

An investigation of how Grade 10 learners make sense of concepts on refraction of light through exploring their cultural beliefs/everyday experiences about the rainbow: A case study

A thesis submitted in partial fulfilment of the requirements for the degree of

Master of Education

(Science Education)

Of

Rhodes University

By

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December 2012

DECLARATION

I, Rauha Homateni, the undersigned, hereby declare that the work contained in this thesis is my own original work and has not previously in its entirety or in part been submitted at any university for a degree.

Signature: Date:

ABSTRACT

This study took place at a private high school in the Kavango region with my 32 grade 10B learners as the research participants. Its objective was to investigate how the grade 10 learners make sense of concepts on refraction of light through exploring their cultural beliefs/everyday experiences about the rainbow. This research study was essentially triggered by my own classroom experience of teaching the topic on refraction of light.

In order to achieve the goal of this research, a qualitative case study located within an interpretive paradigm was adopted. To gather data I used multiple data gathering techniques such as brainstorming session, learners conducting interviews in the community, practical activities and focus group interviews. This resulted in descriptive data that qualified to be analyzed in a qualitative way. The themes that emerged from the generated data were coded using upper letter cases and various colours. A methodological triangulation was employed by using multiple data generation techniques. Member checking during focus group interviews also ensured validity in this case study.

The findings of this study revealed that the use of learners' cultural beliefs/everyday experiences can be used to enhance learner engagement, meaning making and conceptual development during the science lessons. In addition, the ways in which practical activities are designed and presented to learners in the science classroom determine learners' participation and conceptual attainment. Therefore, based on my research findings, I recommend that teachers need to be trained to be able to elicit and integrate learners' cultural beliefs/everyday experiences in conjunction with hands-on practical activities which focus on conceptual development during their science lessons. However, although this study had many benefits, it also showed that it is not easy to close the gap between learners' prior everyday knowledge and school science. This warrants further research.

ACKNOWLEDGEMENTS

I wish to acknowledge my supervisors, Dr. Kenneth Ngcoza and Mr. Charles Chikunda for their academic, emotional and professional guidance and support during the entire process of my study. This study would never have been accomplished without your support of all kinds.

I also wish to acknowledge all my research participants for setting time aside in order to take part in my research study. On the same note, I would also like to extend my acknowledgement to the parents of the participants for giving approval to their children to take part in this study. To the school management, I would like to acknowledge your support and positive response to my request for conducting my study at the institution you head.

To my classmates, the MEd science group (2011-2012), a million thanks for your support and critical comments that you gave me throughout the course of this study. You served as pillars where I leaned on whenever I needed support.

I would like to extend my special words of gratitude to my family who accepted my frequent absence from family events during the course of my study. I really appreciate your understanding and moral support that you have shown to me during my study. To my brother Shetekela, thanks for being there for my children in my absence while I was studying.

Above all, I would like to thank God, the almighty for the wonderful strength, and courage that He gave me in order to work on this research despite all kinds of hardships that I went through during the course of my study. Let His good name be glorified!

DEDICATION

This thesis is dedicated to my children Hennie and Paul II Nghilundilwa, my mother Rauna Shanyengana and my late father Risto Haindongo and their entire generation because I love them. Let this thesis serve as an academic foundation for *Meme* Rauna and *Tate* Risto's progenies.

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LIST OF ACRONYMS AND ABBREVIATIONS

A:	Answer
C2005:	Curriculum 2005
IK:	Indigenous Knowledge
ICT:	Information Communication Technology
L:	Learner
LCA:	Learner Centred Approach
LCE:	Learner Centred Education
MOE:	Ministry of Education
NCBE:	National Curriculum of Basic Education
OBE:	Outcome Based Education
PAAI:	The Practical Activity Analysis Inventory
PEEOE:	Predict; Explain; Explore; Observe; Explain
Q:	Question
SCORE:	Science Community Representing Education
ZPD:	Zone of Proximal Development

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Chapter One

Situating the study

Research is a systematic process of collecting, analyzing and interpreting information (data) in order to increase our understanding of a phenomenon about which we are interested or concerned (Leedy & Ormrod, 2010, p.2).

