, I was seeking to understand the contribution of the moves used by teachers. Therefore, the dialogic discourse shows interaction in terms of the length of dialogic discourse as well as how the dialogic discourses unfolded.

3.7.2 Analysis of Video-stimulated Recall Interviews

Video-stimulated recall interview questions were developed and constructed based on the dialogic episodes observed per teacher. Data obtained from VSRI was transcribed, and the transcripts were analysed inductively and deductively in line with the literature reviewed in Chapter 2. Inductive analysis is defined by Schoormann et al. (2021) as a method that qualitative researchers use in search of comparability, categorised in themes on numerous levels of interpretation by studying printed material and recordings. Codes were used in the interpretation and analysis to make meaning of the data collected. After the coding process, themes were generated. Themes are patterns that are generated as a result of coding and categorising data sets. In the current study, coding was done manually, using colour pens and highlighters to uncover, organise and categorise similar patterns (Saldaña, 2021) of data to make meaning of what factors influence the teachers' use of specific discursive moves at specific points during the lesson. These codes were derived from the findings in the current study, and themes were generated to answer the third research question. After the coding process, when generating themes, I started with pre-determined themes from the conceptual framework and literature review. I then categorised all the remaining data that did not fit into the pre-decided themes into new themes. I read the data again, now using pre-decided themes and newly generated themes in a repetitive data analysis process. Such analysis helped me to presume why a certain teacher used specific discursive moves and whether or not it led to dialogic discourse (see Step 4 in Section 4.4).

Table 3.4: *Summary of Data Collection Instrument, Sources, and Analysis*

Research sub-questions	**Data collection instruments**	**Data sources**	**Data analysis approach**
What is the nature of discursive moves used by Life Sciences teachers when teaching about the topic of the cell cycle?	Classroom observation checklist/ protocol	4 Teachers and their learners	Deductive by coding teachers' initiation and rejoinders. Learners' utterances will be deductively coded
In what ways do the moves contribute to the establishment of a dialogic discourse in the Life Sciences classrooms?	Classroom observation checklist/ protocol	4 Teachers and their learners	Identifying the episodes that indicate dialogic discourse and then mapping the progression of discursive moves
What influences the kind of moves the Life Sciences teachers use?	Video-stimulated recall interview protocol	4 Teachers	Transcripts were inductively analysed

3.8 Quality Assurance

3.8.1 Classroom Observations

In this section, the true value to be placed on data collection and how that data is analysed and interpreted is described (Kivunja & Kuyini, 2017). As data was collected using video-stimulated recall interviews and classroom observations, information gathered with each instrument served to ensure the authenticity of the data collected. the following quality assurance criteria were followed to ensure the quality of the study: dependability, credibility, confirmability, and transferability (Gill et al., 2018). In the

current study, dependability was ensured by conducting prolonged classroom observations (each teacher observed three times). After that, data obtained from observations were transcribed, ensuring that the transcripts were free from errors for clear interpretation and to demonstrate the findings with the data collected. Observations were persistent and in-depth, enabling me to capture correct and relevant data to the current study and findings to certify research credibility (Moser & Korstjens, 2018; Nomazulu, 2018). Transferability is concerned with the application of the findings from the study to other contexts and settings. In the current study, transferability was ensured by employing verbatim transcription and providing thick descriptions in the analysis of data. Transcribed data was interpreted in search of themes and clues that make outcomes more believable.

3.8.2 Video-Stimulated Recall Interviews

During VSRIs, lengthy interviews were conducted, characterised by probing questions to the participants to ensure dependability (Moser & Korstjens, 2018), which led to a greater explanation from the participating individuals. Credibility was certified through the interpretation of data obtained to identify codes and themes to help analyse data. Transcribing the VSRI and taking field notes was done to ensure transferability. Finally, for confirmability, I employed active citations to indicate and support empirical claims.

3.9 Ethics and Consideration

Ethics are decent values (Kivunja & Kuyini, 2017) that govern a person's behaviour (considering what is acceptable and what is unacceptable). Prior to conducting my research, I applied for clearance to the University of Pretoria ethics committee, as legal practices are imperative when one adheres to research (see Appendix D). After

receiving clearance from the ethics committee, I wrote a letter to the Mpumalanga Department of Basic Education requesting permission to conduct research since my research took place in schools, and permission was granted (see Appendix E). This was followed by writing consent letters to each of the principals (see Appendix F1) in the schools sampled for the research. The letter of request sent was accompanied by a consent form (Lys et al., 2018) for parents or legal guardians (see Appendix F3) of the learners, as well as assent forms for learners (see Appendix F4). Signed letters were received from each participating school. All participating individuals were informed of the purpose of the research as well as the methods to be used for data collection. In the process, the confidentiality and voluntary nature of participation in the study were also outlined. Additionally, the participants were informed that information obtained, or data collected from interviews and classroom observations were for study purposes and could be published in scientific journals. Finally, pseudonyms were employed in the study to protect the participants' and the schools' identity, confidentiality, and anonymity (Nomazulu, 2018).

3.10 Chapter Summary

In this chapter, the research design and methodology have been explained and described in detail. This aspect of the research guided the entire process of the study to thoroughly unpack the data obtained from information-rich cases selected to participate in the study. In my description of the methodology and design that guided this study, I started with definitions that showed how they formed the basis of my study. Following that, I showed the link between the research design and my study and substantiated the reasons that influenced the research design employed in my study. I then discussed the selected schools and teachers as well as the criteria for selection.

I also showed a connection between the data collection methods I used and the research questions and then provided a description of the data collected and how I opted to open and analyse it. In this section, I also unpacked how the data gathered was analysed, compiling an analytical framework. Moreover, I provided an explanation of how I addressed and ensured the quality assurance issues as well as the ethical considerations in my study.

In the next chapter (Chapter 4), I give a more step-by-step and detailed analysis of the data and how it links with the analytical framework model designed in Chapter 3. This will be established through the analysis of different sets of video data obtained to answer research questions one and two. As for the third research question, the generated themes will also be described and discussed from video stimulated recall interviews.

CHAPTER 4: ANALYSIS AND PRESENTATION OF FINDINGS

4.1 Introduction

The previous chapter, Chapter 3, discussed the research design and methodology that governed my study. An analytical framework was designed to analyse teachers' utterances. In this chapter, I provide a detailed description of the analysis of the data collected, as well as the tools and processes involved in the analysis of data and then present the findings. The first main part of this chapter is about the video data. I first explain how I drew from Tytler and Aranda's (2015) framework to analyse rejoinder moves used by teachers and Hardman (2019) to analyse learner responses. I then explain how I developed and applied the analytic framework and tools that suited my study. These sections will also help explain how the analytic framework was used in relation to my research questions to prove its relevance in answering my research questions. This explanation is done by examining different areas of interest that resemble dialogic and authoritative interaction in Grade 10 Life Science classrooms during the teaching and learning about the topic of the cell cycle. The second main part of this chapter is about the analysis and presentation of findings from the VSRI. Similar to the first part, I first describe in detail how the data was analysed, then present findings from this analysis.

4.2 Detailed Description of the Analysis of Transcripts from Video Data

To analyse the transcripts, I used the analytical framework presented in Chapter 3 (see Table 3.1). When doing the analysis, I followed the series of steps described below.

Step 1: Coding of teachers' utterances using the broad categories of teaching moves (i.e., initiations and rejoinders). In this step, I considered this the first level of coding teacher utterances. The posing of questions to start a discussion was categorised as the initiation move, move "I" of the IRF pattern. Teachers use initiation moves to invite learners into a classroom discussion and usually ask questions. The feedback provided after the learners' responses was categorised as rejoinder moves "F" moves of the IRF pattern (see Table 4.1). The new question was regarded as an initiation if a teacher was beginning a new line of inquiry. However, if a question was used to continue the same inquiry or argument, that question was regarded as a rejoinder.

Step 2: Coding of teachers' utterances at the second level. In this step, I went back to the first-level coding of teachers' utterances but with a closer lens to focus and characterise the nature of initiation and rejoinder moves. In the analytical framework (see Table 3.1), Initiations I were categorised as closed-ended and open-ended questions. I did not rely solely on the keywords but looked at how the questions were constructed and the kind of responses that were expected from the learners based on the reviewed literature. At this stage, I identified different ways in which questions were constructed in the text. Recall, factual, and other questions that required one straight answer from the learners were categorised as closed-ended questions. The questions that did not require one straight answer but allowed flexibility for the learners in their responses were deemed open-ended questions. The rejoinders were categorised into broad categories: eliciting and acknowledging rejoinders, clarifying rejoinders and extending rejoinders. See the abbreviated codes in Table 3.1.

As I was coding the teachers' utterances at the second level, I also coded learners' utterances. This approach was followed because learners' utterances contribute to how the interaction unfolds in the classroom by influencing rejoinder moves used by teachers; therefore, learners' utterances cannot be ignored. I used Hardman's (2019) framework for characterising learner utterances. Hardman's framework granted me an opportunity to analyse a wide range of learner responses and, as such, characterise them accordingly. Table 4.1 shows an example of how I coded the lesson transcripts.

Table 4.1: *An Example of how Teacher and Learner Utterances Were Coded (From Elijah's lesson)*

Turns	**Speaking**	**Utterance**	**Category of teacher moves and learner responses**	**Nature of category**
1	T	What do we call chromosomes before cell division?	Initiation	Closed-ended question
2	L1	Cells	Response	Short/limited
3	T	No, the ones that are in the nucleus	Rejoinder	Requesting clarification/asking an extended question
4	L1	Chromosomes	Response	Short/limited
5	T	They form, I will give a clue…	Rejoinder	Elaborating
6	L1	DNA	Response	Short/ limited
7	T	Part of the DNA, they form a wave-like structure	Rejoinder	Elaborating
8	L1	Chromatic network	Response	Short/ limited
9	T	Chromatic network, very good	Rejoinder	Affirming

Table 4.1 above is an example of teacher and learner utterances, which was captured in the first lesson on the topic of the cell cycle, although learners had just completed a topic on cells and had a chance to read on the topic to prepare for the lesson. In this segment, the teacher initiated a discourse with a closed-ended question, asking the learners to provide a term used to refer to chromosomes before the cell starts or prepares for division. Elijah showed the use of different rejoinder moves under different categories of rejoinders.

Step 3: Searching for dialogic episodes. In this step, I went back to the transcripts and looked at instances where there was dialogic discourse. I marked these as episodes of interest for each teacher (see Appendix A). After marking these episodes, I then formulated a VSRI protocol for each teacher to find and understand what influenced the kind of moves that Life Sciences teachers use during the teaching and learning of the cell cycle. The VSRI questions were formulated according to the teacher's dialogic episodes identified per lesson (see Table 4.9 for an example of generated questions for VSRI).

Step 4: Since my study was about how Life Sciences teachers establish dialogic discourse using discursive moves, I then mapped the sequence of the discursive moves used in each dialogic episode. This approach allowed me to see the trends that reveal how discursive moves were used to establish a dialogic discourse. While I was mapping the sequences, I revealed a set of patterns that were evident in each dialogic discourse identified and analysed. While analysing the video data transcripts, I then counted the occurrence of initiations and rejoinders for each teacher.

4.3 Presentation of Findings from Video Data Transcripts

This section presents findings from transcripts obtained from the video data. With the transcripts from the video data, I sought to answer the first and second research questions by generating codes and categorising those codes. In other words, I wanted to see the nature of the discursive moves that Life Sciences teachers used to establish the dialogic discourse when teaching about the topic of the cell cycle, as well as the contribution of those moves to the development of dialogic discourse. As such, the mapping of discursive moves from different episodes that resemble dialogic discourse is presented and discussed below to unwrap the trends that led to dialogic discourse.

4.3.1 Elijah (School A)

I begin by showing the discursive moves that were used in Elijah's lessons in Table 4.2. As stated in Chapter 3, Elijah was only observed for two lessons.

Table 4.2: *Prevalence of Discursive Moves in Elijah's Lessons*

Teacher moves	**Category**	**Sub-category**	**Lesson 1**	**Lesson 2**
Initiation moves (types of questions)	Open-ended questions/	-	1	2
	Closed-ended questions		10	4
	Eliciting and acknowledging rejoinders	Eliciting further responses/ restating a question	0	0
		Marking	0	0
		Acknowledging	3	6
		Affirming	1	1
	Total		**4**	**7**
	Clarifying rejoinders	Requesting confirmation	0	2
		Requesting clarification	3	0
		Reframing question	2	3
		Revoicing	1	3
	Total		**6**	**8**
	Extending rejoinders	Requesting elaboration	2	0
		Asking an extended question	2	1
		Canvassing opinion	1	0
		Challenging to extend ideas	1	0
		Elaborating	3	1
		Present scientific views	0	0
	Total		**9**	**2**

Table 4.2 reveals the prevalence of discursive moves used by Elijah across the two lessons. In Lesson 1, Elijah initiated interaction eleven times as opposed to six times in the second lesson. The first and second lessons have more closed-ended than

open-ended questions. In particular, Elijah initiated interaction by using close-ended questions ten times in the first lesson and only used an open-ended question once. In the second lesson, he initiated interaction by asking close-ended questions four times and using open-ended questions two times. There is a noticeable difference in the choice of rejoinder moves employed in Elijah's lessons. In the first lesson, more extending rejoinders were used than in the second lesson. However, eliciting and acknowledging learner contributions were used in the second lesson rather than the first. A specific discursive move that seems to be dominating across the two lessons is *affirming.* However, there are some instances where Elijah sought *elaboration,* requested learners to clarify and revoice, and reframed questions asked.

Although Elijah used close-ended questions in his lessons, there were some instances where dialogic discourse was established as a result of the use of some discursive moves. In Table 4.3 below, I show how Elijah used discursive moves to establish dialogic discourse in his lessons.

Table 4.3: *Elijah's use of Discursive Moves in Dialogic Discourse Episodes*

Lesson	Episode	Usage of discursive moves
1	1	Cl-Q ➧ Clr ➧ Ackn ➧ Clr/Ext ➧ Ext ➧ Clr ➧ Ackn
	2	Op-Q ➧ Ext ➧ Clr ➧ Ext ➧ Ext ➧ Ext ➧ Ext ➧ Ackn ➧ Ext ➧ Ext Ext ➧ Clr ➧ Ackn ➧ Clr
2	2	Op-Q ➧ Clr ➧ Ext ➧ Ext ➧ Clr ➧ Ext ➧ Clr ➧ Ackn ➧ Clr ➧ Ackn ➧ Clr ➧ Ackn ➧ Clr ➧ Clr ➧ Ext ➧ Clr ➧ Ackn

As can be seen in Table 4.3, there were only two dialogic episodes in the first lesson and only one in the second lesson. The three episodes reveal different ways in which Elijah employed the initiations and rejoinders. In Lesson 1 Episode 1, there appears to be more clarifying rejoinder moves used among the acknowledging and extending rejoinders, where the interaction pattern began with a close-ended question. In Episode 2, there was frequent use of extending rejoinders, with eight counts compared to the acknowledging and clarifying rejoinders. In this case, the interaction pattern began with an open-ended question. In Lesson 2 Episode 2, Elijah opened the discussion with an open-ended question, and more clarifying rejoinders were employed than acknowledging and extending rejoinders. There was, therefore, a variety of ways in which Elijah used discursive moves to facilitate dialogic discourse. I show two examples of dialogic discourses that took place in Elijah's lessons below.

The first example (Excerpt 1) comes from Lesson 1 Episode 1. This line of enquiry was initiated in the middle of the first lesson after explaining the occurrence and significance of DNA replication. Nonetheless, it is evident that Elijah had intended to ask the question at an early stage of the lesson.

Excerpt 1: Example 1 of Elija's dialogic episodes

(1)	**Teacher:**	What do you think happens if you remove the nucleus of a cell? ***(cl-q)*** What's the obvious thing that will happen?
(2)	**Learner 1:**	The cell will die
(3)	**Teacher:**	Not immediately It will not die immediately, there is something that can never happen as long as you carefully remove the nucleus, what happens to the cell? ***(Clr)***
(4)	**Learner 2:**	It stops functioning
(5)	**Teacher:**	when you say it stops functioning, what function are you referring to (***Ackn***)
(6)	**Learner 2:**	It's cell division.
(7)	**Teacher:**	What about cell division? (***Clr/Ext***)

(8)	**Learner 2:**	The cell division stops functioning.
(9)	**Teacher:**	What are you saying? What happens, the obvious thing that happens when you remove the nucleus? (***Ext***)
(10)	**Learner 3:**	It will live for a short time, and die after a number of days.
(11)	**Teacher:**	But one thing that can never happen when you remove the Nucleus? (***Clr***)
(12)	**Learners:**	Cell division won't take place
(13)	**Teacher:**	Cell division won't take place. The first thing that will stop is cell division. We're 100% sure that (***Ackn***) won't take place, so why? (***Ext***)
(14)	**Learner 1:**	Because there is no nucleus.
(15)	**Teacher:**	Yes because there is no nucleus it won't take place why? (***Ext***)
(16)	**Learner 2:**	Because the cell division occurs in the nucleus.
(17)	**Teacher:**	so why? (***Ext***)
(18)	**Learner 3:**	The nucleus is the largest cell organelle.
(19)	**Teacher:**	So why? Okay, I agree with you cell division won't take place because you have removed the nucleus so definitely cell division stops, but why does cell division stop or not take place when you remove the nucleus? (***Clr***)
(20)	**Learner 4:**	Sir I'm not sure if I'm right about this but doesn't the nucleus control everything that goes in and comes out.
(21)	**Teacher:**	No, no, no. (***Ackn negatively***)
(22)	**Learner 5:**	In the chromatin network there are chromosomes, there are no chromosomes present for cell division to take place.
(23)	**Teacher:**	Once you remove the nucleus? Okay, okay, fine, very good! (***Clr***)

The above excerpt is an example of a dialogic discourse that was evidently initiated by a closed-ended question (see Turn 1). In this episode, the first teacher's utterance is characterised by a request for unlimited and flexible ideas from the learners. The first learner to respond could not explicitly explain what would lead to the death of the cell. Instead, the learner provided a short response. Interestingly, instead of evaluating whether Learner 1's contribution was correct or not, in Turn 3, the teacher gives extended feedback and further rephrases his initial question, which, in this case, is regarded as an extended rejoinder, canvasing opinion. What follows this is a buzz of

learner-learner discussion. However, in Turn 5, Elijah employs an extended rejoinder by asking an extended question to dig deep into the learners' understanding in Turn 6. However, Learner 2 still responds with a short answer. Instead of Elijah just telling learners the answer he was expecting, he probes further by using an extended rejoinder to request elaboration in Turn 7. In Turn 9, Elijah employed an extended rejoinder again, requesting elaboration, thus, a clear understanding of the enquiry. In Turn 13, the teacher requested elaboration. At this point, some learners had been quiet from the beginning of the lesson while others were discussing things between themselves but did not necessarily respond to the teacher's question. When the learners started sharing their ideas, Elijah appeared to make use of a negative evaluation rejoinder, which assisted in discouraging the out-of-context answers, avoiding answers that were deviating and irrelevant. Nevertheless, among the learners who were quiet while others responded to the teacher's question, Learner 5 gave a detailed and lengthy response, which revealed that the learner had been paying attention and following the lesson. Additionally, this shows that the use of this rejoinder helped Learner 5 in Turn 22 to be able to align and shape her answer explicitly and correctly.