1.1 Introduction

This chapter is an introduction to my study. Its focus was an investigation of how grade 10 learners make sense of concepts on refraction of light through exploring their cultural beliefs/everyday experiences about the rainbow.

The first section of this chapter outlines the research motivation, followed by the research methodology, research goals and research questions, research site and participants. I also provide the definition of key concepts and thesis outline. I end this chapter with some concluding remarks.

1.2 Research motivation

According to the National Curriculum of Basic Education (NCBE) Namibia Ministry of Education (MoE) (2009), teaching and learning in Namibia should be conducted in a learner- centred way. This curriculum also puts more emphasis on using learners' prior everyday knowledge during teaching and learning. Nyambe (2008) also advocates that teaching in a learner-centred way should involve learners as a whole by considering their prior knowledge, experiences, skills, beliefs *etcetera*. My personal criticism when this new curriculum was introduced is that we were made to believe that all the 'old traditional' approaches we used were not conducive to effective learning, instead of also acknowledging some of the good things we had been doing in the past.

In contrast, for the past ten years that I have been teaching physical science, I thought that prior everyday knowledge only referred to what learners had learned in the previous lesson or grade. However, during the course of my BEd Honours with Rhodes University, the concept of prior everyday knowledge became clearer to me and I felt a need to investigate how considering learners' cultural beliefs/everyday experiences, in particular about the rainbow, can enhance learning of refraction of light. Therefore, this study was influenced by both my experience of teaching science as well as curriculum issues.

1.3 Research methodology

According to Leedy and Ormrod (2010: 12), "Research methodology is a general approach the researcher takes in carrying out the research". To support this view, Cohen, Manion and Morrison (2010) also argue that the aim of methodology is to provide a researcher with an in-depth understanding of research terms. Thus, this research has been conceptualised as a qualitative case study informed by an interpretive paradigm to provide me with the immediate and local meaning of the phenomena under investigation (McRobbie & Tobin, 1997). According to Cohen, Manion and Morrison (2007/2010), the interpretive paradigm is characterised as having a concern for an individual. This indicates that an interpretive approach to research tries to understand the individual's actions and their surroundings.

In addition, this qualitative case study was informed by a socio-cultural perspective with a focus on meaning making through social interactions. Babbie and Mouton (2001) further explicate that the distinctive feature of qualitative research is that it focuses on process rather than on outcomes. It also tends to provide description and insight in understanding of actions. Creswell (2003) posits that qualitative research provides a platform for the researcher to interact with the research participants. Interaction with participants was at the heart of this study.

Hence, during the implementation of my research I became more deeply involved with the participants than could have happened in any other lesson. For example, most learners at this school did not know that I could also speak the local language until I made a follow up on the statements made in the learners' local language during brain storming session.

1.4 Research goal, objectives and research questions

The main goal of this study was to investigate how grade 10 learners make sense of concepts of refraction of light through exploring their cultural beliefs/everyday experiences about the rainbow. This was important because the Namibian National Curriculum of Basic Education emphasis that learning should emerge from what learners already know National Curriculum of Education (2009). The problem is how learners' prior everyday experiences can be used to enhance effective learning of concepts of refraction of light.

The objectives of this study were to:

- explore how learners' cultural beliefs/everyday experiences about the rainbow enabled/constrained learning of concepts on refraction of light;
- teach and engage learners in practical activities associated with the rainbow to facilitate meaning making of refraction of light; and
- Clear contradictions and tensions between learners' cultural beliefs/everyday experiences and scientific knowledge on the natural phenomenon of the rainbow.

To realize this goal and objectives of this study, the following questions were asked:

- What are learners' cultural beliefs/everyday experiences about the rainbow?
- What are community members' cultural beliefs/everyday experiences about the rainbow?
- Does the mobilization of learners' cultural beliefs/everyday experiences about the rainbow enable or constrain learner engagement?
- What are the contradictions and tensions between learners' cultural beliefs/everyday experiences and scientific knowledge of the rainbow as a natural phenomenon?
- Does teaching and engaging learners in practical activities associated with the rainbow facilitate meaning making concerning refraction of light?