The following excerpt (Excerpt 2) comes from the third episode in Table 4.3, extracted from Lesson 2. This discussion was initiated in the middle of the lesson after Elijah had explained how the cells divide as well as all the functions of the cell components involved in the cell division. Here, Elijah was trying to drive the learners to make a connection between the appearance of the cell's genetic contents during the early stages before and after the cell division takes place.

Excerpt 2: Example 2 of Elijah's dialogic episodes

(1) Teacher:	Now I want you to think about it if this cell is not going to Immediately divide, each one of them; what is going to happen in the chromosomes? Please don't tell me that they will disappear. Because they don't, what, think about it, what do you think will happen to the chromosomes? What will happen to them? Okay, let me give you a bit of time. What do you think will happen to the chromosomes? The cells are not going to divide; let's take just 1 of them. It's not going to divide; what will happen to the chromosomes? (Op-q) Please don't check the books.
(2) Learner1:	They will add up again
(3) Teacher:	They will replicate? meaning that they will double up? (***Clr***)
(4) Learner 1:	Yes.
(5) Teacher:	They will only double up under what circumstance? (Ext) Huh? Yea, he is saying that. I am saying this cell is not going to divide, right? But he is saying that one of the things that will happen to the chromosomes is that they will double up in number. So inother words, replication will take place. Then I am saying, Okay first of all let me ask like this, do you agree with him?
(6) Learners:	Yes **(chorus)**
(7) Teacher:	Okay, if you agree with him, we discussed the circumstance under which the chromosomes replicate, under which they double up. What is that? What is the condition under which the chromosomes double up? Where they become more number, when the cell is what? (***Ext***) You seem like you are thinking very hard, give us the answer.
(8) Learners:	**(silence)**
(9) Teacher:	Okay, didn't I say that replication takes place during interphase? Didn't I tell you that? And then I told you that the interphase is a preparatory stage before the cell starts to divide. So, a cell does not go into interphase unless it is going to divide. So, I am saying, okay, fine, if it was going to divide, it was going to go through interphase. I am saying it is not going to divide; it has reached its destination. Oh, by the way, I must also mention this:

specialised cells do not divide. Cells that are specialised to perform a specific function generally do not divide. But now, I am not saying this is a specialised one; it is just a cell. I am just saying it is not going to divide; what happens to the chromosomes? And also remember there was only one centriole here and in here. So, obviously there is now going to be one here and one somewhere there. (The teacher points at the structure of the centriole on the board). So what will happen to the centriole? (***Clr***) Yes!

(10) Learner 1: The chromosomes will move away from the equator.

(11) Teacher: You are talking about the centrioles or the chromosomes? (***Ext***) Which ones are you talking about?

(12) Learners: The chromosomes.

(13) Teacher: The chromosomes, you are saying they will move away from the equator? (***Clr***)

(14) Learner 1: Yes.

(15) Teacher: Now, there are people here who have never answered even a single question. Yes!

(16) Learner 2: Will have, isn't this thing the… er

(17) Teacher: Yes, the centriole (***Ackn***)

(18) Learner 2: They will disappear.

(19) Teacher: They will disappear? (***Clr***) No, please raise up your hand.

(20) Learner 3: They will die

(21) Teacher: They will die? (***Ackn***) Yes!

(22) Learner 4: They will move to the equator.

(23) Teacher: You see, we start talking about the equator when the cell is dividing. Basically, usually. Okay, fair enough; looking at it, you can [see] that [it] is the South Pole. This is the equator, or whatever, but we usually refer to it. However, what is going to happen is they will replicate and be two because they'll be needed when it starts dividing to move to the opposite poles of the cell, but my question still remains: What happened. No, no that one was an easy one. I was I expected you to know because you are supposed to have two. One will go on this pole the other one will go on the other pole. But my question still remains What do you think happens to the chromosomes? (Clr) Yes!

(24) Learner 5: Sir chromosomes will not be distributed evenly amongst the cells.

(25) Teacher:	No (Ack). They've already been distributed evenly amongst. If this is a human, then remember we said during replication. We said they became 92, so if this is a human, each would have 46 chromosomes. So, they have been distributed equally. We started with a mother cell, which also had [how] many chromosomes? 46. So that is maintained. Now, what happens? They are already 46 inside there. What do you think will happen to them? (Clr)
(26) Learner6:	Decrease
(27) Teacher:	They will decrease? (***Clr***) I don't understand that statement. Okay, I don't, you [are] discussing as long as you are sharing ideas about this. If you are talking about something else, then we will have a problem. Okay, let me give you pause], Don't open the books. Okay, let me give you a clue x2. Let me give you an idea. What did we say chromosomes are like before the cell enters interphase to prepare for cell division? That is how they will be. Huh? We said we described chromosomes before the cell starts dividing actually before it enters interphase to prepare for cell division, so they go back to that. So, they will be what? (***Ext***)
(28) Learner 7:	They'll be like a snake.
(29) Teacher:	They'll be like a snake? (***Clr***)
(30) Learner8:	Chromatin network
(31) Teacher:	Yes, (***Ackn***) they are going now to turn into a chromatin network. Stop saying you knew the answer, you didn't. So, they are going to do, remember during the interphase when the cell is going to divide, they coil and become shorter and thicker. So, they uncoil now, become slim, if you, they become string-like. And they form what is known as the what? The chromatin...
(32) Learners:	Networks **(chorus)**

In Excerpt 2, Elijah initiated a discussion after explaining the formation of two cells at the end of mitosis and the components that the newly formed cells would have. This discussion was initiated using an open-ended question (see Turn 1), which was not a clearly stated or detailed question. An interesting point to make regarding this initiation

is that Elijah continually rephrased his question and provided further details to direct learners. As a result, Learner 1 could not answer the question. Elijah used a clarifying rejoinder move to request confirmation; however, when he used an extending rejoinder move requesting elaboration, he also provided a brief description that unpacked the previously stated question (see Turn 5). The learners still struggled to respond to the question, and that led to Elijah asking more questions in an elaboration of the previously posed question, to which, again, the learner did not respond. Elijah further elaborated, trying to make sense of the response Learner 1 gave in Turn 2; he gave a detailed explanation starting with the phase in which replication occurs as well as the reason why replication occurs (see Turn 7). In this instance, Elijah asked two questions at the same time: “What happens to the chromosomes? What will happen to the centriole?” This act created a bit of confusion for the learners.

Although this was a second lesson, the learners were still mostly unfamiliar with the parts of the cell involved in cell division, as was evident in Turn 16. Elijah responded with a clarifying rejoinder, where he revoiced the learner's response, eliciting and acknowledging the rejoinder move, which was soon followed by a negative evaluation from Elijah. The negative evaluation discouraged the irrelevant answers. Even though Elijah tried to eliminate deviating thoughts, it appeared that the learners were still confused. As such, Elijah gave another explanation based on the movement of the centriole to opposite poles and the reason for the move and then asked the question again.

Even after that explanation, Learner 5 still appeared lost and did not understand what the question required of her (see Turn 24). In response, Elijah started with a negative

evaluation and then continued with an explanation of the number of chromosomes in each cell. Still, this did not shed light on the issue for the learners until he gave them a clue in the form of a question (see Turn 27). After being given a clue, the learners could arrive at the correct answer. This excerpt shows a dialogic discourse because creative thinking is shared between the teacher and learners, where the teacher continuously provides feedback to the learners to shape their responses and make connections between existing and newly acquired knowledge.

4.3.2 Kol (School B)

The second participant in this study was Kol, who was teaching in School B. Below, I present what I gleaned from the analysis of his two lessons. Table 4.4 reveals the prevalence of discursive moves used by the teacher across the two lessons.

Table 4.4: *Prevalence of discourse in Kol's lesson*

Teacher moves	Category	Sub-category	Lesson 1	Lesson 2
Initiation moves (types of questions)	Open-ended questions/	-	2	1
	Closed-ended questions		15	2
Rejoinders	Eliciting and acknowledging rejoinders	Eliciting further responses/ restating a question	1	0
		Marking	0	0
		Acknowledging	3	1
		Affirming	7	1
		Evaluating negatively	0	0
	Total		**11**	**2**
	Clarifying rejoinders	Requesting confirmation	0	0
		Requesting clarification	2	0
		Reframing question	2	1
		Revoicing	1	1
	Total		**5**	**2**
	Extending rejoinders	Requesting elaboration	2	2
		Asking an extended question	5	0
		Canvassing opinion	1	0
		Challenging to extend ideas	0	0
		Elaborating	0	0
		Present scientific views	0	0
	Total		**8**	**1**

In Lesson 1, Kol initiated interaction 17 times and in the second lesson three times. There is a slight difference in the initiation moves employed in Kol's lessons for both Lessons 1 and 2. For both lessons, closed-ended questions dominated in comparison to the use of open-ended questions. In terms of the use of rejoinders, there were many eliciting and acknowledging rejoinders throughout the lessons. Many rejoinders were used in the first lesson rather than the second lesson. The second lesson seemed to take the transmission of information from the first lesson. Kol used affirming rejoinders and asked an extended question. What is interesting to note is that Kol never used higher-order rejoinders like elaborating, challenging ideas and contesting scientific views in the two lessons. Only two dialogic episodes were observed in Kol's lessons. I present Table 4.5, which is a representation of how the dialogic interactions unfolded in the two lessons below.

Table 4.5: *Kol's Use of Discursive Moves in Dialogic Discourse Episodes*

Lesson	Episode	Usage of discursive moves
1	1	Cl-Q ➧ Ackn ➧ Ext ➧ Clr ➧ Ext ➧ Ackn
2	1	Cl-Q ➧ Ackn ➧ Ext ➧ Ackn ➧ Ackn ➧ Clr ➧ Ext ➧ Ackn ➧ Ackn

Kol established a total of two dialogic episodes, one in each lesson. Both dialogic discourses were initiated with closed-ended questions. In the first dialogic episode, Kol employed an equal amount of acknowledging and extending rejoinders (two), with one clarifying rejoinder in between. In the second lesson, however, three acknowledging rejoinders were employed with equal counts of clarifying and extending

rejoinders (one). Neither of these dialogic episodes showed a variant use of rejoinder moves or initiation moves, as they were both initiated with closed-ended questions.

I show two examples of dialogic discourses that took place in Kol's lessons below. The first example (Excerpt 3) was extracted towards the end of the first lesson. Kol had just given a brief explanation of the replicated chromosome structure and the process of DNA replication.

Excerpt 3: Example 1 of Kol's dialogic episodes

(1) Teacher:	Let me ask then, what is DNA before cell division or in a non-dividing cell? (Cl-q)
(2) Learner 1:	DNA sir
(3) Teacher:	*No! Think about it again…**(Ackn)** When the cell has not started the process of dividing? **(Ext)**The one we said appears as coiled…*
(4) Learners:	Chromatin network
(5) Teacher:	Right, now, when the cell divides, this does what? (***Clr***) We said it unwinds to form what? (***Ext***)
(6) Learners:	Chromosomes
(7) Teacher:	Right, clearly visible chromosomes. (***Ackn***)

In Excerpt 3, Kol initiated the discussion with a closed-ended question, to which Learner 1 responded abruptly with a repetition of the teacher's question. When Kol provided feedback, he started with a negative evaluation. On the surface, this episode looks like an authoritative discourse because of the negative evaluation, but looking at it closely suggests that it may be a dialogic discourse. Kol's negative evaluation was followed by an instruction requesting Learner 1 to think of the question again. He further asked an extending question, suggesting that he was still keen on getting learners' further responses. Perhaps this might be the tension that Mortimer and

Scott's (2005) research highlighted between authoritative and dialogic discourses in science classrooms. The negative evaluation discouraged the idea of using DNA as a possible answer, and then he asked an extended question, which was followed by a clarifying rejoinder used to reframe the question. After the use of rejoinders, the learners were able to get to the correct answer–the chromatin network. Although Kol directed the learners to the correct answer, he did this by using a variety of rejoinders.

The second example was extracted from the middle of the second lesson when Kol was trying to help the learners understand where, when and why the process of DNA replication occurs and check if the learners were listening throughout the lesson. This line of enquiry was initiated when Kol realised that the learners were confused about the growing stage, DNA replication and mitosis itself.

Excerpt 4: Example 2 of Kol's dialogic episodes

(1)	**Teacher:**	Yes! It is a continuous process. What is the starting point? Where does this process start? (***Cl-q***)
(2)	**Learner 1:**	Interphase sir,
(3)	**Teacher:**	Interphase, (***Ackn***) mhm do we all agree with him? And why? **(Ext)**
(4)	**Learner 2:**	Yes sir, but before interphase, there is a growing stage then the first phase is the interphase.
(5)	**Teacher:**	All right, all right, what happens in the interphase? (***Ackn***) the important process that occurs in the interphase.
(6)	**Learners:**	DNA replication!
(7)	**Teacher:**	Right,(***Ackn***) can someone help us define this term? (***Clr***) Somebody, anybody.
(8)	**Learner 3:**	Umh… Sir, we said it is a process whereby DNA makes an identical copy of itself.
(9)	**Teacher:**	Good! So, people were listening, okay, and we said why is this process important? (***Ext***)
(10)	**Learner 1:**	To produce 2 daughter cells.
(11)	**Teacher:**	mhm… (***Ackn***) yes, your hand was up?

(12)	**Learner 2:**	For the equal sharing of chromosomes in the daughter cells produced.
(13)	**Learner 3:**	It is a preparatory phase for cell division to occur.
(14)	**Teacher:**	Wait, wait, wait! The interphase is the preparatory phase Right **(Ackn)**, where the cell prepares for cell division by replicating its DNA, where single-stranded chromosomes become double-stranded. The DNA must be replicated so that it can be equally shared amongst the two produced cells. Right?

In Excerpt 4, the teacher initiated a discussion using a closed-ended question, which was soon followed by a rejoinder move before the learners could respond. The rejoinder employed here was a clarifying rejoinder of reframing the question. In this lesson, the learners were doing a recap of the previous lesson, specifically, on the starting point of the cell cycle, so that a link could be created while continuing with the topic. As such, Kol was expecting that learners would provide answers that were more specific to the content, also considering that this was a recap and linking lesson. This point is supported by the manner in which the initiation question was phrased: “What is the starting point?” (see Turn 1). This demonstrated that the learners must already have had knowledge of this. Therefore, one may say that Kol was on a mission to extract the right and straightforward answers from the learners. The use of rejoinders, however, still served the purpose of inviting the learners’ contributions and aligning their answers correctly. What is interesting about this episode, however, is the fact that in Turn 11, Kol did not respond to Learner 2’s response in Turn 10; he continued to draw out more responses from other learners. Due to this, the learners’ responses drifted from one another as they came in segments, thus indicating uncertainty and confusion. In Turn 14, however, Kol provided feedback that summarised all the responses from the three learners who responded to the question. He also provided highlights of some of the learners’ responses, creating a coherent link and unpacking

them. In this turn, Kol used eliciting and acknowledging rejoinders, affirming what the learners had shared after arranging the responses in an orderly fashion.

4.3.3 Cami (School C)

Cami also used a variety of discursive moves to orchestrate interaction in his lessons. Table 4.6 shows the prevalence of these discursive moves.

Table 4.6: *Prevalence of Discursive Moves in Cami's Lessons*

Teacher moves	**Category**	**Sub-category**	**Lesson 1**	**Lesson 2**	**Lesson 3**
Initiation moves (types of questions)	Open-ended questions/	-	2	3	2
	Closed-ended questions		6	14	8
Rejoinders	Eliciting and acknowledging rejoinders	Eliciting further responses/ restating a question	1	0	0
		Marking	0	0	0
		Acknowledging	1	0	1
		Affirming	8	5	5
		Evaluating negatively	1	0	0
	Total		**11**	**5**	**6**
	Clarifying rejoinders	Requesting confirmation	0	2	0
		Requesting clarification	2	1	2
		Reframing question	1	1	2
		Revoicing	0	0	1
	Total		**3**	**4**	**5**
	Extending rejoinders	Requesting elaboration	0	2	1
		Asking an extended question	6	1	1
		Canvassing opinion	1	0	0
		Challenging to extend ideas	1	0	0
		Elaborating	0	1	1
		Present scientific views	0	0	0
	Total		**9**	**3**	**3**

In Lesson 1, Cami initiated interaction seven times in the first lesson and seventeen times in the second lesson. There is a slight difference in the initiation moves employed in all of Cami's lessons captured. In all the lessons, closed-ended questions dominated in comparison to the use of open-ended questions. Nonetheless, Cami used hints that served as reminders or to give clues to the learners when initiating discussion, including asking questions about the structures that were still on the board to check whether the learners were still paying attention. Despite the use of different rejoinders, affirmations dominated both lessons in eliciting and acknowledging rejoinders. There was no count of other rejoinders in the second lesson apart from affirmations. Clarifying rejoinders were used very minimally in both lessons by requesting clarification and reframing of the question. Extending rejoinders were dominated by asking an extended question for both lessons, with no counts of presenting scientific views. Table 4.7 shows the two dialogic discourse episodes extracted from Cami's two lessons.

Table 4.7: *Cami's use of Discursive Moves In Dialogic Discourse Episodes*

Lesson	Episode	Usage of discursive moves
1	1	Cl-q ➧ Ackn ➧ Clr ➧ Ackn ➧ Ext ➧ Ackn
2	2	Cl-q ➧ Ext ➧ Clr ➧ Clr ➧ Ext ➧ Ack

As can be seen in Table 4.7, two dialogic discourse episodes were observed in Cami's lessons. Both of Cami's dialogic episodes began with a close-ended question; in the first episode, acknowledging rejoinders were used more frequently than extending and clarifying rejoinders. In the second episode, equal counts of clarifying and extending rejoinders were employed, and the episode closed with an acknowledging rejoinder.

Both dialogic episodes appear to be very short, based on the initiation moves and choice of rejoinder moves Cami decided to use.

I show two examples of dialogic discourse that took place in Cami's lessons below. The first example (Excerpt 5) comes from the first lesson when Cami was still introducing the topic and recapping the previous topic of the cells. By So doing, Cami was trying to create a link between the two topics and the prior knowledge the learners already had. Cami's dialogic discourses appear rather short, which is evident in both Excerpt 5 and Excerpt 6, extracted from Lessons 1 and 2.

Excerpt 5: Example 1 of Cami's dialogic episodes

(1) Teacher:	What else are we expecting? (***Cl-q***)
(2) Learner 1:	Chromatin network
(3) Teacher:	No! (***Ackn***) I'm talking about the basic structure of a cell, not inside the nucleus (***Clr***)
(4) Learner 2:	Mitochondrion
(5) Teacher:	Mitochondrion, (***Ackn***) and what else? (***Ext***)
(6) Learner 3:	Cytoplasm
(7) Teacher:	Cytoplasm, right? (***Ackn***)

Excerpt 5 above was extracted from the beginning of the first lesson, where Cami was still introducing the lesson and trying to connect the learners' prior knowledge of cells and the new topic of the division of cells. This dialogic discourse was initiated by a closed-ended question, where the learners were required to provide any part they could think of that is found inside the cell. This question gave the learner enough room and flexibility to name any part they could recall. Learner 1, however, seemed somewhat confused because the chromatin network is inside the nucleus. This was evident when Cami used an acknowledging rejoinder to evaluate negatively; Learner

1 still struggled to rectify the response until Learner 2 came up with another partial response, which was correct. The teacher affirmed the response with an eliciting and acknowledging rejoinder move. Cami was still extracting information about other parts found inside the cell as she used an extending rejoinder to challenge extended ideas. Learner 3 then gave the final answer, which was the cytoplasm and the teacher affirmed this response with an acknowledging rejoinder.