However, a few people hold the Christian beliefs that a rainbow as a covenant made by God after the story of the flood in the Old Testament.

For example, in the twelve years that I have been teaching physical science at a junior secondary level in a typical rural school in the *Kavango* Region, in *Mpungu* village, I learned that learners hold multiple views about the natural occurrence of the rainbow. Thus, my interest to explore learners' cultural beliefs/everyday experiences about the rainbow was triggered by the curriculum issues and by my personal experience of teaching science, in particular, refraction of light.

Below is the picture of how a rainbow appears on the sky even though has been adopted from a different environment.



Photo: Eric Roph. Rainbow at Alaska's Wrangell-St. Elias National park. Adopted from: <http://www.environmentalgrafiti.com/featured>. Retrieved 07 December 2012.

1.7 Definition of key concepts in the study

Belief: Is something people accept as 'true'.

Cultural beliefs: Are the beliefs that are passed from one generation to another.

Cultural knowledge: All the knowledge and values that are shared by a society.

Everyday experience: Is the term used to describe the type of experiences/knowledge that learners acquire prior to being presented with formal school lessons in a particular area. That could be what learners learnt at their homes or from the community (Stears & Malcolm, 2005).

Learning: Is the process of acquiring and upgrading skills and understanding of concepts and ideas in an organised way.

Mediating learning: Is the process in which teachers support the learning process.

Practical activity: Is the teaching/learning activity in which learners learn by interacting with learning/teaching object using their different senses (Millar, 2009).

Prior knowledge: Is the knowledge that learners acquire through their everyday experience or from the previous lesson (Roschelle, 1995).

Society: Is an extended social group having characteristic cultural and economic organisation (McRobbie Tobin, 1997)

Teaching: A process of facilitating and scaffolding the learning process within an organised set up (Vygotsky, 1978)

Zone of proximal development (ZPD): A distance between a child's problem solving ability when working alone and with the assistance of a more progressive partner (Vygotsky, 1978)

1.8 Thesis outline

This thesis documents findings of my research study which was on the investigation of learners' cultural beliefs/everyday experiences about the rainbow in conjunction with practical activities on refraction of light. It consists of seven chapters.

In **Chapter One**, I present the research context, motivation of the study, research goals and research questions, significance of the study. I also present the research methodology in which I outlined the research paradigm and explain how each of the research questions was addressed.

In **Chapter Two**, I present the literature relevant to my research study. The main focus in this chapter is to explore the curriculum issues related to teaching and learning science, the role of practical activities in learning, the role of cultural/everyday experiences in teaching and learning science with their implications for teaching and learning science.

In **Chapter Three**, I present the research orientation, methods I used in data gathering, validating and verifying trustworthiness. I conclude by discussing the ethical issues involved.

In **Chapter Four**, I present my data from the brainstorming session and feedback from learners' interviews conducted in the community as well as its analysis.

In **Chapter Five**, I present data that emerged from practical activities and focus-group interviews as well as their analysis.

In **Chapter Six**, I present how I analysed and interpreted my data and outline how I came up with the different themes and the coding system used. I also explain how the analytical statements were formulated and used in discussing my research findings. A table is presented to outline the source of each theme, the analytical statement and the research questions which are answered by analytical statements.

In **Chapter Seven**, I present a summary of my findings, limitations, recommendations, potential value of the study and areas for future research, my critical reflections and conclusion.

1.9 Concluding remarks

In this chapter, I discussed what motivated the choice of this research study. This is followed by a brief outlined of the research methodology. In addition, the research goals, objectives and research questions are also discussed in this chapter. Furthermore, the research participants and the research site are also highlighted. I also defined key concepts of the study. In the last part of this chapter, I offered a brief overview of each chapter. In the next chapter, I discuss the literature relevant for my research study.

Chapter Two

Literature Review

Literature review is a means of demonstrating knowledge about a particular field of study including vocabulary, theories, key variables, and phenomenon, and its methods and history (Randolph, 2009, p. 2).

2.1 Introduction

This chapter is based on the literature that was reviewed to inform my research study. Primarily, this chapter is divided into three major parts that include sub-sections.