Excerpt 6: Example 2 of Cami's dialogic episodes

(1) Teacher:	What did we call these chromosomes again? (***Cl-q***)
(2) Learner 1:	Single-stranded
(3) Teacher:	So now they need to undergo? (***Ext***)
(4) Learner 2:	Mitosis
(5) Teacher:	Mitosis? (***Clr)***
(6) Learners:	DNA
(7) Teacher:	DNA repli? (***Clr***)
(8) Learners:	cation
(9) Teacher:	Where they will be making a copy? (***Ext***)
(10) Learners:	of itself
(11) Teacher:	Okay, let's continue (***Ack***)

The excerpt above was extracted from Cami's second lesson, where she was continuing with the topic of the cell cycle. As evident in the excerpt, she initiated the discussion at the very beginning of the lesson with a closed-ended question. This initiation move did not give the learners any flexibility since the question had only one correct answer, as gathered in the previous lesson. What is interesting about this excerpt is how the interaction unfolded, where learners struggled to determine or recall that the single-stranded chromosome undergoes DNA replication. Cami employed a clarifying rejoinder to request clarification, and the learners were able to grasp it and thus finish up the term guided by the feedback that Cami provided.

Nevertheless, the clarifying rejoinder that Cami employed was more obvious (see Turn 7); hence, the learners grasped it quickly. One may say the learners were finishing off the teacher's sentence (see Turn 8) without a clear understanding of the concept or when it occurs. Cami punctuated this interaction with an extending rejoinder, where she was requesting elaboration of the term DNA replication. In this episode, the learners' interaction was very limited and predetermined. This limited interaction occurred because of the choice of discursive moves Cami decided to use, which reveals that she wanted to rectify the incorrect term used by Learner 2 but did not make an effort to explain why it is not mitosis but DNA replication. Instead, she gave them hints and clues (see Turn 9) that every learner could follow through to answer the question.

4.3.4 Mary (School D)

Mary was the 4th participant who was based in school D. I present the prevalence of discourse established from her lessons below (see Table 4.8)

Table 4.8: *Prevalence of Discourse in Mary's Lesson*

Teacher moves	**Broad category**	**Sub-category**	**Lesson 1**	**Lesson 2**	**Lesson 3**
Initiation moves (types of	Open-ended	-	0	0	0
	Closed-ended		1	18	16
Rejoinders	Eliciting and acknowledging rejoinders	Eliciting further responses	0	0	0
		Marking	0	0	0
		Acknowledging	0	0	0
		Affirming	1	9	9
		Evaluating negatively	0	0	0
	Total		**1**	**9**	**9**
	Clarifying rejoinders	Requesting confirmation	0	2	0
		Requesting clarification	0	0	3
		Reframing question	0	1	0
		Revoicing	0	0	1
	Total		**0**	**3**	**4**
	Extending rejoinders	Requesting elaboration	0	0	5
		Asking an extended question	0	0	1
		Canvassing opinion	0	0	0
		Challenging to extend ideas	0	0	0
		Elaborating	0	3	0
		Present scientific views	0	0	0
	Total		0	**3**	**6**

Table 4.8. shows three lessons that were recorded from Mary's lessons. Closed-ended questions initiated all discussions during all the lessons, and no open-ended questions were observed or recorded. In all three lessons, all three categories of rejoinders were used, although in different frequencies. There was a prevalent use of affirming rejoinders across all three lessons, no other acknowledging rejoinders were observed. There was one affirming rejoinder employed in the first lesson, nine in Lesson 2 and

nine in the third lesson. There was no variety and flexibility in the usage of acknowledging rejoinders. Clarifying rejoinders were not employed in the first lesson but were evident in the second and the third lesson, although in minimal use. Moreover, a variety of clarifying rejoinders were used. Again, there was no use of extending rejoinders in the first lesson, but the second and third lessons showed evidence of extending rejoinders, but they were also used very minimally. For example, in the second lesson, elaborating was the only extending rejoinder used. In the third lesson, five counts of requesting elaboration and one of asking an extended question were used. Therefore, there was no variety in the use of rejoinders, as there was no usage of canvasing opinion, challenging to extend ideas and presenting scientific views for all three lessons.

Although Mary did not use a lot of extending rejoinders, although dialogic discourse episodes were observed in the second and third lessons. Table 4.9 shows these dialogic discourse episodes and how they were driven by certain discursive moves.

Table 4.9: *Mary's use of Discursive Moves in Dialogic Discourse Episodes*

Lesson	Episode	Usage of discursive moves
2	1	Cl-Q ➧ Ext ➧ Ext ➧ Ackn
3	1	Cl-Q ➧ Clr ➧ Clr/Ext ➧ Ext ➧ Clr ➧ Clr

Table 4.9 shows the two dialogic episodes extracted from Mary's lessons. There was no variant use of initiation moves, as both episodes were initiated with closed-ended questions. In the first lesson, only extending and acknowledging rejoinders were used without a clarifying rejoinder. In the second lesson, only clarifying and extending rejoinders were used, and no acknowledging rejoinders were used. Nevertheless, the

second episode appeared to be somewhat longer than the first episode because of Mary's choice of discursive moves.

Excerpt 7: Example 1 of Mary's dialogic episodes

(1)	**Teacher:**	What is DNA replication? (***Cl-q***)
(2)	**Learner 1:**	It is a process
(3)	**Teacher:**	The process, yes, whereby what? (***Etx***)
(4)	**Learner 2:**	Whereby DNA makes an identical copy of itself
(5)	**Teacher:**	Whereby? (***Ext***)
(6)	**Learners:**	DNA molecule makes an identical copy of itself **(chorus)**
(7)	**Teacher:**	DNA makes molecule an identical copy of itself, right? (***Ackn***)

Excerpt 7 was extracted from Lesson 3, right after Mary explained the function of storage organelles and after that gave the learners an activity. In this excerpt, Mary was trying to shape the learners' phrasing of the concept of DNA replication. This dialogic discourse was initiated by a closed-ended question (see Turn 1), to which Learner 1 responded with a short and limited answer. Mary responded positively to acknowledge how the learner started the sentence. She then elaborated with an extending rejoinder to request elaboration (see Turn 3) to request continuation from the learners, and that is when Learner 2's response was missing the keyword, to which the teacher continued to request elaboration with an extending rejoinder. The learners then realised there was a missing term, and they responded with the correct answer, as the teacher had specifically taught the learners. The learners realised there was a missing term on their own but were obviously guided by Mary's question without her having to tell them what was missing in the definition. Seeing that Mary had established her goal, she then affirmed with an eliciting and acknowledging rejoinder move and punctuated the episode.

Excerpt 8: Example 2 of Mary's dialogic episodes

(1)Teacher:	Yes, which is the outline of the nucleus that is formed. The chromosomes that were separated and are now covered. And then, two identical cells with the same chromosome number as the original cell is formed. Right? This means– If [we] started with seven chromosomes, how many are we going to have here? (*Cl-q*)
(2)Learner1:	Seven
(3)Teacher:	If we initially had six, six chromosomes, how many chromosomes will we expect to find here? (***Clr***)
(4)Learners:	Six/ three **(chorus)**
(5)Teacher:	Six or three (***Clr***)
(6)Learners:	Six/ three **(chorus)**
(7)Teacher:	Why? (***Ext***)
(8)Learner2:	They divide
(9)Teacher:	They divide right? (***Clr***) Okay, so you are saying there will be three here? (***Clr***)
(10)Learners:	Yes **(chorus)**
(11)Teacher:	What happened to identical?x2 (***Ext***) Listen carefully now, that means there is a bit of confusion here with the number of chromosomes.

Excerpt 8 was extracted from the third lesson, where she had taught all the phases of the cell cycle. She wanted to see if the learners understood the key points and the entire process of the cell cycle by providing the resultant number of chromosomes when provided with the starting number. Mary explained before initiating the new line of enquiry with a closed-ended question in Turn 1. In her explanation, Mary mentioned that the same number of chromosomes found in both cells makes the cell identical; after that, she asked a question. This reminder that the number of chromosomes does not change allowed Learner 1 to respond easily with a correct answer in Turn 2. However, when the teacher decided to change the number of chromosomes, it created confusion and uncertainty for some of the learners as evident in Turn 4. Some learners

said three, while others said six. The teacher employed a clarifying rejoinder to request clarification, which can also be characterised as an extended rejoinder of asking an extended question. The confusion was maintained, although it was not easy to point out if it was from the same learners as before because they recited in a chorus. Nevertheless, these rejoinders were meant to assist the learners in coming clean and taking a stand, but the confusion remained as the response did not change in Turn 6.

Interestingly enough, the continued use of rejoinder moves led to prolonged interaction and also assisted with the identification of learner confusion and thus being able to address it. However, Mary did not spend time and employed other rejoinders to find out why the learners believed there would be three or six chromosomes in a resultant cell (see Turn 7). Instead, when she asked why, one of the learners responded that they divided, and the assumption would remain that this was a resultant cell with three chromosomes, as it was not clarified. Therefore, Mary explained the concept again to address the confusion.

In this section, I have presented the findings from the video data of the four teachers. A summary and discussion of these findings are provided in Chapter 5.

4.4 Detailed Description of Analysing Transcripts from VSRIs

In this section, I focus on answering the third research question. The data in this section was transcribed from the audio-recorded VSRIs that were conducted with the individual participating teachers. Each participating teacher was interviewed based on the dialogic episodes extracted from each lesson to determine “What influenced the kind of moves that Life science teachers used in their lessons”. Table 4.10 shows the

number of VSRIs I conducted for each teacher and examples of questions asked during the interviews.

Table 4.10: *Number of VSRI Interviews and Interview Questions for Each Teacher*

Teacher	**Number of interview sessions**	**Examples of questions asked**	**Duration in minutes**
Elijah	2	Why did you ask this question here? There is a frequent use of "why" in this lesson. Was this intentional?	27:00 minutes
Kol	2	What was the significance of this question at the beginning of the lesson? Is there any other way that you could have phrased this question?	32:22 minutes
Cami	2	Why did you phrase this question like this? You did not respond to the learner here; was it intentional?	15:00 minutes
Mary	2	Did you ask the same question in other classes? What was the significance of this question?	14:38 minutes

As can be seen in Table 4.10, the questions asked to each teacher were different. This difference is because these questions were devised based on the preliminary analysis of the individua; video data. In total, there were eight interview transcripts. In analysing the transcripts from these interviews, I followed the steps below:

Step 1: Familiarising myself with the data–I had data in the form of audio recordings and transcripts. I did a thorough reading of all the interview transcripts at least three times while listening to the audio recordings to double-check in case I missed anything when I was transcribing. Although I got a sense of new emerging codes from each interview transcript, at this point, there was no coding. While I was reading the transcripts, I was trying to do a basic-level interpretation of the teachers' utterances.

Step 2: I began with the transcript from one teacher and coded the transcript both inductively and deductively. The inductive coding was influenced by the literature presented in Chapter 2. I then extracted the codes from the transcript and described these codes.

Step 3: I applied the codes to the second transcript. I was able to code most of the teachers' responses using the pre-determined codes since most of their comments were on learner participation, avoiding confusion and minimising distractions. However, I did not use all the pre-determined codes, as some of the teacher's utterances did not fit; as a result, I noted these utterances aside, and that is how and where the newly developed theme emerged. I did the same with the other transcripts (see Appendix G for codes used and their descriptions).

Table 4.11: *Codes and Generated Themes*

Teacher	Asked questions	Teachers' responses
Elijah	Why did you ask this question at the beginning of the topic?	Because it is part of what we did in cells (***acknowledging prior knowledge***), I was trying to connect the discussion on cells and the topic (***creating links***)
Kol	What was the significance of this question? What were you trying to establish?	Is linking the chromatin network to the chromosome (***creating links***), to say this is the very same structure, just in different times. Then, when the cell starts to divide, the DNA is going to, will be as the chromosome [is] now (***memorising/drilling).*** Which is also an exam question ***(influence of exam),*** especially in Grade 12, and I gave the answer at the same time without giving a chance to reply **(wait-time).** It's because I knew that it was going to confuse them. … I'm teaching it just like that, to say DNA is a chromatin network but DNA is also a chromosome. When the cell is not dividing, it's going to remain as chromatin; when the cell starts to divide, then we [are] going to have the chromosomes (***memorising/ drilling***) because…
Cami	Why did you ask this question at the beginning of the lesson?	Because we did cells in Grade 9, so it was to remind one another that when we [did] them in Grade 9, what they looked like and build on that (***creating links***).
Mary	This one is the one that links with the function of a vacuole?	Yes, the function of a vacuole, since we are talking about vesicles specifically; vesicles are types of vacuoles. And vacuoles are used for storage most of the time, and those vesicles are the ones that form the plates between the two daughter cells, which assist in the formation of cell wall, but what I wanted to say is, that it goes back to our organic compounds, carbohydrates (***creating links***).

Step 4: Finding patterns and relationships – After coding all the transcripts and filtering the codes, I looked at the patterns encompassing the teachers' utterances in response to their choice of discursive moves employed. Four themes that characterise what influenced the teachers' moves emerged from the analysis. The first theme is about escorting and supporting learners' knowledge-building process. The second theme pertains to the teachers' implicit or explicit intentions to address areas of difficulty or misconceptions. The third theme is about establishing the link between the content and its relevance in the learners' everyday lives. The fourth theme is about the curriculum demands. These themes are unpacked below.

4.5 Presentation of Findings from the Analysis of Interview Transcripts

The themes that emerged from the analysis described above are reflected below. As I present these themes, I also link them to what they have done in the classrooms. As such, you will notice that I refer to some of the excerpts presented in the previous section.

4.5.1 Theme 1: Escorting and Supporting Learners' Knowledge-Building Process

All the participating teachers exhibited support for the knowledge building, although for some, in great detail. Therefore, the need to support learners' knowledge-building became one of the factors that influenced the teachers' use of discursive moves. By knowledge building, I mean classroom interactions such as a) learners are encouraged to participate, b) there is less dominance of the teacher's voice to force content knowledge on them, c) often, learners are awarded opportunities to explore ideas, sometimes by questioning (Tang, 2020). This trend was evident in Elijah and Cami's lessons in the form of acknowledging prior knowledge and creating links

through talk. In both these occurrences, the teachers would explore the learners' responses and challenge their thinking, often eliciting more responses. Cami, for example, in her first lesson, tried to ensure that every learner remembers the basic structure of a cell and, as such, understands the reason they need to remember the cell structure. Also, in Elijah's lessons, he would give the learners a chance to arrive at the correct answer on their own by using as many rejoinders as possible. However, in some instances, he would ignore irrelevant answers, although the interactions in which he engaged the learners were prolonged. The knowledge-building process in the learners starts from acknowledging prior knowledge (Alkhouri et al., 2021; Mönch & Markic, 2022), which allows learners to create their own links with the content through talk. In acknowledging prior knowledge, misconceptions can be addressed. All the participating teachers showed the necessity of the practices, as mentioned earlier. When the teachers were asked "why did you asked this question beginning of the lesson?" Their utterances are shown in the extracts below.

Elijah:	It is part of what we did earlier on cells; I was trying to connect the discussion on the cells and the topic.
Kol	So, there I was trying to link the chromatin network to the chromosome, to say, this is one and the same thing, just that on different occasions, it appears as different structures or different forms.
Cami:	Because we did cells in Grade 9, it was to remind one another that when we did them in Grade 9, what did they look like? Because that is where we are building from; we can't build up on something that they can't even remember. Hence, we need to remind one another because they've done it, and we are continuing from here.
Mary:	But what I wanted to say is, it goes back to our organic compounds, carbohydrates. Plants store carbohydrates in their vacuoles, right? These carbohydrates that form the cell wall is cellulose.

As can be seen from the teachers' utterances above, they seem to understand that the use of talk moves is influenced by the necessity to promote knowledge-building. When Elijah was asked why, he asked, "What do we call chromosomes while they are in the nucleus, before they become visible?" At the beginning of the lesson, his reasoning was based on connecting what the learners had done already in the previous grades. He asked that specific question as a way of sparking a discussion. This was followed by a series of rejoinder moves that channelled the learners into arriving at the correct answer themselves. Cami and Mary's decisions to initiate discussions in specific ways were also influenced by their objectives of building on what the learners have done already and making links.

In Cami and Mary's lessons, they relied mostly on closed-ended questions, where the learners were directly required to tap into their memory. Some episodes resembled drilling and recitation, which still contributed to the knowledge building. For example, see Excerpt 8 of Mary's second episode and Except 6, the first episode of Cami's dialogic interactions. It is important to note that Elijah, Cami, and Mary allude to making links at the beginning of the lesson. However, Kol's choice of discursive moves was influenced by his quest to make links and support knowledge-building during lesson development. For example, see Excerpt 3, where Kol used clarifying and extending rejoinders to guide the learners on the relationship between a chromatin network and a chromosome. The second example is Excerpt 4, in which he used an acknowledging rejoinder followed by a clarifying rejoinder move to get learners' understanding of what DNA replication is and how it occurs. In both encounters, Kol guided the learners to new knowledge by engaging them verbally through questioning to extract their

thoughts and understanding. By so doing, learners would get a chance to confront what they already know in the process of building new knowledge (Dorimana et al., 2022).

The teachers also talked about the role of asking focused questions to build knowledge, but also with the purpose of influencing learners to prepare for their examinations. Thus, when teachers were asked about the descriptions in a form clues that they gave the learners, their responses were as follows:

Elijah:	Because I realised, they didn't know; they didn't realise what I was talking about. So, I tried to give them a clue so that they could realise that I was talking about the chromatin network.
Kol:	It's a recap question, we are recapping we are recapping but focusing on exam questions. So, the recapping part I usually do is in the form of the exam questions that are coming from the previous lesson. So, I create the exam questions that I know from the lesson we've had; the possible exam question is this and this, and then I use it to recap. Or as an introduction for the second lesson.

In the above extracts, Elijah noted the influence of learners' lack of knowledge of the chromatin network. Hence, he had to provide a clue related to the question he was asking. His deliberate provision of clues emanates from the fact that learners need to understand key concepts for their examinations. This insight was also gleaned from Kol's interviews, in which he deliberately created questions on the basis of possible examination questions. In other words, his way of weaving interaction was influenced by examination question types. Normally these types of questions are given to learners on paper, but teachers in this study revealed that they can be incorporated in verbal whole-class discussions to drive interaction.

4.5.2 Theme 2: Using Discursive Moves with the Intention to Implicitly or Explicitly or Both Address Areas of Difficulty and Misconceptions

All four participating teachers talked about how areas of difficulty and misconceptions in teaching the topic of the cell cycle influenced their use of discursive moves. In these areas, the teachers intentionally employed discursive moves that would shed light and channel the learners' understanding of the question and the expected answer. For example, when the participants were asked why they phrased the question in a manner in which they did, they had this to say:

Elijah:	No, that question was not clear, that's why they struggled to answer. Yea. I led them through until she realised no, this man should be talking about what is in the nucleus. I think at that point, that one realised. That's why she referred to chromosomes being on the nucleus. But the initial question was ambiguous. Kol: I refrain from talking about something that is not relevant to the topic. So that's why I ignored that one. I ignored it on purpose because by explaining it, they would think that it is part of the content, meanwhile, I'm trying to explain why it is wrong so… I'll make…, I'll give them information that is not going to help in the exam.
Cami:	Like I'm making a copy, only, of what? Here, we are not copying just anything, like we're saying that they just think a piece of paper only; we are specific to say we are copying DNA.
Mary:	Even for them the number of chromosomes was confusing because I used eight chromosomes as an example for them. Others were saying two, others saying four and others saying 16. And I was like, how? And so, I explained DNA replication again then the division again.

The above responses given by the participating teachers to the study indicated that they were aware of the learners' difficulties in understanding and responding to the

question, which led them to use specific discursive moves. Elijah gave the learners clues to ease the pressure and difficulty of the question, especially when using rejoinders. In Kol's case, he stated that anything that is not examination-related or that is general knowledge he does not entertain. However, dialogue helps eliminate misunderstandings and misconceptions. This is because Kol would continuously pose an example of an examination question to the learners in line with his current explanation. One may, therefore, say that the learners are being trained to believe that what is being studied is what they will be assessed on, rather than general knowledge. Similarly, Cami and Mary also wanted specifications from the learners, but in order to achieve this, they first had to assess the learners. Mary established that the number of chromosomes is rather confusing for the learners, and she realised this after asking follow-up questions. Then, she had to explain the process of DNA replication again.

5.4.3 Theme 3: Establishing the Link Between the Content and its Relevance in the Learners' Everyday Lives

All four participating teachers were able to invite the learners to varying learning spaces to create a credible link between the content and authenticity of everyday life. This was mostly evident in Elijah's lessons, where he used day-to-day examples to convey the content delivered to the learners better, which was at the beginning of the first lesson. In Kol's and Cami's lessons, continuous use of scientific terms appeared, merged with general language terms, to assist the learners in creating their links. For example, when Kol was introducing the topic, he used building bricks and the growth of people and books before taking the explanation to a scientific context. Similarly, Cami referred to what the learners observe every day, like the growth of a baby and making copies of a book or a piece of paper. When the participating teachers were

asked why they asked that question at the beginning of the lesson, they had the following to say:

Kol:	I would say I asked it because I wanted to make an introduction to the topic to grab learners' attention because they know that people grow. So, I wanted to create the question in their heads why is growth happening; you see?
Cami:	It's because they should be able to link this with what they experience on a daily basis; even if they see a child, they should think that it's because of cell dividing, also getting damaged, but at some point, you heal, tissues get repaired.

For the learners to understand science, they should be able to merge what they learn with what they know to be true to their lives and the environment in which they live. The participating teachers seem to respect and understand this view in their science classrooms, as they have made use of real-life examples to engage the learners in the discussion. It is also important to note that these authentic examples were not only used at the beginning of the lessons but in the middle of the lesson, in some cases with the introduction of the outstanding concepts that require the learner's undivided attention to understand fully. Kol, for example, in his response to why he asked the question at the beginning of the lesson his response was he was trying to capture the learners' attention because they would think the lesson is about what they already know, and it would be easier to relate. It was a similar instance with Cami; nonetheless, most of these examples were used when the participating teachers explained the uses of mitosis.

5.4.4 Theme 4: The Curriculum Demands

South African science curriculum encourages learner engagement, participation, and development of creativity (DBE, 2011), which can be established through dialogic

discourse. These curriculum reforms require teachers to be more knowledgeable and fully understand the teacher-to-learner interaction dynamics to impart knowledge as per the demands of the curriculum effectively. Both responses given by the participating teachers below reveal that apart from learner engagement and participation, they were trying to challenge the learner's reasoning. When the participating teachers were asked, "Why did you not give a clear response?" they had the following to say:

Elijah:	You see, there is a question where if you want them to sink, you spend a bit of time on it. Make follow-ups and follow-ups. The idea is to catch everyone's attention so that everyone can participate.
Kol:	Yes, because if I say, in my head, how I look at it, or how I looked at it, is that if I say how does growing happen, then I'm challenging the learner to think about growing as a person to say, okay, as I'm a person the reason why I'm this height is because my skeleton is this height as well. Then that means if I grow to be taller than this that means even the skeleton, the bones must grow as well. I was then challenging them to go inside the bone to say why the bone has to elongate or become longer that's where the answer would be to say the cells will have multiplied in the bones then the bones will become longer. So, I was trying to give them a very challenging level of thinking.

In both Elijah's and Kol's episodes, they were trying to challenge the learners' reasoning during the lesson. Elijah used many follow-up questions to ensure that every learner engaged and thus participated during the lesson. This approach tends to lengthen the discussion (see Excerpt 2 of Elijah's episode). In this episode, after Elijah posed a question, he responded with, "So why?" in almost all the responses the learners gave, his reasoning was he wanted a full answer where he did not have to

add anything. As such, he kept on with the follow-up questions until the question sunk in and the learners could respond. In Kol's lesson, he used an explanation so that the learners could envision what he was explaining. This forms part of the curriculum reforms because it provides an insight into how the learners' thinking is challenged to bring or develop creative and innovative thinkers.

5.4.5 Theme 5: Language Constraints

Language in science education is a famous research topic due to its dynamics and contributions to science education. These dynamics include spoken and written language, as well as comprehension of the language in context. This focus stems from an understanding that in South Africa, eleven official languages are recognised; as such, by virtue, South African classrooms are multilingual. Regardless of this, most South African schools often choose to use English as their language of medium (Department of Basic Education, 2010), although these schools are in Black communities and English is neither the teachers' nor the learners' mother tongue. The issue of language was not my primary focus in this study, but I could not turn a blind eye to its apparent impact on classroom discussions because of the ongoing debates around language in education. However, in the current study, only two of the four participating teachers commented on the use of language and its effects in the classroom. This was evident in Elijah's and Kol's lessons. Elijah mentioned that his question was not clear for the learners to understand, as it was ambiguous. As a result, he had to use certain rejoinder moves to lead learners to the correct answer. The second encounter was with Kol, who admitted struggling with vocabulary, which impacted how he phrased a question to the learners. Thus, when teachers were asked if there was consistency in phrasing of the questions from the previous day, they had the following to say:

Elijah: No, the question was ambiguous, it was not clear. They struggled; you see. That is why they went back to the fact that the nucleus is removed, so the… I should have maybe said why is the removal of the nucleus causing this, you see, then it would have been clear. So, then I wanted them to, but then, it's like the question was ambiguous. Can I see? Didn't I make a follow-up on this one?

But even that follow-up, is still "so why", I feel like the question was [pause] ambiguous; it was not very clear. No, that question was not clear; that's why they struggled to answer.

Kol: If it was possible it was going to be the same, but I guess the vocab played a role in the phrasing of the question.

When Elijah was questioned on his choice and frequent use of a follow-up discursive move, he reasoned, as indicated above, the ambiguity of the question. His frequent follow-up move was "why", which he asked as the means to probe and help the learners understand the context fully. As a result, the learners provided a few answers, and others were relevant, so he tried to establish if the learners understood the question and, therefore, gave a clear answer that was not vague. In Kol's case, he asked a question that he had previously asked but in a different way. When he was asked, he responded that lack of vocabulary drove him to phrase his question in that particular manner. One may say that Kol's vocabulary hindrance could also be a hindering factor on the learners' end in terms of development in the subject content.

4.6 Chapter Summary

The focus of this chapter was on the analysis of data obtained from the current study. I started with the analysis of video data, where I showed how I incorporated Tytler and Aranda's (2015) framework to analyse teachers' rejoinder moves and Hardman's

(2019) research to analyse learner responses. I then explained how I developed the analytical framework used and the tools that suit my study. I extracted and showed examples of dialogic discourse episodes for each teacher and explained the gist of each episode. The second part was the analysis and presentation of data from VSRIs. Similarly, regarding the data obtained from the video, I described in detail how the data was analysed and then presented my findings. I finally generated themes that were described in detail in terms of how they were determined and their relevance to my current study.

CHAPTER 5: DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

In this chapter, I discuss the results described and analysed in Chapter Four. With these discussions, I seek to answer the research questions of my current study and compare my findings with the claims made in the literature reviewed if there are any connections or lack thereof. I then provide limitations that I encountered in my current study, areas for further research, recommendations for future studies, and finally, the concluding remarks. This was guided by the main question, “How do Life Sciences teachers use discursive moves to establish a dialogic discourse when teaching about the cell cycle in Grade 10?” This main question was then broken down into three sub-questions:

1) What is the nature of discursive moves used by Life Sciences teachers when teaching about the cell cycle?
2) In what ways do the moves contribute to the establishment of a dialogic discourse in the Life Sciences classroom?
3) What influences the kind of moves that Life Sciences teachers use?

5.2 Discussion of Findings and Addressing the Research Questions

5.2.1 The Nature of Discursive Moves Used by the Teachers

The findings in this study indicate that teachers use both the initiation moves and rejoinders to facilitate interaction and, in some cases, further establish dialogic discourse. Table 5.1 below shows the summary of discursive moves used by each teacher. This is a combination of Tables 4.2, 4.4, 4.6 and 4.8 presented in Chapter 4.

Table 5.1: *A Summary of the Nature of Discursive Moves Used by the Four Teachers*

			Elijah		Kol		Cami			Mary		
Teacher moves	**Category**	**Sub-category**	**Lesson 1**	**Lesson 2**	**Lesson 1**	**Lesson 2**	**Lesson 1**	**Lesson 2**	**Lesson 3**	**Lesson 1**	**Lesson 2**	**Lesson 3**
Initiation moves	Open-ended questions/	-	1	2	2	1	2	3	2	0	0	0
	Closed-ended questions		10	4	15	2	6	14	8	1	18	16
Rejoinders	Eliciting and acknowledging rejoinders	Eliciting further responses/ restating a question	0	0	1	0	1	0	0	0	0	0
		Marking	0	0	0	0	0	0	0	0	0	0
		Acknowledging	0	0	3	3	1	0	1	0	0	0
		Affirming	3	6	7	1	8	5	5	1	9	9
		Evaluating negatively	1	1	0	0	1	0	0	0	0	0
	Total		**4**	**7**	**11**	**4**	**11**	**5**	**6**	**1**	**9**	**9**
	Clarifying rejoinders	Requesting confirmation	0	2	0	0	0	2	0	0	2	0
		Requesting clarification	3	0	2	0	2	1	2	0	0	3
		Reframing question	2	3	2	1	1	1	2	0	1	0
		Revoicing	1	3	1	1	0	0	1	0	0	1
	Total		**6**	**8**	**5**	**2**	**3**	**4**	**5**	**0**	**3**	**4**
	Extending rejoinders	Requesting elaboration	2	0	2	2	0	2	1	0	0	5
		Asking an extended question	2	1	5	1	6	1	1	0	0	1
		Canvassing opinion	1	0	1	0	1	0	0	0	0	0
		Challenging to extend ideas	1	0	0	0	1	0	0	0	0	0
		Elaborating	3	1	0	0	0	1	1	0	3	0
		Present scientific views	0	0	0	0	0	0	0	0	0	0
	Total		**9**	**2**	**8**	**3**	**9**	**3**	**3**	**0**	**3**	**6**

Firstly, the four teachers used initiation moves such as closed-ended and open-ended questions. However, the teachers mostly used close-ended questions instead of open-ended questions to initiate discussion (see Table 5.1). Close-ended questions are still a necessity in science classrooms (Chen et al., 2017) because they can be used as a good starting point and can unfold into a lengthy discussion, as found in Khoza and Msimanga's (2022) study. Generally, this is supported by previous literature arguing that closed-ended questions limit learners' possibilities and opportunities to engage in authentic conversations (Buma & Nyamupangedengu, 2020; Sherry et al., 2019). In other literature, close-ended questions do not challenge learners' thinking and reasoning (see Mangwiro & Machaba, 2022). Instead, they focus on shaping the learners' responses to be correctly phrased in line with the authoritative nature of science.

Nonetheless, many scholars agree that instead of close-ended questions, open-ended questions should be used as initiators because they offer a variety of opportunities and answers that are authentic to the learner's reasoning (Morris & Chi, 2020). This means that through initiating classroom discussions using open-ended questions, teachers can get a variety of responses from learners, thus, opening for more contributions. On the other hand, in the South African context, Khoza and Msimanga (2022) found that it is not about the kind of initiation that would help the teacher establish a heightened interaction. Instead, they found that the facilitation of the interaction using a variety of rejoinders has the potential to maximise the interaction in a science classroom, which awards more possibilities for dialogic discourse. Therefore, although the four teachers relied on close-ended questions, it might not necessarily mean a lack of heightened interaction patterns, as I will discuss later.

In the current study, the teachers seemed to use a variety of rejoinders to facilitate interaction. Tytler and Aranda (2015) talk about rejoinders as direct teacher responses to the learners' input in an interactive lesson. This means rejoinders are influences by learners' contributions as well as the inherent messages that the teacher may get from these contributions. As such, discursive moves can help teachers support a high level of thinking to promote classroom discussion. As argued earlier in this dissertation, there are a variety of rejoinders that teachers can use. These include acknowledhing, clarifying and extending rejoinders (Tytler & Aranda, 2015). In fact, Tytler and Aranda's (2015) framework seems to prefer extending rejoinders rather than acknowledging rejoinders. This is because acknowledging elicits and shapes learners' responses, and clarifying rejoinders follow up on the learners' understanding of the content. On the other hand, extending rejoinders challenges the learners' thinking process, which ensures that learners contribute to their learning process. However, the teachers in this study used a lot of acknowledging and clarification moves. This is evident in Kol's classroom Lesson 2 Episode 2 and Mary's Lesson 3 Episode 2 (see Table 5.2 below).

One would argue that instead of acknowledging rejoinders, using extending moves would result in heightened interaction because learners are challenged and get the opportunity to voice their ideas. However, as it was seen in this study, sometimes learners provide responses that are extended even if the rejoinder move used is acknowledging (I will later show this).

In answering the first research question, nature, in this case, refers to the use of specific discursive moves during the lesson to drive or channel the learners toward a

dialogic discourse. This was about understanding how the discursive moves were used, whether they were more or less frequent, and how they contributed to the teaching and learning to probe learners or elicit and impart a deeper understanding of the content knowledge. In the current study, it was evident that teachers used more closed-ended questions to initiate discussions and in rejoinders out of the three categories, acknowledging rejoinders were the most prevailing. This is in line with what Khoza and Msimanga (2022) found in their study. However, this study also found that even acknowledging moves can be used to establish heightened interaction. I discuss this point below.

5.2.2 Discursive Moves Used to Establish Dialogic Discourse

The use of certain discursive moves seemed to establish a dialogic discourse. I defined dialogic discourse as when the teacher accepts and negotiates learners' contributions regardless of whether these contributions conform to the scientific story or not. This is in line with Mortimer and Scott's (2003) framework and Khoza and Msimanga (2022) have adopted this definition. However, the establishment of a dialogic discourse does not emerge due to the sole use of specific moves. It is the specific progression of the use of discursive moves that seemed to be working in establishing a dialogic discourse. Table 5.2 shows a summary of the dialogic discourse episodes that emerged from the teachers' lessons. This table is a combination of tables 4.3, 4.5, 4.7 and 4.9 illustrated in the previous chapter.

Table 5.2: *Summary of Dialogic Episodes Observed in Each Teacher's Lesson*

Teacher	Lesson	Dialogic episode	Usage of discursive moves
A	1	1	Cl-Q → Clr → Ackn → Clr/Ext → Ext → Clr → Ackn
	2	2	Op-Q → Clr → Ext → Ext → Clr → Ext → Clr → Ackn → Clr → Ackn → Clr → Ackn → Clr → Clr → Ext → Clr → Ackn
B	1	1	Cl-Q → Ackn → Ext → Clr → Ext → Ackn
	2	2	Cl-Q → Ackn → Ext → Ackn → Ackn → Clr → Ext → Ackn → Ackn
C	1	1	Cl-Q → Ackn → Clr → Ackn → Ext → Ackn
	2	2	Cl-Q → Ext → Clr → Clr → Ext → Ackn
D	2	1	Cl-Q → Ext → Ext → Ackn
	3	2	Cl-Q → Clr → Clr/Ext → Ext → Clr → Clr → Ext → Ext

Table 5.2 above shows all the dialogic episodes in each teacher's lesson. The first noticeable trend is how all the episodes begin. They begin either with an open-ended question or a close-ended question. For example, in Episode 2 of Elijah's dialogic episodes, the first episode was initiated with a closed-ended question, whereas the second one was commenced with an open-ended question. Open-ended questions are described by Morris and Chi (2020) as questions that increase the learners' thought processing because they require a greater understanding of content knowledge and, thus, the application of skills through scientific language and externalising their ideas. These types of questions award flexibility for the learners to provide multiple answers to one question (Mangwiro & Machaba, 2022). Additionally, Ramadhani and Zainil (2019) argued that open-ended questions require thought

processing to generate lengthy responses. It is through this processing that learners first cognitively engage with the question then vocalise their responses in a whole class discussion (Khoza & Nyamupangedengu, 2018). Consequently, open-ended questions have been argued as the type of questions that lead to dialogic discourse. In the current study, Elijah is the only teacher who employed a dialogic discourse by initiating interaction with an open-ended question (see Table 5.2). However, in this study, it was found that even close-ended questions can lead to the establishment of dialogic discourse (see for example, findings from the last two teachers).

The other seven dialogic episodes observed in the four teachers' lessons were initiated using close-ended questions. The study conducted by Morris and Chi (2020) reveals that closed-ended questions limit the opportunities for the learners to respond, reason and exercise their high thought-processing ability since these questions only have one correct answer. Teachers ask closed-ended questions as a starting point in science classrooms to see whether the learners have content knowledge to build from or not (Mangwiro & Machaba, 2022); therefore, closed-ended questions are also necessary in science classrooms as they give the teacher an idea of how much the learners know. In this way, close-ended questions can serve as means to gather learner prior knowledge. This study found that close-ended questions can also lead to a dialogic discourse in science classrooms.

Secondly, there is variation from one episode to the next in terms of how rejoinders were used to build interaction. For example, in Elijah's lessons, Episode 1 is characterised by three clarifying rejoinders, two acknowledging rejoinders and two extending rejoinders. However, in Episode 2, eight clarifying rejoinders were used,

four extending rejoinders and four acknowledging rejoinders. In Kol's lessons, Episode 1 is characterised by two acknowledging and extending rejoinders, and then one clarifying and extending the rejoinder. The interaction was closed off with an acknowledging rejoinder. In Episode 2, however, which was also initiated in a closed-ended question, the acknowledgement was followed with the extending rejoinder, and then a combination of acknowledgement to acknowledgement finally closed off with a clarifying rejoinder. In Cami's lessons, Episode 1 exhibited an unusual trend of utilisation of the eliciting and acknowledging rejoinder during the interaction, which usually in other episodes, is used to punctuate the interaction. This is not the case in Cami's first episode, where there is a turn-taking between the eliciting and acknowledging and clarifying rejoinder, followed by the extending rejoinder, and this interaction is closed off with the acknowledging rejoinder. The second Episode was characterised by turns between the extending and clarifying rejoinder. Mary's second episode is characterised by an extending rejoinder, which was followed by a clarifying rejoinder, and then the same combination of extending rejoinder and clarifying rejoinder, and finally closed off with a combination of clarifying rejoinder and extending rejoinder.