In the first part of this chapter, I discuss literature related to the curriculum issues in Namibia by drawing ideas from international curriculum documents such as the one followed in South Africa. In the second part, I discuss the main theoretical frameworks that underpin my study with the main focus on the socio-cultural perspective on learning and social constructive theory in learning and teaching. In the third part of this study, I discuss the conceptual framework that was necessary for my research, viz., practical activity and its role in teaching and learning refraction of light, the role of learners' everyday experiences in teaching and learning science; and the implications for considering learners' everyday experiences in teaching and learning science. I end with some concluding remarks.

2.2 Curriculum issues

Until 1990, teaching in Namibia was characterized by teacher-centred approaches in which teachers were perceived as the only sources of knowledge. As a result, learners were passive recipients of, for example, scientific facts which they had to memorize and regurgitate during the examinations (Nyambe, 2008).

After independence in 1990, however, a government-driven transformation in curriculum was introduced underpinned by learner-centred education (LCE) pedagogy with a focus on learning. In LCE learners are regarded as central to their learning. Essentially, the LCE pedagogy is informed by the constructivist perspective whereby learners are required to take responsibility for their learning. Thus, the National

Curriculum for Basic Education in Namibia foregrounds empowering learners for the development of Namibia for the future as a knowledge-based society (Namibia. MoE, 2009).

Pomuti, LeCzel, Liman, Swarts and Van Graan (2003:12) contend that the concept of learner-centeredness further relates to attaining the educational goals of *access, equity, quality* and *democracy*. Similarly, Nyambe (2008) argues that learner-centred education is intended to foster learners' skills, attitudes and values. It thus regards learners' prior everyday experiences and background as a vital starting point during teaching and learning.

Based on these new approaches to pedagogy and learning, the Namibia MoE (2009) now also accentuates that teaching science should be based in part on what learners already know. Thus, the Namibia MoE (2003/2009) recommends that teachers should use learners' prior everyday experiences in making learning meaningful to their everyday life.

Despite this curriculum innovation concerned with the transformation of teachers' pedagogical practices, many Namibian teachers are faced with challenges of putting the theory into practice. For example, when using a learner-centred approach in teaching, many teachers see this as simply boiling down to using group work (Nyambe, 2008). Or they exaggerate the facilitative role of the teacher relegating her/him to a very passive role. Swarts and van Graan (2003:21) warn that if education reform is predicated on teachers being both the agents and implementers of change, they have to be adequately prepared for that task. The results show that this did not and does not happen.

Furthermore, a number of researchers argue that educators should develop understanding of the role that learners' everyday experiences play in teaching and learning science (Barab & Luehmann, 2003; Rivet & Krajcik, 2008). To contextualize science teaching is to use learners' prior everyday experiences as a mechanism for conceptual attainment (Otero & Nathan, 2008). Otero and Nathan (2008) argue that eliciting and building on learners' prior everyday knowledge can play an essential role in enhancing meaningful learning.

Research further reveals that when learners' prior everyday knowledge is not recognized, they may find it difficult to grasp new concepts or information and relate these to their preconceptions about a phenomenon they have experienced outside the classroom (Krause, Kelly, Corkins, & Tasooji, 2009;

Sutherland, 2005). That is, consideration of learners' prior everyday experiences can allow learners to relate the content that they are learning in the classroom to their own context (Rivet & Krajcik, 2008; Oloruntegbe & Ikpe, 2011; Rennie, 2011).

A study conducted by Oloruntegbe and Ikpe (2011) in Nigeria confirmed that learners come with rich cultural knowledge from their immediate environment that needs to be recognized in the science classroom. They thus advocate that science teachers should find a way of engaging learners in what they already know about science concepts, identify the science as well as possible misconceptions that can hinder conceptual understanding (Thompson & Logue, 2006).

Ramorogo and Ogunniyi (2010) conducted a similar study in South Africa in which they investigated teachers' beliefs about the rainbow. Their findings revealed that most teachers who participated in their study held both religious and scientific beliefs about the rainbow while a few also had cultural beliefs about the rainbow. In contrast, this study is about the learners' beliefs about the rainbow.