Nevertheless, the rejoinder moves that each teacher employed were what determined the length of the dialogic interaction. This supports the claims made in the literature reviewed that feedback provided to the learners determines the direction in which the interaction is going to unfold (Khoza & Msimanga, 2022). However, in the current study, teachers did not use extending rejoinders much compared to other rejoinders, such as acknowledging and clarifying rejoinders. However, extending rejoinders have been argued to bring about more interaction because they confront the learners into

rethinking their ideas, thus broadening their understanding (Tytler & Aranda, 2015). Acknowledging rejoinders has been argued as having the potential to intensify classroom interaction (Khoza & Msimanga, 2022), provided that the learners engage and the teacher responds by asking another question. Gillies (2020) argued that when there is an interaction between the teacher and learners for knowledge sharing and understanding of science, this also allows interacting socially with their counterparts, which is argued to keep the learners in ongoing discussions and thus motivated to learn scientific concepts (Mavuru & Ramnarain, 2019).

According to Mangwiro and Machaba (2022), meaningful interactions in science classrooms can be established by asking extended questions and requesting elaboration. My current study revealed that the feedback provided by the teachers at 'F' level of the IRF pattern facilitated eliciting and probing learners for more responses and was mostly elaborative. This feedback was provided in the form of questions and phrases. Eliciting and acknowledging rejoinders were used mostly to punctuate the dialogic discourse. These findings indicate a correlation with what Alkhouri et al. (2021) argued – that interactive participation is highly recommended in science classrooms for effective teaching and learning. However, the current study established this by employing more clarifying rejoinders. Furthermore, the data obtained from this study suggested that teachers do not rely solely on traditional teaching methods, as argued by Ramnarain and Clive (2020) and Taole (2020), but there is a transition where teachers become authoritative (by adhering to the IRE interactive pattern) as well as becoming a dialogic discourse (by entertaining different voices and ideas). This suggests that the tension between authoritative and dialogic discourse will always

exist in science classrooms largely because, at some point, the authoritative science knowledge needs to be acquired by learners.

The established dialogic episodes varied in length. The only dialogic episode that appeared long was Elijah's second episode from Lesson 2 (see Table 5.2). This episode was the only one initiated with an open-ended question. In this instance, one may say an open-ended question allowed the learners to be flexible in coming up with answers (Sandoval et al., 2021); as a result, the interaction became lengthy because the teacher was trying to see if the learners understood what they were talking about using more questions. However, in some cases, the length of dialogic episodes depends on learners' contributions and rejoinders, as shown in the literature (see Khoza & Msimanga, 2022). The learners were trying to justify their answers through interaction. Hence, the teachers used more clarifying rejoinders, which led to more interaction, and the teacher formulated more questions to escalate the discussion (Aranda et al., 2020). A similar study conducted in higher education Life Sciences classrooms also showed that when learners justify their answers, interaction patterns become extended (Buma & Nyamupangedengu, 2020).

In contrast to this, all the dialogic episodes initiated with closed-ended questions appeared to be short (see Table 5.2). This is because closed-ended questions have been argued to limit the learners' thought process and, thus, collaboration (Ramadhani & Zainil, 2019). According to Morris and Chi (2020), learners are prevented from providing other relevant answers, the questions are ambiguous, and learners take longer to respond, which are some of the factors leading to limited interaction (Ahmad et al., 2020). Although there appears to be flexibility in the use of rejoinder moves, this

did not affect the length of the dialogic episodes (see Teacher C in Table 5.2). There are six turns in both episodes, and there are a variety of rejoinder moves. Based on the literature reviewed, one may have expected Episode 2 to be a bit lengthy because there was an alteration between clarifying and extending rejoinders. It has been argued that extending rejoinders prolongs interaction (Tytler & Aranda, 2015).

Lastly, many of these episodes are closed off with an acknowledging rejoinder, for example, Episode 2 from Elijah's lessons. Kol's first lesson was closed off with acknowledgement. Episode 1 of Cami's episode was also closed off with an acknowledging rejoinder. Similarly, Mary's first episode was also closed off with an acknowledging rejoinder (see Table 5.2). Acknowledging rejoinders is low-level feedback (Aflalo & Raviv, 2022), e.g. affirming the learner's response and repeating the learner's utterance. One may, therefore, say that this reflects the emphasis and encouragement of learners' ideas, thus certifying that learners' responses are correctly shaped. Generally, to acknowledge is to admit or accept the existence of valid responses from the learners; similarly, in this instance, to punctuate the dialogic episodes, the teachers used acknowledging rejoinders to accept the learners' ideas.

In answering the second research question, the second sub-question was about understanding how dialogic discourse is established using these discursive moves. I looked at the progression of moves, and the key finding is that teachers relied on acknowledging rejoinders and altering them with clarifying rejoinders to establish dialogic discourse. These moves were used to prompt and elicit the learners for more responses.

5.2.3 Factors Influencing the Kind of Moves Used by Teachers

In this section, I discuss the findings emanating from the analysis of the interview transcripts to address the question of what influences the kind of moves that teachers use.

The findings suggest that the Life Sciences teachers' choice of moves when teaching about the cell cycle is influenced by their intentions of making links between concepts and building knowledge. The idea of creating links and knowledge-building in science education literature is defined as teaching for coherence (Mork et al., 2021). It emanates from Scott et al.'s (2011) model of Pedagogical Link Making (PLM). Most often, teachers (unconsciously) use a PLM framework to teach for coherence and promote knowledge building. In fact, when Scott et al. (2011) proposed their model, they argued that teachers use specific communicative approaches (defined as discourses in this study) to make certain pedagogical links. Therefore, it is surprising that these teachers talked about link-making as what influences their talk moves. The teachers in this study believe that they look at how the learners contribute to the discussion and link it with other concepts. According to Scott et al. (2011), making links in science classrooms fosters conceptual development and helps learners to visualise science as a 'whole'. This is because, when teachers make links, they also draw from learners' prior knowledge. In this study, it was found that science teachers can make these links by using a variety of discursive moves.

Furthermore, in terms of initiation moves, the kind of questions they ask are influenced by how the concept at hand links with what they have already done. Previous studies have shown that science teachers' deliberate use of discursive moves is usually

influenced by what happens in the classroom. In particular, after Elijah (see Excerpt 2) had explained the DNA replication concepts, he then took a different route to say, “What if the cell is not going to divide?” This steered up a discussion in the classroom as the learners were still trying to make sense of the question. Nevertheless, Elijah was compelled to use several extending rejoinders and clarifying rejoinders to explain the question, rephrase the question and seek clarity in the learners’ answers. As Mary was trying to establish if the learners could merge the concept of mitosis with the actual appearance of the cell (see Excerpt 8), she posed a question on the number of chromosomes in a cell. She realised, based on the answers the learners provided, that she had to use clarifying and extending rejoinders to extract what the learners understood at that time. The use of rejoinder moves revealed that the learners understood cell division as a basic term in general English, which led them to believe that half the number of chromosomes would be found in each cell. The term “identical” was, therefore, in question, driving Mary to define mitosis again with a much more detailed perspective. Hence, the choice of moves was influenced by the links that were applicable at that moment. In this regard, the teacher fostered PLM by using specific discourse moves as a result of how learners responded to a question.

Secondly, the teachers’ moves are also influenced by learner contributions, specifically if there is a detection of a misconception or an implicit or explicit indication of conceptual difficulties. This finding is not surprising in the sense that a rejoinder at the “P” level should, in any case, be a response to a learner at the “R” level in the IRPRPRP…F/E interaction pattern. It is important to note that this is specific to the choice of rejoinders. The intention is to outline or clarify or both, which is more than just a necessity so that the interaction becomes meaningful to channel the learners

towards a specific direction. Scholars who have researched conceptual difficulties argued that a concept is a collection of prior knowledge leading to a person's thinking (Hissan & Ntow, 2021). As such, learner misconceptions are most common in science classrooms (Naz & Mushtaq, 2022) since understanding scientific ideas requires learners to confront their existing knowledge to gain a better understanding of the subject matter.

Additionally, conceptual difficulties are gaps occurring between held scientific understanding and learner understanding. Therefore, teachers need to identify the gaps to guide the learners' learning process by ensuring that they address the misconceptions. The study conducted by Soysal and Tuzun (2019) revealed that these meaningful classroom interactions can influence conceptual understanding. Expanding on this, Hissan and Ntow (2021) argued that these interactions involve classroom discussions. In the current study, when the learners appeared to have difficulties understanding the concept of DNA replication, the teachers used different rejoinder moves to guide the learners. Elijah focused on providing clues using specific rejoinders, which led to a lengthy discussion and learners arriving at the correct answer. In Kol's classroom, he disregarded any irrelevant answers to his questions. This disregard came with a few hints that also led to a classroom discussion. Nevertheless, identifying misconceptions and addressing them during classroom discussions as the means to help the learners understand concepts first helps learners to use that knowledge gained to solve problems. This has been noted in studies like those of Khoza (2023), reporting the significance of detecting misconceptions and then deciding on which discursive move to use in driving interaction.

Given that learners come to class with different experiences, they must be confronted and redefined so that they can connect and build their knowledge (Alkhouri et al., 2021), hence the posing of well-constructed and purposeful questions. Similar to what Alexander (2020) argued, these questions maintain control of the interaction during tuition time, as questions that are poorly constructed may negatively impact how the learners respond. Learners could take longer to answer the question or provide irrelevant answers, impeding the intended role of the question. Therefore, the participating teachers had to use specific rejoinders to clarify and ensure that learners fully understood the questions. This approach supports the claim made by Morris and Chi (2020) that ambiguous questions limit classroom interaction. Similarly, data analysis in the current research suggests that the teachers had to use rejoinder moves constantly to facilitate channelling the learners towards the teachers' intended direction.

Thirdly, learners' ability to make credible links between their real world and the scientific world relies on teachers asking the right questions, providing explanations, and offering real-life examples. Currently, scientific literacy emphasises the learners' engagement with scientific ideas as well as related issues to generate knowledge (Cirkony, 2023). Such engagement involves asking learners questions, conducting practical experiments (Aranda et al., 2020), and sharing ideas through discussions to make sense of the data. From this view, teachers are expected to provide the learners with authentic activities and facilitate classroom discourse that allows learners to acquire scientific concepts and make sense of them. In the current study, teachers who participated used real-life examples that learners already had to assist them in understanding new concepts. For example, when Elijah was explaining the

preparatory stage in DNA replication, he used the term “preparation” in a general English context, which the learners were already familiar with and provided an example in which they would generally use the term. When Kol was trying to explain the term DNA replication and how it occurs, he used the building of a house with the same bricks. Researchers who have previously looked at the use of real-life examples in science classrooms revealed that the use of real-life examples can stimulate the learners’ thinking as they can easily relate to their observations in real life. The learners’ real-life observations, therefore, were used as a starting point to initiate classroom discussion, which is a sign of adaptability to different forms of curriculum demands.

According to Aranda et al. (2020), classroom discussions require teachers to do away with traditional teaching methods that limit learner contribution to knowledge building. They further argued that different discursive moves can be employed to facilitate productive classroom discussions. For example, questioning is a discursive move that can be used by the teacher, which would require the learners to explain what has been taught based on their understanding. Thus, the teacher’s questioning can encourage the learners to externalise their responses (Mangwiro & Machaba, 2022). The learners’ response depends on the nature of the question itself, whether it is an open-ended or a closed-ended question. Open-ended questions are more recommended when promoting classroom discussions.

Furthermore, explanations provided by teachers to disseminate scientific content also contribute greatly to promoting classroom discussions (Aranda et al., 2020) and thus creating a credible link between real-life and scientific subject matter (Cirkony, 2023).

When providing these explanations, teachers can use real-life examples that learners can relate to, understand and, in some instances, experience. As such, they can make sense of the content being taught, solve scientific problems, and find solutions to real-life problems.

Fourthly, language is a barrier in science classrooms in South Africa. Generally, teachers have complained about language as a hindering factor for learners in comprehending and grasping science knowledge (Olayemi & DeBoer, 2021). Since studies done in classroom talk argue that science is a language on its own, that learners struggle to comprehend, thus the struggle with the biological terms (Khoza, 2024). Teachers in this study talked about the issue of language as a contributing factor to the discursive moves they employ when teaching science. Language is key to communication (Márquez & Porras, 2020), but to understand scientific language, learners would have to be familiar with the language to communicate in the exchange of ideas. According to Mönch and Markic (2022), language is a primary requisite to being scientifically literate and thus acquiring knowledge in a science classroom. They further argued that language is a vehicle for education, even more so because in science classrooms, there is an additional scientific language that needs to be fully understood to ensure learner participation. As such, Mavuru and Ramnarain (2019) argued that both teachers and learners are affected by the language as a barrier. Expanding on this, they acknowledged that teachers must construct instructional activities, construct and pose questions and finally negotiate scientific ideas with the learners to support learner development, thus promoting scientific literacy (Mönch & Markic, 2022). For example, the question posed by Elijah (see Excerpt 1) acknowledged that it was an ambiguous question that learners struggled to

comprehend, thus connecting with their content knowledge and finally responding. Ambiguity in science education is often recommended due to its potential to expand the room of interpretation (Frankenhuis et al., 2023). However, in this instance, it was a barrier because even when the learner had answered, Elijah continued to ask more questions so that the learner could give a detailed answer. Morris and Chi (2020) revealed that poorly constructed questions may cause hindrances in learner development and their knowledge-building process. The struggle in this encounter was the inability to switch from the home language to the instructional language and scientific language (Mönch & Markic, 2022) of both the teacher and the learner. As a result, vocabulary and grammar became a hindering factor (Mavuru & Ramnarain 2019). In Kol's classroom, there were also instances where the learners tapped into their home language to respond to questions, indicating a lack of scientific vocabulary (Block, 2019). Nonetheless, even Kol acknowledged the lack of vocabulary, which led to him phrasing the question in a certain way.

Finally, other revelations are that meeting the curriculum demands for teachers is the driving force to implement specific discursive moves. One of the specific aims that govern Life Sciences as a subject is Specific Aim 3, which speaks to "appreciating and understanding the history, importance and application of sciences in society" (Department of Basic Education, 2011, p. 17) as stipulated in the CAPS document. It becomes difficult to convey science knowledge to the learners without engaging them with the subject content. Additionally, when the teachers' content knowledge is not efficient, this may become a hindering factor to the delivery of content knowledge and facilitating the dialogic discourse (Khoza, 2024). According to Relela and Mavuru (2023), this is highly influenced by the teacher's knowledge and confidence in the

topic, meaning that a lack of content knowledge leads to a lack of confidence and thus resorting to teacher-centred teaching methods (Meeran & Van Wyk, 2022). These teaching methods have been re-informed, with a requirement of involving the learners more to establish Specific Aim 3 of the CAPS document.

Nonetheless, the application of certain skills requires one who is well-vested in the subject and who can assist the learners in learning and mastering those scientific skills. Out of all four the teachers, Elijah is the most experienced, with 20 years of experience; Kol has seven years of experience; Cami, with nine years of experience, and Mary has the least teaching experience. Teaching experience in the current instance played a crucial role in establishing a dialogic discourse and the use of discursive moves. Hence, Elijah's ability to create an interactive medium for the learners was demonstrated by his employing a variety of discursive moves and, therefore, being able to mediate the learning process for the learners. Elijah also showed variety in the length of the dialogic discourse as well as variety in the initiation of the new line of enquiry. Based on the observer data, he was the only participating teacher who used an open-ended question in his lessons.

All three other teachers, with less than ten years of experience, were still able to establish a dialogic discourse, but they introduced a new line of enquiries with only closed-ended questions. As such, their interactions were quite limited. However, Elijah, with the most years of teaching experience, was able to establish lengthy dialogic discourses, in disregard of whether initiated by a closed-ended or open-ended question. Therefore, in the current study there is evidence that experience plays a role in establishing a dialogic discourse. In the current study, the teachers initiated the

discussions, and their moves were guided by the need for the learners to learn and apply certain skills as prescribed by the CAPS document. These skills include application, use of knowledge, analysis of information, and critically evaluating and recognising relationships between existing knowledge and newly formed ideas. For example (see Excerpt 1), Elijah asked what appeared to be an abstract question; nevertheless, in his defence, he alluded that in the previous week, they had completed a topic on the cells. Thus, he wanted the learners to exercise their skills, use that knowledge, and apply it to the newly acquired knowledge that is being guided by the teacher. Regarding this dialogic episode, Elijah emphasised that he wanted the question to sink in so that the learners could recognise any relationship between what they know and what they have been asked. However, the learner could not apply processing skills such as interpretation as the question was ambiguous.

The third research question, which is answered by the video-stimulated recall interviews, focuses on the influences that caused teachers to use specific moves; the term influence in the current study speaks of where the employed discursive moves stemmed from. The first key influence that emerged was supporting the learners in knowledge building, which compelled the teachers to tap into the learners' prior knowledge. The second factor was addressing areas of difficulty, which most often stem from misconceptions. Teachers uttered that learners struggle to comprehend certain scientific terms or concepts; this results in them struggling to understand the content itself fully. The third influence was establishing a link between content learnt and everyday life. Teachers mentioned that learners relate more easily to content learnt when it is authenticated by real-life examples. The fourth influence was curricula demands, as some topics overlap from one Grade to another; as a result, the learners

need a firm foundation on those topics. Finally, in considering the language constraints that govern the teaching and learning process entirely, the teachers revealed that poorly constructed questions cause learners to struggle in responding to questions or comprehending the subject matter. This stemmed from the misinterpretation of the question posed by the teacher.

5.3 Addressing the Main Research Question

We can now finally address the main research question, “How do the Life Sciences teachers use discursive moves to establish a dialogic discourse when teaching about the cell cycle in Grade 10?” The teachers initiate discussions with discursive moves such as open-ended and closed-ended questions. Both types of questions enabled the teachers to establish a dialogic discourse. However, when the teachers utilised open-ended questions, the dialogic interactive chain was longer than when close-ended questions were used. This supports the idea that open-ended questions can lead to heightened interactions as they tend to provide learners with an opportunity to voice their ideas. Initiating moves were followed by rejoinder moves used by teachers to give the learners feedback. These rejoinder moves were used after the other rejoinders while the learners were also providing their responses, thus creating a chain of interaction response and feedback (R, F, R, F, R, F). The F in the interaction chain was also accompanied by certain probes that elicit learners’ responses. The acknowledging rejoinders in clarifying rejoinders were used in conjunction to elicit the learners’ responses, and very minimally applying extending rejoinders to establish dialogic discourse. This suggests that although extending rejoinders are perceived as higher order discursive moves that challenge learners (Tytler and Aranda, 2015),

clarifying and acknowledging moves can lead to a dialogic discourse in science classrooms. However, I have to acknowledge that learner contributions played a major role in the sense that they contributed to the types of rejoinders that the teachers use. In this regard, although establishment of a dialogic discourse in science classrooms can be attributed to teacher discursive moves, learner contributions still play a role of influencing the teachers' rejoinders.

5.4 Limitations of the Study

This study was limited to only four schools in the Gert Sibande district, Mpumalanga. The participants were four Grade 10 teachers who were purposively selected and only observed teaching about the cell cycle. Although the data obtained proved valuable and rich due to the selection criteria employed in the current study, the findings afforded value to the research. I cannot generalise the results obtained from the current study to other South African schools. Moreover, the schools were purposely selected to obtain rich data, and teachers were observed for one class each from the beginning of the topic till the end of it. This sample therefore, served as a limitation as the number of participants was quite minimal, and the case may be different in many other schools.

Another limitation of my study stems from the inability to observe two of my participants until the completion of the topic of the cell cycle. This was due to unforeseen circumstances, as the teacher had to relocate to a different school. The second teacher had to be away from school for a certain period. As a result, for both teachers, only two lessons were captured, while I had initially considered having three lessons per teacher. This could have provided a holistic overview of how teachers use

discursive moves to establish a dialogic discourse when teaching the topic of the cell cycle.

5.5 Recommendations Regarding Teacher Professional Development

The first contribution to the science field that came from the current study is the idea of proper planning and careful selection of teacher talk moves. My study has demonstrated that science can be better understood through the understanding and provision of several opportunities for the learners to share their thoughts, guided by the teacher to reach their full cognitive potential. Hence, dialogic discourse is necessary in science classrooms. Such practices challenge the notion of repetition of what is in the textbook as it is, but rather awarding the learners a platform to be creative and question and externalise their thoughts. Consequently, broadening the teachers' discourse in science classrooms will ensure the cascading of rich and more interactive lessons. As part of pre-service teacher training, professional learning communities should investigate and unpack how the use of questioning in dialogic discourse can be explicitly taught to pre-service teachers–not only taught but also modelled for them to see how questions are being responded to for the establishment of dialogic discourse.

Moreover, in-service teachers should be trained in authenticating content taught in class with the use of real-life examples. In so doing, teachers will be able to develop well-constructed questions that contradict traditional teaching methods. More exposure to training programmes could help the teachers overcome their shortcomings in the dialogical teaching approach, as they will be practising it more in developmental workshops. I acknowledge that many professional development

workshops take the ‘top-down’ form where an academic would develop teachers on a specific aspect of practice. Since this study illustrated that some teachers have the knowledge of establishing dialogic discourse, I suggest that the professional development workshops should take a reflective format. This reflective format can be when teachers are brought together to observe each other’s lessons and reflect on their practice by focusing on how they respond to learners’ contributions to establish a dialogic discourse. In this regard, teachers can be part of their professional development and begin to understand the nuances of facilitating interactions as well as establishing a dialogic discourse.

Finally, if curriculum developers are in line with the recent research findings, prescribed teaching material and curriculum reforms could be tailored to the new findings for the dialogic teaching approach to be made possible. The tailoring could involve providing teachers with opportunities to integrate learners’ prior knowledge as well as making a room for teachers to explore learners’ ideas through the use of discursive moves. This would, therefore interpreted as dispensing more time to scientific disciplines to cater for the new developments in scientific research fieds.

5.6 Areas of Further Research

I stated earlier that learner contributions contribute significantly influence how the teacher uses discursive moves. So far, there is limited research that investigates the influence of learner contributions both internationally and in the South African context. instead of focusing on teacher talk, future research can also be focused on analysing learner talk. This research is proposed because, as much as teacher responses are influenced by learner talk, learner responses are also influenced by the kind of

initiations and rejoinders used Further research can look at how learner responses contribute to the dialogic discourse and teachers' follow-up moves; as I was looking at the interaction between the teacher and the learner, my focus was on the teacher moves, and that is where I conducted an in-depth analysis. As a result, learner contribution was not thoroughly analysed. Deep analysis of learner contributions can greatly contribute to literature on science classroom interactions. Therefore, researchers can look at the impact of learner contributions on teachers' use of discursive moves like rejoinders.

Secondly, my study focused on teacher-learner interaction, where the teacher leads the interaction. My findings indicated success in teachers' ability to establish dialogic discourse. However, true success would come from research done at a larger scale or a bigger group. As such, many teachers or participants may be used to see if the increase in the number of participants would have had any impact on the results. Such studies can also look at how contextual factors like number of learners in a classrooms contribute to how teachers establish a dialogic discourse (if at all). This kind of research can shed some light on how such factors influence interactions especially in the South African context.

Thirdly, the issue of language is a thorn in the flesh in science classrooms, and both teachers and learners are affected by it. Teachers struggle to provide well-constructed questions that will promote dialogue in a science classroom and thus expand the scientific language to the learners. This hinders the development of learners' scientific language and reasoning. This kind of research can help other researchers understand

the intricacies of science classroom interactions, examining teacher-learner interaction and discourse as a whole to make meaning-making of scientific concepts.

From the suggestions mentioned above, further research can also be based on science talk, which will then accommodate both teachers and learners. Learner cognition plays a crucial role in classroom interaction and reasoning, such that some learners may not participate in classroom interaction at all, and the reason behind this may be cognition. Additionally, this study was only done in Life Sciences classrooms, therefore, this practice could also be tested in other science subjects to see if the results obtained will be similar to the current study.

Finally, one of the factors that influenced the teachers' use of discursive moves and how they responded to learner contributions was their PCK. One area of research that has not been explored is the role of PCK on teachers' use of follow-up moves in science classrooms. As my current study examined how teachers establish dialogic discourse in classroom interaction, it did not dig deep into the teachers' PCK and its influence in establishing a dialogic discourse in science classrooms. Nevertheless, although this was not an area of interest, it still emerged as an area of concern in the current study, and it is a factor that needs to be researched more in line with discursive moves. Therefore, I suggest that future research investigate the role of teachers' PCK on the use of discursive moves, as well as how they notice certain learner contributions and how these influence patterns of interaction.

5.7 Contributions of the Study to Society

This study contributes to the current literature on orchestrating science classroom interactions. I have particularly illustrated how dialogic discourse can be established by using specific discursive moves using a specific Life Sciences topic as an example. I have also shown several factors that contribute to the teachers' use of discursive moves and establishment of discourse. These factors are important in science education research.

Exploring the teacher discursive moves employed by Life Sciences teachers to establish dialogic discourse in this study will help in identifying discursive moves and interactive patterns that lead to dialogic discourse in a science classroom. Therefore, the recommendations made in the current study will help learners, teachers, and upper structures in the field of education. In the upper structures, curriculum planners will have a broader spectrum of dialogic approaches to recommend for science teachers. Recommendations made using this study will help create a baseline for teaching strategies that encourage dialogic discourse in science classrooms. These strategies can also be discussed further in content workshops and can be transformed creatively to suit the learners' needs. Secondly, this study's findings can be incorporated into the training of pre-service teachers to use discursive moves strategically and productively when teaching. As such, teachers will have more opportunities to be creative, from pre-service to in-service, and therefore convey the necessary skills to the learners. In-service teachers will be able to improve their content knowledge and strategies to deliver content knowledge, thus helping learners comprehend the subject matter. Therefore, data obtained from the current study is meant to contribute to and broaden how discourse is understood in science classrooms. This is accomplished by

challenging teachers to develop well-constructed questions and thus engage learners in dialogue.

The findings from the current study are that inducing creativity in teachers will help them ensure more participation from the learners. Therefore, the learning process will be guided positively and effectively through the employment of well-constructed questions that stimulate discussions in science classrooms, as recommended by curriculum reforms. Additionally, such tools will help the teachers to cascade rich content in more interactive lessons to develop various ideas from the learners.

5.8 Personal Reflection of the Study

When I started this study, I had no idea how much growth I would experience. My knowledge of research was very limited because I had been moving from one university to another after obtaining my qualification as an undergraduate; therefore, I thought it would take me longer to pick up and understand what was happening in a master's program. Partly, yes, it was an issue because of this limited understanding. I would say that this has been a journey of enlightenment, thorough questioning, and introspection, searching for answers that grew me as an individual from the starting point of familiarising myself with reading at least one article every day. Secondly, this study was governed by qualitative research methods, which worked well in assisting me in selecting and obtaining rich data sources and unpacking data to provide explanations of findings. Taking field notes during classroom observations would have been ideal. I believe it would have played a crucial role during the analysis process, as I had to revisit my data constantly for minor things. Nevertheless, the data collection tools I used in my study worked well.

Through lots of reading and research, I have bettered my understanding of the learners, the subject and the education system entirely. As much as most of what I read did not make it part of my dissertation, I do not regret having sight of it. It has contributed largely to how I teach and interpret Life Sciences as a subject, as well as how I deliberate in class. Therefore, I can boldly say that I have grown from being a mere Life Sciences educator to a researcher in science education and a lifelong learner, so much so that I am considering doing a PhD, which I previously thought was out of my reach.

5.9 Concluding Remarks

In this chapter, I started by providing a full discussion on the nature of discursive moves, establishing dialogic discourse, and identifying factors that influence the use of specific discursive moves. In the discussion, I went into detail about the use of discursive moves, from initiation to rejoinders and how they influenced the unfolding of dialogic episodes. I then answered the research questions based on the discussions on each question. The focus was to show any relationships, or lack thereof, between the literature reviewed and my findings in this study and provide substantiative reasoning based on my findings. I also looked at theoretical reflections on the relevance of socio-cultural theory in the current study and how using it was advantageous. I then reflected on the methodology and looked at the relevant use as well as the shortcomings of the methodology I used in the current study. Based on the discussion, I finally drew conclusions for my study and then developed recommendations and areas for further research.

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APPENDICES

APPENDIX A: Observation transcript

Data collection: observation 1 transcript

Lesson 1: Elijah A (School A)

keys

Teacher utterances coded using deductive coding

Initiation moves : Closed-ended question
: Open-ended questions

Rejoinder moves : Eliciting and acknowledging 1
: Clarifying 2
: Extending 3

Learner utterances coded using deductive coding

Dialogic responses : Lengthy
: Detailed
: Deep understanding
: Descriptive

Authoritative responses : Short
: Limited

Teacher: Our discussion like I said last time will be on cell division, now we discussed the cells in detail and some of the organelles found in the… in the cell, but today I would like to concentrate on the nucleus because that's very relevant to our discussion.
Now, I told you what chromosomes are, you all know, we also drew chromosomes but before they are visible and they become chromosomes while they are in the nucleus, okay while they are in the nucleus, what do we call them? (initiation move, closed-ended question)

Teacher: When they are in the nucleus before cell division, they are seen as what? (clarifying rejoinder move- reframing the question)[2]

Learner1: Cells (short/limited)

Teacher: No, the ones that are in the nucleus. I did give you a word and how we describe them. (Clarifying rejoinder move- requesting clarification[2]/ extending rejoinder move- asking an extended question[3])

Learner: Chromosomes sir (short/limited)

Teacher: Found in the nucleus and they form, I will give you a clue, they form a… yes! (extending rejoinder move- elaborating)[3]

Learner 2: DNA sir (short/limited)

Teacher: Okay DNA is part of the chromosome but they are not, we don't call them DNA when they are in the nucleus before the cell starts to divide. They just form some kind of wave-like structure. (extending rejoinder move- elaborating)[3]

Learners: Chromatin network. (short/limited)

Teacher: Yes, chromatin network. Very good! (eliciting and acknowledging rejoinder move- affirming)[1]

Teacher: So one of the things that you find in the nucleus is a chromatin network that then if the cell is going to divide, it forms into chromosomes, now just to remind you. (Teacher draws the structure of a chromosome). That is a structure of a chromosome basically, with a chromatid and a chromatid.

Teacher: This one is what? (initiation move- closed-ended question)

Learner: Centromere (short/limited)

Teacher: Yeah, that's the centromere, separating/ connecting the 2 chromatids so this forms a chromosome. (eliciting and acknowledging rejoinder move- affirming)[1] Now, as we were discussing before we could even talk about cell division, why should cells divide? To give rise to more cells and to cause growth. Because fact in sexual reproduction the sperm fertilizes the ovum or the egg but we usually call it an ovum to form a zygote. Now it's from this zygote that these cells are formed. To form the entire organism, even if it's a human being.

Big as human beings may be, they start as one cell, the zygote. Then this cell should start dividing, give rise to more cells, more and more cells come up, and then organs start forming until the whole organism is formed. So it starts from one cell. Now then, the cells must divide to give rise to more cells, and that is then what we call cell division, simple, as self-explanatory as it sounds. Cell division means the cell is dividing. There are some organisms, whereby that one cell divides into two and those two cells again are organisms, like the *Amoeba* and other unicellular organisms, just divide into two. Then those two

	are actually organisms on their own. Now, we have two types of cell divisions, it's mitosis and which one?
Learners:	Meiosis. (short/limited)
Teacher:	It's meiosis and mitosis. Meiosis, I think I've mentioned before to you that it is strictly for the formation of gametes, and then mitosis of any other cells that are formed as a result of mitosis. Now before any cell divides, it must prepare itself for cell division. So, the cell has to prepare before it starts cell division, now then, the preparation should be in accordance with the cell division, the main essence of cell division is how the chromosomes are going to be divided into the daughter cells, once that is done then the preparation itself must be related mainly to how the chromosomes will be divided because that's the main aim. Now I think earlier on I told you that each organism has a a definite number of chromosomes in its cell in the nucleus. Human cells have how many chromosomes? ordinary human cells, (Initiation move- closed-ended question)
Learners:	46 (short/limited)
Teacher:	46, correct. And they exist in pairs, how many pairs is that, from 46, (Initiation move- closed-ended question) if you're talking about the human ones?
Learners:	(distinct noise of learner discussion)
Teacher:	Okay, how many pairs are in 46? (Initiation move- closed-ended question)
Learners:	24 (short/limited)
Teacher:	24?, 24 then x 2 is 48 (Clarifying rejoinder move- revoicing and reframing question)[2]
Learners:	23 (short/limited)
Teacher:	So in this case, we have 23 pairs of chromosomes, in other words, they exist in pairs. Now when the cell enters the preparatory stage, we call that interphase. That's what we call it. Inter means in between, so interphase occurs between 2 divisions between the previous one and the next one. During the interphase, some of the things that happen are that the chromosomes double up, and they become double, the process that results in chromosomes becoming double is known as replication. That is the situation where the chromosomes make a copy of themselves, so the number of chromosomes then doubles up. Now, remember I said that every organism has a characteristic number of

chromosomes, so if it doubles up it becomes x2, and that can only occur when the cell is dividing it is going to undergo cell division. It's not a normal thing that happens in every cell unless the cell is going to divide during the interphase the replication takes occurs. Now, chromosomes carry genes, and the gene is a small portion of DNA, so it's also correct when we say that chromosomes replicate we are also saying that the DNA is because chromosomes carry the DNA. So DNA also does what, replicate. Now, why should the chromosomes double up in number? Because during the cell division which is going to take place before we even come to it the number of chromosomes must be maintained in the daughter cells, in other words, let's say that this is a human cell and it is in interphase preparing for cell division then from 46 when the chromosomes double up, they become what? From 46, they become what? (initiation move, closed-ended question)

Learners: 92 (short/limited)

Teacher: And then this cell is going to divide and produce two cells so in that case each one of those daughter cells will have what? after cell division after cell division, how many chromosomes will be in each cell?
(initiation move, closed-ended question)
Of the doubling up they become 92 then that 92 should be divided equally amongst the two cells that are going to form and they will be 46 in each cell phone so it goes back to?

Learners: 46 (short/limited)

Teacher: The same number of chromosomes that the human cell is supposed to have now is very important then it's going to reduce replication doesn't occur then it won't be a human cell. As this is the human cell, this is the chromosome the number that should be maintained, Do you understand?

Learners: Yes

Teacher: Okay, so now the processes of mitosis or stages we call phases. The phases that we shall be discussing in the next few periods are the cell division does not start stop start again and stop it is a process that is continuous when the the cell starts dividing it goes on continuously until you have two daughter cells, but there are certain occurrences that are observed in each of the phases as we have explained what happens in the interphase. And then the chromosomes, before the cells divide, they are not clearly visible because they

appear as a chromatin network it's just the network of fiber like cotton, but then when the cell is about to divide the chromosomes shorten and become thicker and therefore they can be seen if you apply colour to it, in other words, you apply a dye then the chromosomes will be seen, clear. That's where they get their name from chromosomes, chromo for colour. Now we said the chromosomes exist in pairs and we call those pairs homologous pairs of chromosomes, during mitosis one important issue is when replication takes place the number of chromosomes is doubled, remember when we talk about cell division, we emphasize a lot of chromosomes that's what is important it is the entire aim of cell division oh by the way there is a question that I must ask you. Let me ask you this question children.

Teacher: What do you think happens if you remove the nucleus of a cell? (initiation move, open-ended question)
What's the obvious thing that will happen?

Learner 1: The cell will die (short/limited)

Teacher: Not immediately, (Extending move- canvasing opinion)[3]
It will not die immediately, there is something that can never happen as long as you carefully remove the nucleus, what happens to the cell?
(Clarifying rejoinder move- requesting clarification)[2]

Learner 2: It stops functioning (short/limited)

Teacher: when you say it stops functioning, what function are you referring to
(extending rejoinder move- asking an extended question)[3]

Learner 2: It's cell division. (short/limited)

Teacher: What about cell division?
(extending rejoinder move- asking an extended question/ requesting elaboration)[3]

Learner 2: The cell division stops functioning. (short/limited)

Teacher: What are you saying? What happens, the obvious thing that happens when you remove the nucleus? (extending rejoinder move- requesting elaboration)[3]

Learner 3: It will live for a short time, and die after a number of days. (Lengthy)

Teacher: But one thing that can never happen when you remove the nucleus?
(extending rejoinder move- challenging to extend ideas)[3]

Learners: Cell division won't take place (short/limited)

(eliciting and acknowledging rejoinder move- affirming)[1]
The first thing that will stop is cell division. We're 100% sure that won't take place, so why? (extending rejoinder move- asking an extended question/ requesting elaboration)[3]

Learner 1: Because there is no nucleus. (short/limited)

Teacher: Yes because there is no nucleus it won't take place why? (extending rejoinder move- asking an extended question/ requesting elaboration)[3]

Learner 2: Because the cell division occurs in the nucleus. (descriptive)

Teacher: so why? (extending rejoinder move-elaboration)[3]

Learner 3: The nucleus is the largest cell organelle. (descriptive)

Teacher: So why? Okay, I agree with you cell division won't take place because you have removed the nucleus so definitely cell division stops, but why does cell division stop or not take place when you remove the nucleus? (Clarifying rejoinder move- requesting clarification)[2]

Learner 4: Sir I'm not sure if I'm right about this but doesn't the nucleus control everything that goes in and comes out. (Lengthy and descriptive/ detailed/ deep understanding of content)

Teacher: No, no, no (Negative evaluation)

Learner 5: In the chromatin network they are chromosomes, there are no chromosomes present for cell division to take place. (Lengthy and descriptive/ detailed/ deep understanding of content)

Teacher: Once you remove the nucleus? Okay, okay fine very good! (Clarifying rejoinder move- requesting confirmation)[2]
Now, didn't we say that the reason for the cells to divide, the biggest reason is to divide and to transfer the chromosomes to the daughter cells, that is our main emphasis here during mitosis that's the chromosomes are being taken into daughter cells in equal numbers as the mother cell? Therefore, if you remove the nucleus nothing will be taken to the daughter cells because you have removed the nucleus and thus have removed the chromosomes. So now, once you remove the nucleus cell division stops playing because you have removed the organelle that is supposed to be playing the biggest role in cell division. So, one important thing that mitosis does as it divides the mother said to form two daughter cells that will be like each other and the mother

cell genetically the same, and therefore DNA must be shared equally. However, people do not have similar DNA except for identical twins, even if you are a brother and sister the DNA will be close but it will not be exactly the same. So now, that is the entire essence of mitosis. During mitosis which okays through phases, we will mention those phases for now; the first phase is prophase followed by metaphase, anaphase, and then last one is telophase. So As I said our main interest, every time we discuss mitosis our main interest we are biased to watch what happens to the chromosomes because even when we were discussing interphase we were talking about what happens to the chromosomes. Discuss how the cell prepares itself for cell division in terms of the number of chromosomes and how many chromosomes will be in each daughter cell. So we will be discussing prophase, metaphase, anaphase, and telophase. And you are expected to know how to draw each phase and describe what happens at every phase. You may also be expected to identify the drawings representing different phases of mitosis. So let us start with the first phase, now we discussed the cells recently, and I'm assuming your memory of the structure of the cell is still very fresh. So we have a cell membrane, does the nucleus have a membrane?
(Initiation move, closed-ended question)

Learners: yes it does. (Short/limited)

Teacher: yes, it does, so during prophase, the nuclear membrane disappears. And from now, remember, the chromatin network has unwound and becomes shorter and thicker, and at this point, we no longer call them the chromatin network we call them what? (Initiation move, closed-ended question)

Learner 1: chromosomes

Teacher: yes we called them chromosomes now, and they scatter around the cytoplasm and the nucleus because we no longer have the nuclear membrane. We have centrioles that start moving to the opposite, no we have this terminology from geography used on the globe like the North Pole South Pole, and the equator so even here (pointing at the center of the cell) we call this the equatorial region or the Equator. And these are the poles, but we don't call them the north pole and the South Pole because there is no north and south, so the centrioles start moving towards the opposite poles of the cell while the chromosomes are scattered around during prophase. That is the prophase, the next phase which

APPENDIX B: Interview protocol

Elijah School A interview protocol

1. Why did you ask this question at the beginning of the topic?
2. So that they could be able to link what they already know with mitosis?
3. Is there any other way that you could have phrased it? Or it was supposed to be exactly like this?
4. Were you trying to give the learners a clue with the description?
5. What was the significance of this question?
6. You always ask this question, why?
7. But why specifically in this section? Why maybe not towards the end of the lesson?
8. So, if you had asked this question, on the nucleus, do you think they would have been able to answer it and understand which angle you were stemming from?
9. Don't you think it would have been better if you maybe said structure your answer correctly?
10. Why didn't you give a clearer response, sort of leading clue or a leading question?
11. So, the frequent use of why was supposed to be probing them and channeling them in that direction?