2.3 Theoretical framework

This research study was set within the framework of learner-centred approach which is embedded in a social constructivist theory (McRobbie & Tobin, 1997). This has been done with the view to align my research study with the goals of education in Namibia. Constructivism supports the ideas that prior knowledge forms the basis of new knowledge (Roschelle, 1995).

Drawing on the work of Vygotsky (1978), Roschelle (1995) argues that new knowledge is rooted within prior everyday knowledge and experiences. Therefore, learning in a social set-up stimulates interest and ability to think, argue over the existing knowledge and open a route for new knowledge to be formed.

This theory is relevant for my study since its main goal was to investigate learners' cultural beliefs/everyday experiences about the rainbow in conjunction with practical activities on refraction of light. By using a constructivist theory for this research I had hoped that it would afford me some insights on learning from the social constructivist perspective. I hoped this would show how to benefit learners using their prior knowledge. I now discuss the socio-cultural perspective.

2.3.1 Socio-cultural perspective

The socio-cultural perspective emphasizes that individuals' understanding of concepts, theories and ideas of a particular community is a dynamic process resulting from acting in situations and from negotiating with other members of that community (Traianou, 2006). From this perspective, interactive classroom arguments and conversations can help teachers and learners to clear their doubts, improve current knowledge, acquire new attitudes and reasoning, skills, gain new insights make informed decisions and even change their perceptions (Ogunniyi, 2007a).

If teachers could consider learners' historical, cultural and prior everyday experience in the science lessons this would help them to understand a learner as a whole and be able to use what learners already know as a preliminary starting point (Namibia. MoE, 2009; Oon & Subramanian, 2009; Stears, Malcolm & Kowlas, 2003). In this regard, Oon and Subramanian (2009) argue that successful learning takes place when there is a conflict between learners' prior knowledge and the presented materials. They further argue that such conflict can lead to the refinement of learners' prior knowledge. A study conducted by Stears, et al. (2003) indicates that when learners' prior knowledge is considered, learners are likely to be engaged in the lesson because the presented materials become part of their context.

In his studies, Vygotsky (1986) further examined the role of prior knowledge in learning science and identified that children have unstructured concepts that are part of the system. In an attempt to understand the nature of human learning, Vygotsky proposed the theory known as the Zone of Proximal Development (ZPD). According to Vygotsky (1978), the ZPD is the distance between a child's actual development levels as determined by independent problem solving and the higher level of potential development as determined through adults' guidance or in collaboration with capable peers. So, establishing where learners are in terms of their prior everyday knowledge is tantamount to finding out where they are in the ZPD.

Aikenhead and Jegede (1999) assert that learners' success in science classes depends on the degree of understanding that exists between their prior everyday knowledge and the science in the classroom. Furthermore, they indicate that knowledge acquisition can only be possible if there is a link between what learners know from their everyday experiences and the content they are presented with in the science classroom. As a result, when learners are provided with an appropriate learning environment and

instructions, they would be able to take part in the lessons (Oon & Subramanian, 2009) in social interactions. I believed that the socio-cultural perspective would contribute to the design and analysis in this research and I now discuss social constructivism.

2.3.2 Social constructivism

The concept of social constructivism can be defined as an approach in which individuals' knowledge relies on its social construction. According to McRobbie and Tobin (1997:194), "social constructivism recognizes the importance of social and personal aspects of learning". McRobbie and Tobin (1997) further posit that the social aspect refers to what learners acquire cognitively while interacting with peers or their significant others while the personal aspect refers to individuals constructing knowledge on the basis of their everyday experiences when new knowledge interacts with the existing knowledge. This means that even if learners learn within the community of practice, individual learners construct their own understanding and knowledge.

Social constructivists recognize that there are many ways of constructing knowledge, all of which are socially mediated (McRobbie & Tobin, 1997). Bencze (2000) echoes that while individuals develop their own understanding, that knowledge is socially mediated. For example, learners can construct their individual knowledge when they are provided with opportunities to negotiate with others in a social set up (Vygotsky, 1978).