APPENDIX C: Interview transcript

Teacher A interview transcript

Researcher:	Right, so this is the question, why did you ask this question at the beginning of the topic?
Teacher:	Because it is part of what we did earlier on cells
Researcher:	On cells. So…
Teacher:	I was trying to connect the discussion on the cells and the topic
Researcher:	On mitosis?
Teacher:	Yea.
Researcher:	Yea, okay. So that they can be able to link what they already know with
Teacher:	Mitosis. Yes.
Researcher:	Okay. Is there any way, or any other way that you could have phrased it? Or it was supposed to be like this.
Teacher:	I could have phrased it better. Give them a bit more clue.
Researcher:	Okay.
Teacher:	Yea, maybe I could have said, what are chromosomes before cell division? how do they look before cell division starts, something like that?
Researcher:	Yea. To make the question much clearer, much simpler for them to understand.
Teacher:	Yea, I realized there that they struggled to understand…
Researcher:	The question itself
Teacher:	Yea,
Researcher:	Yea, but they did know, I saw that they knew, just that they were uncertain whether the question was actually…
Teacher:	Referring…
Researcher:	Referring to that
Teacher:	Chromatin networks, yea.
Researcher:	Yea, yeah okay. We are now done with the first question, let us now move on to this one. (Plays the video and pauses) All right, so this is the description here. When you gave the learners a description of the chromatin network, were you trying to give the learners a clue with the description?
Teacher:	Yea
Researcher:	Why?
Teacher:	Because I realized they didn't know, they didn't realize what I was talking about actually. So, I tried to give them a clue so that they can realize that I was talking about the chromatin network
Researcher:	Chromatin network. And since it was the beginning of the lesson and I realized this, the learners struggle to connect the topics

Teacher: Yea.

Researcher: All right, so this is the question. I know this is in line with what we do in Grade 12, the pairs of the…

Teacher: Homologous chromosomes

Researcher: Yes. Homologous chromosomes are the number of human cells, of chromosomes in human cells. Somatic cells more specifically. But now, you spoke about this here when you were doing mitosis, and it seems like you have spoken about it prior. It is something that they know they must recall. What was the significance of this question?

Teacher: Okay, not that question, because usually, they would understand the human one better because it is almost in all the books. In fact, I was trying to make them understand two things here. One is the same issue as saying that each organism must have a specific number, which was important for them to understand. I like it when they understand it in Grade 10 for the sake of Grade 12. and also, the fact that they exist in pairs. Now, here, it was important to emphasize the pairing of homologous chromosomes because it plays, it is significant in mitosis

Researcher: Yea, so that they know the splitting part, that this is when they will have the identical number of chromosomes because of the pairing that occurred.

Teacher: Yea.

Researcher: Okay, all right. So, this is the question, here.

Teacher: I always ask this question.

Researcher: You always ask this question, why?

Teacher: Actually, that question achieves two things, one, is that the nucleus is important in cell division. Secondly, that cell division is all about the distribution of chromosomes in the daughter cells.

Researcher: Okay,

Teacher: Yea, so that's what the question usually achieves. Once they understand that, then in Grade 12, they will be all right.

Researcher: But why specifically in this section? Why maybe not toward the end of the lesson? Why here, because you asked this question after mentioning the prophase or metaphase. After mentioning those phases of what happens there, then you dived into that question.

Teacher: Yea, because actually, in fact, I should have asked that question earlier. Then I said, no before I asked, you could see that I…

Researcher: It was something at the back of your mind.

Teacher: I realized that I should have asked it earlier. It's best when it is asked earlier, you are right. But I had forgotten to ask them, so I asked them at that stage.

Researcher: But do you think, if you had asked this question at the beginning of the lesson instead of the one you asked for, one of the appearances of chromosomes as chromatin network? So, if you had asked this question, on the nucleus does you think they would have been able to answer the question and understand which direction or angle you are stemming from.

Teacher: Yea. Most probably yes. But then the chromatin network could have come after that. But yes, that question should have been asked earlier. The one on the removal of the nucleus.

Researcher: Nucleus

Teacher: When I was teaching in Swaziland and Zambia this used to be a very important question in the exams. Like you heard some of the answers. They said the cell will die.

Researcher: They said the cell will die. And then you said not immediately.

Teacher: Yea.

Researcher: But if they answer like that it would make sense. you would expect them to answer like that if you asked it at the beginning of the lesson. It would make sense for them to say the cell will die because they know the functions of the nucleus. The controlling of all the activities of the cell, and the hereditary characteristics. But they are uncertain, to the point where they do not know anything about mitosis they would be uncertain how the hereditary characteristics are transmitted. I think it is a very abstract question.

Teacher: Yea.

Researcher: Right so this learn here, was trying to link. I think she was trying to link her response to that other learner's response who said it will stop functioning. And then she thought about cell division and then she said… because your response to that learner was, what functions are referring to? And then the Another one said, cell division will stop functioning.

Teacher: Yea.

Researcher: Yea. But that response, you said to the learner, what are you trying to say? I am just trying to understand, don't you think it would have been better maybe if you gave the learner an idea, to maybe say structure your answer correctly? There is something there, you are getting close but structure your answer correctly. But instead, you just said what are you trying to say.

Teacher: Okay,

Researcher: Yea, I am just trying to understand that one, why didn't you give a clearer response, sort of a leading clue or a leading question?

Teacher: Because she had already answered the question actually, she had already given the correct answer.

Researcher: Yea, but she had not structured it correctly.

Teacher: She had not structured it correctly. But she had already given the correct answer.

Researcher: So, you just didn't want to say more because you thought you will be giving them the answer.

Teacher: I wanted her to come out, on her own, clear. Did she by the way?

Researcher: No, she didn't but it was just the structuring of the answer.

Teacher: You see, there is a question where if you want them to sink, you spend a bit of time on it. Make follow-ups and follow-ups. The idea is to catch everyone's attention so that everyone can participate.

Researcher: Yea.

Teacher: When there are certain questions that you just ask, they give you the wrong you give them the correct answer and it passes. But some of the very important questions that hinge on the topic itself then it will attract attention from almost all of them, then you hang on. Until everyone, even the ones that were not thinking

Researcher: They start thinking, I know right, because this one I feel like this one got them thinking. Because when those other learners responded when they gave their answers and then you kept on probing and probing. It started  nering to them, they started asking themselves, wasn't that the correct answer, what is wrong with that answer if you are not taking it?

Teacher: Mhm. Yea.

Researcher: Here is another one, another interesting one. When you say why? I feel like the question was cold because the learners tried to answer the first question and you just said why.

Teacher: No, the question was ambiguous, it was not clear. They struggled; you see. That is why they went back to the fact that the nucleus is removed, so there I should have maybe said why is the removal of the nucleus causing this, you see, then it would have been clear. I realized they didn't really, they wouldn't connect because I wanted them to say, okay, the chromosomes. As I had mentioned earlier to say the whole essence of cell division is where the chromosomes will be distributed in the daughter cells, right? So, I wanted them to connect to that, but the way I asked, they went back to the fact that the nucleus has been removed. They couldn't think deeper. Because if the nucleus has been removed, that it has been removed there was no discussion anymore. I wouldn't ask such a question in relation to the fact that the nucleus has been removed because that's what we said.

Researcher: Yea.

Teacher: So, then I wanted them to, but then, it's like the question was ambiguous. Can I see? Didn't I make a follow-up on this one?

Researcher: There is a frequent use of so why and they kept. Of trying and trying. You see this one because the nucleus is important but not going into depth about how is it important? You see this one because cell division occurs in the nucleus. But even that follow-up, is still "so why", I feel like the question was…

Teacher: Ambiguous, it was not very clear.

Researcher: Yea

Teacher: No, that question was not clear, that's why they struggled to answer. Yea.

Teacher: I lead them through until she realized not this man should be talking about what is in the nucleus? I think at that point, that one realized. That's why she referred to chromosomes being on the nucleus. But the initial question was ambiguous.

Researcher: Okay. So this frequent use of "so why" was supposed to be probing them and channel them in that direction.

Teacher: Yea. Toward that…

Researcher: There is this other description that you are going to give here, that I wanted us to talk about as well.

Teacher: Yea

Researcher: The learners usually struggle with this one, I really don't know why

Teacher: Even in Grade 12

Researcher: Even in Grade 12 they struggle, even with the number of chromosomes inside the cell. In mitosis even the definition itself, a parent cell divides to form two identical daughter cells. So, they know that there are supposed to be two cells that are formed, but when they are asked that question, even the cell you drew on the board had a cleavage farrow narrowing that is happening there. And it shows that this is where the cell is going to divide but when they have to answer that question, they struggle. I would like to know when you asked that question was you trying to understand if they understood the definition or what is happening in mitosis or if you just wanted them to see it on the board? If they are able to be vigilant enough or observant enough to see that there are two cells that are going to form here?

Teacher: Yea both actually, that's the main issue, even now, is in Grade 12 when you talk about say, meiosis because that is what we are doing there. You can tell them that you have eight chromosomes in a somatic cell, then how many will be in the gamete? They say 23 because of how we emphasize the human.

	Even on the diagram, some of them will write 23 but they can't count 23 or 46 so it's that thing I was trying to emphasize.
Researcher:	So that was the clue? The even distribution also the daughter cells remind them that
Teacher:	They get the same number of chromosomes.
Researcher:	Yea.
Teacher:	Because if you run through them, the issue of two cells being formed is very very crucial. So, yea, I could have said okay I run through it, and somewhere they were going to remain behind.
Researcher:	Yea, because even the one who knows that it's two cells. But they are now contemplating because they are uncertain
Teacher:	How they are thinking what could be the answer
Researcher:	Right, here is another question. You phrased this question, it is almost similar to the question you asked on the very first…
Teacher:	Chromatin network, is that the one?
Researcher:	Yes, that is the one. Why did you phrase it like this?
Teacher:	How did I phrase it, that if the cell is not going to divide what happens to the chromosomes? Yes, I wanted them to connect to the first question.
Researcher:	To the first lesson?
Teacher:	Yes. Did they get it?
Researcher:	They did but after you gave them clues. They did, yea.
Teacher:	It was a very difficult question.
Researcher:	It is, even that first one.
Teacher:	Because at this stage. No at this stage this was difficult for them. Because I don't I don't know if I had mentioned it. But I think I had mentioned
Researcher:	You mentioned all the phases.
Teacher:	I was discussing interphase, because, I had mentioned that once the cell division takes place and the cell is not going to divide then they go back to the chromatin network. I think I mentioned it. But then they wouldn't connect because this one is a different lesson altogether.
Researcher:	Yea, so if had mentioned it in the first lesson
Teacher:	I think I did I am not very sure, but I think I did.
Researcher:	But even if you didn't mention it, I think that very first question you asked on how chromosomes are going to appear. I think because you asked it beginning of the question so
Teacher:	Yea
Researcher:	Do you think it was an issue of ambiguity in the question again?
Teacher:	No, it was just tough, there was no ambiguity there. I think they wouldn't just

	connect. But the fact that they could remember that the chromosomes would replicate, okay, that happens to chromosomes during cell division. During the whole, during the entire process. But remember that they then uncoil and become threadlike and become a network of…
Researcher:	Going back to the cell as it had started.
Teacher:	Yea, that's what they couldn't connect.
Researcher:	Right, now this learner here sounded confused because she spoke about the centrioles, she spoke about the chromosomes the opposite poles, and everything. She completely deviated from the question you were trying to ask. But you did not respond to her, you just revoiced what she was trying to say, but you did not respond to it. You quickly moved on to the others.
Teacher:	Yes, that was just misleading. I mean, isn't this the same one about what happens to the chromosomes.
Researcher:	Yes, that's the question
Teacher:	And she was talking about centrioles, that they separate, so I didn't want to dwell much on that, it was just completely out.
Researcher:	Because it was totally… okay
Teacher:	Because there are some who can just get that point
Researcher:	So, you are saying, asking this question was intentional so that they are able to link the knowledge that they already have with the newly acquired knowledge
Teacher:	Yea, it was important for them to know what happens, once cell division has ended to the chromosome. And I was hoping they would then connect, and say okay before cell division these must change into actual chromosomes or something
Researcher:	So that the process can start again.
Teacher:	Yes.

APPENDIX D: Ethical clearance

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

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FACULTY OF EDUCATION
Ethics Committee

1 December 2022

Dear Miss LG Zondo

The application for ethical clearance for the research project described below served before this committee on 16 November 2022:

Ethics Protocol No:	**EDU155/22**
Principal investigator:	**Miss LG Zondo**
Student/Staff No:	**22881230**
Degree:	**Masters**
Supervisor/Promoter:	**Dr C Khoza**
Department:	**Science Mathematics and Technology Education**

The decision by the committee is reflected below:

Decision:	**Approved**
Comments:	
Period of approval:	**Two years**

The approval by the Ethics Committee is subject to the following conditions being met:

1. The research will be conducted as stipulated on the application form submitted to the Ethics Committee with the supporting documents.
2. Proof of how you adhered to the Department of Basic Education (DBE) policy for research must be submitted where relevant.
3. In the event that the research protocol changed for whatever reason the Ethics Committee must be notified thereof by submitting an amendment to the application, together with all the supporting documentation that will be used for data collection namely; questionnaires, interview schedules and observation schedules, for further approval before data can be collected. The changes may include the following but are not limited to:
   - Change of investigator,
   - Research methods any other aspect therefore and,
   - Participants.

The Ethics Committee of the Faculty of Education does not accept any liability for research misconduct, of whatsoever nature, committed by the researcher(s) in the implementation of the approved protocol.

Best wishes

Prof Funke Omidire
Chair: Ethics Committee
Faculty of Education

Room 3-63, Level 3, Aldoel Building
University of Pretoria, Private Bag X20
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Faculty of Education
Fakulteit Opvoedkunde
Lefapha la Thuto

APPENDIX E: Mpumalanga Department of Basic Education letter of permission

Groenkloof Campus
Pretoria
0002
30 January 2023

Head of Department
Mpumalanga Department of Education
Private Bag X11341
Nelspruit 1200
Government Boulevard
Riverside Park
Building 5
Republic of South Africa

Dear Sir/ Madam

LETTER OF INFORMED CONSENT: MPUMALANGA DEPARTMENT OF EDUCATION

I am a Master's student studying at the University of Pretoria in South Africa, Faculty of Education, conducting a research project titled *Life Sciences teachers' use of discursive moves to establish dialogic discourse when teaching about the cell cycle*. In the current study, I intend to explore the Life Sciences teachers' discourse moves employed in the classrooms when teaching about the cell cycle topic taught by Grade 10 Life Sciences teachers, during the first term, in South Africa, Mpumalanga.

For this research study, I would like to collect data at four of the following six secondary schools in the Msukaligwa 1 and 2 circuits, Gert Sibande District, Mpumalanga Province: Raggie Masuku Secondary School, Nqobangolwazi Secondary School, Ithafa MSTA Secondary School, Cebisa Secondary School, Camden Combined school, and Ermelo Combined School. I respectfully seek your permission to conduct this research at the schools mentioned and, as part of the research, observe the lessons when the topic of mitosis is being taught during the first quarter of 2023.

The findings of this study will help guide intervention strategies that would be useful in equipping life sciences teachers with the relevant practices and discursive moves they can employ to assist in the teaching of the cell cycle effectively. The findings will also help inform the Department of Basic Education (DBE), and other education stakeholders of the difficulties teachers experience in teaching about the cell cycle and the support they need.

I am seeking authorization to interview four Grade 10 Life Sciences teachers in four of the six secondary schools in the Msukaligwa 1 and 2 circuits after school hours. The interview schedule has 5 questions and will last for 20 minutes at most. The interviews will be conducted outside of school, at a convenient time for all the participating teachers. The interviews will be recorded so that I can retrieve the conversations at a later stage for analysis. The audio recordings and interview transcripts will be treated with confidentiality. Only I, as a researcher, my supervisors, and a transcriber will have access to the interview recordings and transcribed data; the transcriber will sign a confidentiality agreement. The transcriber will transcribe the interview data, which will be sent back to the teachers upon request. Data obtained from this study will be interpreted for the identification of themes and codes. This will ensure the study's credibility, which is necessary for the quality assurance of the study.

This study also involves lesson observation when the cell cycle is taught. However, this research will not comment on the teachers' competencies as Life Sciences teachers.
I, therefore, seek your permission to video-record the classroom observations to capture the teachers' and learners' utterances during the lesson. Observations will prolong for four days and be persistent to ensure the dependability and credibility of the study. Final findings will be sent to you on request, but no individual identifying information will be released to you or any other interested parties. Transcripts obtained from the recordings will be treated with

confidentiality. Only the supervisor, myself, and the transcriber will have access to the recordings and transcripts. The transcriber will sign a confidentiality agreement.

The information teachers provide will be used for academic purposes only and may be published in scientific journals. A summary of the findings will be provided upon request. I also request permission to use data from the current study confidentially and anonymously for further research purposes. The data sets are the intellectual property of the University of Pretoria, and where relevant, project funders. The confidentiality and privacy applicable to this study will be binding on further research studies.

No tuition time will be lost since the normal teaching activities will not be disturbed. The participants will not be awarded incentives to avoid bias and promote voluntary participation. There will also be no implication for academic assessments for participation or non-participation.

Only I, as a researcher, and my supervisors, will know the names of the schools and the teachers. These names will be treated with confidentiality and will not be disclosed. Pseudonyms will be used in spoken and written reports. All participating individuals will be asked to sign a consent/agreement letter, and all participation in the current research project will be voluntary. No deception or manipulation will be employed in any element of the research process.

The Ethics Committee of the Faculty of Education at the University of Pretoria has approved this study. The recordings and all the data collected will be stored at the Faculty of Education at the University of Pretoria for at least 15 years, as per the rules and regulations of the Ethics Committee of the University. Electronic data will be stored on a password-protected flash drive.

Although all participation in the research will be voluntary, the participation of the schools in Msukaligwa 1 and 2 circuits is important for the success of this research project. I would highly appreciate the completion of the accompanying consent letter if you agreed to grant the research permission. Should you have further inquiries, you are more than welcome to contact my supervisors or me.

Yours sincerely

Ms. Lungile Zondo
Researcher

Our contact details:

Researcher	Supervisor	co-supervisor
Ms. Lungile Zondo	Dr. C Khoza	Prof J. J. R. de Villiers
u22881230@tuks.co.za	climant.khoza@up.ac.za	rian.devilliers@up.ac.za
0625639914	0124205734	0124205529

DECLARATION OF CONSENT

Signing this page means that you grant permission for schools in Msukaligwa 1 and 2 circuits, Gert Sibande District, Mpumalanga Province to participate in the current study and that you are aware of the purposes of the project.

I_____(name and surname), the Head of the Department of Mpumalanga Department of Education, hereby give consent for secondary schools in Msukaligwa 1 and 2 circuits, Gert Sibande District, Mpumalanga Province to participate in the study and declare that I understand the procedures described above and that my questions about this study have been answered.

_____	_____
Signature of the HOD of Mpumalanga Department of Education	Date
_____	_____
Signature of the researcher	Date
_____	_____
Signature of the supervisor	Date
_____	_____
Signature of the co-supervisor	Date

APPENDIX F: Assent and consent forms

5.9.1.1.1 F.1 Principal's consent

LETTER OF INFORMED CONSENT: PRINCIPAL

Groenkloof Campus
Pretoria
0002
16 October 2022

Dear Principal

I am a Masters student studying at the University of Pretoria in South Africa, Faculty of Education, conducting a research project titled, *Life Sciences teachers 'use of discursive moves to establish dialogic discourse when teaching about cell cycle*. In the current study, I intend to explore the Life Sciences teachers discourse moves employed in the classrooms when teaching about the topic cell cycle being taught in Grade 10 by Life Sciences teachers, first term, in South Africa Mpumalanga.

I would like to collect data at a number of schools in Mpumalanga in the Msukaligwa 1 and 2 circuits, including your school, for this project. Thus, I humbly request your permission to also conduct my research at your school. Findings from the current study will help equip Life Sciences teachers with skills that will develop their teaching strategies when teaching about the cell cycle. The upper structures will also benefit from this current study as well as the Department of Basic Education.

I am seeking authorisation to interview one of your schools' Grade 10 Life Sciences teachers in person. The interview schedule has five questions and the interview will last about 20 minutes after the school hours. The interviews will be audio-recorded. The recordings obtained from the interviews will be used for transcription and analysis of data.

Data obtained from this study will be interpreted for identification of themes and codes, this will ensure credibility of the study, necessary for quality assurance in the study.

This study also involves lesson observation when the topic of cell cycle is taught. However, this research will not comment on the teachers' competencies as Life Sciences teachers. Observations will prolong for four days and be persistent to ensure dependability and credibility of the study. Final findings will be sent to you on request, but no individual identifying information will be released to you or any other interested parties. Transcripts obtained from the recordings will be treated with confidentiality, only the supervisor, myself and the transcriber will have access to the recordings and transcripts. The transcriber will sign a confidentiality agreement.

The information provided by teachers will be used for academic purposes only and may however be published in scientific journals. Summary of the findings will be made available on request. I also request permission to use data obtained from the current study confidentially and anonymously, for further research purposes, as the data sets are the intellectual property of the University of Pretoria and, where relevant, project funders. The confidentiality and privacy applicable to this study will be binding on further research studies.

There will be no tuition time lost, no teaching activities interrupted, no incentives of any sort will be awarded to the participants to avoid bias and promote voluntary participation. There will also be no implication for academic assessments for participation or non-participation.

Only myself as a researcher and my supervisors will know the names of the schools and the teachers, these names will be treated with confidentiality and will not be disclosed. Pseudonyms will be used in spoken and written reports. All participating individuals will be asked to sign a consent/ assent letter, and all participation in the current research project would be voluntary. No deception and manipulation will be employed in any element of the research process.

The Ethics Committee of the Faculty of Education at the University of Pretoria has approved this study. The recordings and all the data collected will be stored at the Faculty of Education at the University of Pretoria for a minimum of 15 years, as per the rules and

regulations of the Ethics Committee of the University. Electronic data will be stored on a password-protected flash drive.

Although all participation in the research will be voluntary, the participation of the schools in Msukaligwa 1and 2 circuits is very important for the success of this research project. I would highly appreciate the completion of the accompanying consent letter if you agreed to grant the research permission. Should there be any further enquiries, you are more than welcome to contact me or my supervisors.

Yours sincerely

Ms. Lungile Zondo
Researcher

_____ _____

Signature of the researcher Date

_____ _____

Signature of the supervisor Date

_____ _____

Signature of the co-supervisor Date

Contact details:

Researcher	Supervisor	Co-supervisor
Ms. Lungile Zondo	Dr C. Khoza	Prof J.J.R. de Villiers
u22881230@tuks.co.za	climant.khoza@up.ac.za	rian.devilliers@up.ac.za
0625639914	012 420 5734	0124205529

DECLARATION OF CONSENT

Signing on this page means that you grant permission for your school to participate in the research project and that you are aware of the intended research process.

I, _____(name and surname), the principal of (name of the school), hereby give consent for my school to participate in the study and declare that I understand the procedures described above and that my questions about this study have been answered.

_____ _____

Signature of the principal Date

5.9.1.1.2 F.2: Teacher's consent

LETTER OF INFORMED CONSENT: TEACHERS

Groenkloof Campus
Pretoria
002
16 October 2022

Dear Teacher,

I am a Master's student studying at the University of Pretoria in South Africa, Faculty of Education, conducting a research project titled *Life Sciences teachers' use of discursive moves to establish the dialogic discourse when teaching the cell cycle*. In the current study, I intend to explore the Life Sciences teachers' discourse moves employed in the classrooms when teaching about the cell cycle topic taught in Grade 10 by Life Sciences teachers, in the first term, in South Africa, Mpumalanga. Discourse moves from the kind of questions the teacher asks and the responses the teacher gives to learner contributions.

I would like to collect data at several schools in Mpumalanga province, in the Msukaligwa 1 and 2 circuits, including your school, for the research project. Therefore, I seek your permission to observe the discourse moves you are using when teaching the topic of the cell cycle to Grade 10 Life Sciences learners. The observations will be video recorded and audio recorded. This will be necessary to transcribe data for analysis purposes. The current study's findings will not comment on your competencies as a Life Sciences teacher. Prolonged observation, which will take four days, will enable me to ensure dependability, a quality assurance measure necessary for the research study. The final findings of this study will be sent to you or your principal on request. However, no individual identifying information will be released to you, your principal, or any other interested parties.

The findings of this study will help in teacher development on how to facilitate interactions by asking certain types of questions and responding to learner contributions in a certain way when teaching about the cell cycle. The upper structures in the Department of Basic Education will also benefit in structuring the content and developing Life Sciences teachers in workshops through this study.

I also request your participation in the video stimulated recall interview (VSRI), where I will play certain parts of the video taken in your classroom and then ask you questions. The interview schedule will have five questions that will last for 20 minutes. The interview will not be conducted during school hours but rather at a time that will be convenient for you. The interview will be audio-recorded to transcribe and analyse the data obtained. The recordings and transcripts obtained will be treated with confidentiality; only my supervisors, the transcriber and myself will have access to the recordings and transcripts. The transcriber will sign a confidentiality agreement. The information you provide will be used only for academic purposes and may be published in scientific journals.

Teaching time will not be lost. The normal teaching activities will not be interrupted. No incentives/compensations will be given to participants to avoid bias and promote voluntary participation. There will also be no implication for academic assessments for participation or non-participation.

Only I, as a researcher and my supervisors, will know the names of the schools and the teachers. These names will be treated with confidentiality and will not be disclosed. Pseudonyms will be used in spoken and written reports. All participating individuals will be asked to sign a consent/agreement letter, and all participation in the current research project will be voluntary. No deception or manipulation will be employed in any element of the research process.

The Ethics Committee of the Faculty of Education at the University of Pretoria has approved this study. The recordings and all the data collected will be stored at the Faculty of Education at the University of Pretoria for at least 15 years, as per the rules and regulations of the Ethics Committee of the University. Electronic data will be stored on a password-protected flash drive.

Although all participation in the research will be voluntary, the participation of the schools in Msukaligwa 1 and 2 circuits is important for the success of this research project. I would highly appreciate you completing the accompanying consent letter if you agree to permit me to conduct this research in your classroom. Should you have further enquiries, you are more than welcome to contact my supervisors or me.

Yours sincerely,

Ms. Lungile Zondo
Researcher

Signature of the researcher	Date
Signature of the supervisor	Date
Signature of the co-supervisor	Date

Contact details:

Researcher	Supervisor	Co-supervisor
Ms. Lungile Zondo	Dr C. Khoza	Prof J.J.R. de Villiers
u22881230@tuks.co.za	climant.khoza@up.ac.za	rian.devilliers@up.ac.za
0625639914	012 420 5734	0124205529

DECLARATION OF CONSENT

Signing on this page means you grant permission for your school to participate in the research project and that you are aware of the intended research process.

I, _____(name and surname), a Life Sciences teacher at _____ (name of the school), give consent to participate in the study and declare that I understand the procedures described above and that my questions about this study have been answered.

_____ _____

Signature of the teacher Date

5.9.1.1.3 F.3: Parent's consent

LETTER OF INFORMED CONSENT: PARENT

Groen Kloof Campus
Pretoria
0002
16 October 2022

Dear Parent/ Guardian,

I am a Master's student studying at the University of Pretoria in South Africa, Faculty of Education, conducting a research project titled *Life Sciences teachers' use of discursive moves to establish dialogic discourse when teaching about cell cycle*. In the current study, I intend to explore the Life Sciences teachers' discourse moves employed in the classrooms when teaching about the cell cycle topic taught in Grade 10, first term, in South Africa Mpumalanga province. In this study, I will observe the teachers' discursive moves and the learners' responses, as this contributes to the interaction. I would like respectfully to ask your permission for your child to participate in this research project. Thus, I would like to provide you with more information about this project.

What will the involvement of your child in this research project be?
First, I will observe Life Sciences teachers and learners during the teaching and learning of the cell cycle topic in Grade 10. The lessons will take place during normal school hours in the normal Life Sciences classroom. Observations will be done for four consecutive days, amounting to four periods. The teachers will teach about the cell cycle topic, ask questions, and provide feedback where necessary. This may lead to your child responding to certain questions, and some interactions may occur as the cell cycle is taught.

The lesson will be video recorded, so I can have access to the data for transcribing and analysis at a later stage. The name of the school, teachers and learners who participate in this study will be treated with confidentiality and will not be disclosed. Instead, pseudonyms (not real names) for the schools, teachers and learners will be used in spoken and written reports. Therefore, there is no need to be concerned about what others may think about your child's responses in class. The recordings will be treated confidentially. Only my supervisors, the transcriber and I will have access to the recordings and transcripts. The transcriber will sign a confidentiality agreement.

Additionally, no tuition time will be lost. The normal teaching activities will not be interrupted, and no incentives/compensation will be provided to the participants to avoid bias and to promote voluntary participation. There will also be no implication for academic assessments for participation or non-participation. The learners will not be exposed to deception at any point of the study.

Finally, we would like to ask your permission to use your child's answers, confidentially and anonymously. This study is for further research purposes to help other learners in their studies, as data sets are the intellectual property of the University of Pretoria and where relevant, project funders. The confidentiality and privacy applicable to this study will be binding on future studies. Note that the information you provide will be used for academic purposes only and may also be published in academic journals.

Will the project help your child?

The findings of this research project might help improve your child's learning skills in Life Sciences and the cell cycle topic. However, this improvement will not be instant and may be used for future purposes in Life Sciences lessons.

What if you have any questions?

Questions about this project can be directed to your child's Life Sciences teacher. If you have any questions later, after school hours, you are more than welcome to contact me via text message or phone call (Lungile Zondo) at 0625639914 or ask to see me at your child's school or even ask my supervisors using the contact provided below.

Does your child know about this project?

The project will be explained to your child in a letter, and they will be informed that your consent will be signed before the child can be part of the project if they want to. You may discuss this with your child before deciding if they want to be part of the project or not.

What will happen to the data collected?

The Ethics Committee of the Faculty of Education at the University of Pretoria has approved this study. The data collected, and all the recordings will be stored for 15 years at the Faculty of Education at the University of Pretoria as per the rules and regulations of the University of Pretoria. Electronic data will be stored on a password-protected flash drive.

Does your child have to be a part of the project?

Participation of your child in this project is voluntary. If your child is not interested in participating in the research, do not give your consent to participate, and should you not give consent for your child's participation, your child will be excluded from the research study. This means that none of your child's responses to the Life Sciences teacher will be used in this study.

If you are willing grant your child permission to participate in this study, kindly complete and sign the accompanying declaration of consent letter.

Yours sincerely,

Ms. Lungile Zondo
Researcher
u22881230@tuks.co.za
0625639914

_____ _____

Signature of the researcher Date

_____ _____

Signature of the supervisor Date

_____ _____

Signature of the co-supervisor Date

Contact details:

Researcher	Supervisor	Co-supervisor
Ms. Lungile Zondo	Dr C. Khoza	Prof J.J.R. de Villiers
u22881230@tuks.co.za	climant.khoza@up.ac.za	rian.devilliers@up.ac.za
0625639914	012 420 5734	0124205529

DECLARATION OF CONSENT

Signing on this page means you permit your child to participate in the research project and understand what will happen during the project. If you decide to withdraw your child from the project, you must inform the Life Sciences teacher or me.

I,_____(name and surname), the parent of _____(your child's name and surname), give consent for my child to participate in the study and declare that I understand the procedures described above and that my questions have been answered.

_____ _____

Signature of the parent/guardian Date

5.9.1.1.4 F.4: Learners' assent letters

LETTER OF INFORMED ASSENT: LEARNERS

Groenkloof Campus
Pretoria
0002
16 October 2022

Dear Learner,

Why am I here?

I am a Master's student studying at the University of Pretoria in South Africa, Faculty of Education, conducting a research project titled *Life Sciences teachers' use of discursive moves to establish dialogic discourse when teaching the cell cycle*. In the current study, I intend to explore how your teachers ask questions and respond to learners' contributions when teaching the cell cycle topic.

What will my involvement be?

First, during your normal Life Sciences periods, I will observe the teaching and learning of the cell cycle topic in Life Sciences classrooms. Lesson observations will occur for four consecutive days, and the teacher and I will be in the classroom. Your Life Sciences teacher will teach you about the cell cycle, ask necessary questions, and provide feedback. I will video-record the lessons, so I can access data at a later stage to transcribe and analyse it. I will use the recording to analyse the discursive moves the Life Sciences teachers use and the learners' responses during the teaching and learning of the cell cycle topic.

The name of the school, teachers and your name will be treated with confidentiality and will not be disclosed. Instead, I will use pseudonyms (not real names) for the schools, teachers,

and learners will be used in spoken and written reports. The recordings obtained from the observations will be treated with confidentiality. Only my supervisors, the transcriber and I will have access to the recordings and transcribed data. The transcriber will sign a confidentiality agreement. Thus, there is no need to be concerned about what anyone will think about what you said in class. Note that the information you provide will be used for academic purposes only and may also be published in academic journals.

Additionally, no teaching time will be lost. The normal teaching activities will not be interrupted, and no incentives/compensation will be provided to the participants to avoid bias and promote voluntary participation. There will also be no implication for academic assessments for participation or non-participation. There will be no deception at any point in the study.

Will the project help me?

The findings of this research project might help improve your learning skills in Life Sciences, the cell cycle topic. This might not improve your learning skills instantly. However, it may help for future purposes in Life Sciences lessons.

What if I have any questions?

Questions about this project can be directed to your Life Sciences teacher. If you have questions later, after school hours, you are more than welcome to contact me via text message or phone call (Lungile Zondo) at 0625639914 or ask to see me at your school.

Do my parents/ guardians know about this project?

The project was explained to your parents/guardians in a letter, and they agreed that you could be part of it if you want to. You may discuss this with your parents/guardians before deciding if you will be part of the project or not.

What will happen to the data collected?

The data collected, and all the recordings will be stored for 15 years at the Faculty of Education at the University of Pretoria as per the rules and regulations of the University of Pretoria. Electronic data will be stored on a password-protected flash drive.

Do I have to be involved in this project?

Although your participation in this project is voluntary, your participation in this study is important. However, if you are not interested in participating in the research, do not give you agree to participate, and should your parent not give consent for your participation, you will be excluded from the research study. This means that none of your responses to the Life Sciences teacher will be used in this study.

If you are willing to participate in this study, kindly sign the accompanying declaration of assent.

Yours sincerely,

Ms. Lungile Zondo
Researcher

_____	_____
Signature of the researcher	Date
_____	_____
Signature of the supervisor	Date
_____	_____
Signature of the co-supervisor	Date

Contact details:

Researcher	Supervisor	Co-supervisor
Ms. Lungile Zondo	Dr C. Khoza	Prof J.J.R. de Villiers
u22881230@tuks.co.za	climant.khoza@up.ac.za	rian.devilliers@up.ac.za
0625639914	012 420 5734	0124205529

DECLARATION OF ASSENT

Signing on this page means you agree to participate in the research project and know what will happen when we do the project. If you withdraw from the project, you must inform the Life Sciences teacher or me.

I,_____(name and surname), assent to participate in the study and declare that I understand the procedure described above and that my questions have been answered.

_____ _____

Signature of the learner Date

APPENDIX G: List of codes and descriptions

Code	Description of code
Authentic examples	Describes real life examples that learners can relate to, to make sense of content learnt in class
Curriculum expectations	Any recommendations made by the curriculum reforms in strengthening the teaching and learning process
Learner prior knowledge	Describes the role of learner prior knowledge in contributing to the classroom discussion
Teaching experience	Any relevant skills that teachers use to convey comprehendible content to the learners
Learner misconceptions	Any response that teachers receive from the learners that show confusion and deviation to the subject matter
Linking content to everyday lives	Descriptions that teachers use to help learners apply content learnt in their everyday life
Teaching strategies	Involves all the necessary teaching strategies and methods that teacher employs to convey content knowledge to the learners
Learners' skills	Any skills in relation to language and science that learners should be furnished with in a science classroom
Drilling or memorising	A teaching strategy used by teachers to help the learners master a specific concept or content for a certain purpose
Influence of exam	Training the learners of different types of questions that subject examiners usually use when setting question papers