2.4 Conceptual framework: Mediating learning

The term *mediating learning* refers to the way in which learning is facilitated by the teacher. There are many ways in which teachers can mediate or enhance effective learning. Drawing from Vygotsky's early work, Gupta (2009) echoes that learning can be effective if learners are provided with necessary support up to the level when they are able to work without it. In his ideas of zone of proximal development (ZPD), Vygotsky (1978) emphasises that learning is possible if it is collaborated. Therefore, it is the role of the teacher to enhance learning by using different strategies such as modelling and encouraging learners to use their background knowledge.

2.4.1 Everyday experience

Learners do not come to school like empty buckets to be filled with information. They have many experiences and are already learning. Teaching which does not build on that experience and learning will limit the learners' thinking and the learners will not see the connection between the world outside the classroom and what is taught and learned in school (Namibia. MoE, 2009, p 29-30).

The term *prior everyday experience* refers in this study to the knowledge and experiences that learners bring to school. This could be their indigenous knowledge (IK), cultural beliefs/practices or even knowledge that they have acquired through formal schooling. Learners come with well-developed knowledge from their different societies.

Considering learners' cultural beliefs/everyday experience does not only create cultural interaction among different cultural groups but provides learners with insight to value their cultural heritage and that of others (Hewson, Javu & Holtman, 2009). Thus, Hewson, et al. (ibid.) further advocate that science teachers should find ways of engaging learners in what they already know about science concepts, identify what is science and what might be misconceptions that can hinder conceptual understanding.

Literature reveals that prior knowledge forms the basis on any type of learning that takes place in the classroom (Roschelle, 1995; Stears, et al., 2003). According to Roschelle (1995:4), "new knowledge does not replace prior knowledge; rather new knowledge uses prior knowledge". This is done by refining prior everyday knowledge and placing it in a more encompassing structure. In addition, Roschelle further stresses that knowledge begins with the selection of ideas from everyday life. Lending support, Stears and Malcolm (2005) speculate that prior everyday knowledge may force a theoretical shift to viewing learning as conceptual change. Hence, it is from a learner's prior everyday knowledge that new concepts can be drawn and developed.

The study conducted by Roschelle (1995) reinforces that educators are able to help learners in the real classroom if they know how everyday experiences enhances or constrains conceptual attainment. In addition, research further reveals that when learners' everyday experiences is not recognized, they might find it difficult to grasp new concepts or information and relate these to their preconceptions about a phenomenon they have experienced outside the classroom (Krause, et al., 2009). That is, consideration of

learners' cultural beliefs/everyday experiences can help them to relate the content that they are learning in the classroom to their own context (Rivet & Krajcik, 2008; Rennie, 2011).

Rennie (2011) refers to this as blurring the boundaries between school and home contexts. Blurring the boundary implies that teachers close the wide gap that exists between learners' everyday experience and the science they are presented in the classroom. Blurring the boundary requires teachers to believe in the significance of science in learners' everyday life (Aikenhead, 2006; Rennie, 2011).

Stears and Malcolm (2005) however, caution that prior everyday experiences should be refined but not replaced with new knowledge. To support this view, Roschelle (2009) indicates that scientific knowledge draws ideas from prior everyday experience and reuses them. Therefore prior everyday experiences should be investigated and used in teaching related concepts. Correspondingly, Otera and Nathan (2008) maintain that eliciting and exploring learners' prior everyday experiences is fundamental and can help teachers to identify problematic issues and use what is useful in enhancing knowledge. This requires curriculum designers to anticipate a long term learning process in order for the short term experiences to form an incremental part. However, the curriculum designers should also bear in mind that learning depends on social interactions as proposed by Vygotsky (1978). For teachers to be able to mediate learning through the use of learners' everyday experiences, Rennie (2011) posits that teachers need excellent pedagogical knowledge.

Roschelle (1995) warns that prior everyday knowledge can be both beneficial and problematic at the same time. Thus, he calls upon curriculum developers to come up with strategies that could be used by teachers when teaching to avoid any possible impairment that might be caused by considering everyday experiences in the science class (Rennie, 2011).

Notwithstanding, it is evident that everyday experiences can enhance learning because learners would be able to link what is learned in the classroom to what they have already experienced at home. Literature has showed that teachers need to be able to assist learners in aligning their everyday experiences to the content that they are presented with in the classroom (Roschelle, 1995). Thus, prior everyday experiences should be viewed as tools for providing flexible building blocks for new knowledge (Roschelle, 1995).

As was mentioned in Section 2.2, learners come to school with knowledge, skills and experiences that they have acquired prior to being taught at school, they expect such knowledge to be given some recognition. However, in the classroom, those skills and knowledge are ignored by some teachers. Instead of using learners' cultural beliefs/everyday experiences as the foundation for new content to be learned, learners are forced to abandon their existing knowledge and adopt the new knowledge (Ogunniyi & Ogawa, 2008).

As a result, learners might experience difficulties in shifting from what they already know to what they are presented with in the classroom. Roschelle (1995) and Kibirige and Van Rooyen (2006) caution that learners are likely to lose interest in schooling once they realize that their experiences do not count for anything in the classroom. When content is not contextualized to address the needs of learners, learners tend to see no significance of learning in school as a whole. Yet, application of knowledge to learners' everyday lives is critical.

Everyday experiences could be viewed as a dual path which transmits both advantage and disadvantages (Roschelle, 1995). At the end of the continuum, prior knowledge can have a serious impact on learning if proper care is not taken during the curriculum planning.

In a study conducted in South Africa by Stears, et al. (2003), it was revealed that even if teachers considered learners' prior everyday knowledge during their lesson planning stage, they still found it difficult to grasp learners' prior everyday experiences and develop it during the lesson. In a study conducted by Ramorogo and Ogunniyi (2010) in South Africa as well, in which they explored teachers' cultural beliefs about the rainbow, they found that teachers held diverse beliefs that could be cultural or Christian-oriented. The participants in the above mentioned study realized the significant of using learners' indigenous knowledge in teaching science. In the case of my research, the focus was on learners' cultural beliefs and everyday experiences about the rainbow.

Even though in the Namibian context it is emphasized that the point of departure in teaching should start with what learners already know and what they can already do (Namibia. MoE, 2009:4), the issue of how to include learners' prior knowledge is not made explicit. The same curriculum argues that learners should acquire scientific skills, processes and scientific knowledge to promote a society which is scientifically literate and allow citizens to live a healthy living style.

Overall, the issue of prior knowledge should be taken into account right from the curriculum development if we want to meet the goals of education. If teachers are well trained on how to approach teaching science in such a way as to use learners' cultural beliefs/everyday experiences, our society at large could benefit from the education system. For the purpose of this study, cultural beliefs/everyday experiences could be viewed as any knowledge, experience and skills that learners have acquired at home as part of their cultural beliefs or experience through interaction. Also, everyday experiences could be in the form of indigenous knowledge. According to Ogunniyi (2007b), indigenous knowledge is a way of knowing and interpreting experiences peculiar or innate to a particular cultural group.

Culture refers to beliefs, experiences and knowledge contained in a particular group or community. In learning science, I believe that these beliefs and experiences could inform the learning process. A study conducted by Hewson, et al. (2009) in South Africa indicates that 30% of the science curriculum should cover the cultural experiences. When science in the classroom does not acknowledge learners' cultural beliefs/everyday experience, learners would not recognize the value of learning science in their lives. As a result, Hewson (1988) emphasises that the backbone of knowledge acquisition is the consideration of learners' cultural background and experiences. In his argument, Hewson, et al. (2009) further posit that learners find it difficult to shift from their cultural knowledge to the science which they are presented with in the classroom and they argue that teachers should help that process.

2.4.2 Practical activities in teaching and learning science

What is meant by practical activity in science?

The term practical activity means different things to different people including science teachers. According to Millar (2004:2), practical activity is defined as "any teaching and learning activities which at some point involves the students in observing or manipulating the objects and materials they are studying". Lending support, Science Community Representing Education (SCORE) (2009a:7) defines practical activity as "a hands-on learning experience which prompts thinking about the world in which we live".

Looking at the two definitions above, they give an indication that there are complementary things involved in practical activities, These include: learners learning through doing, prompting of learners'

mental functioning and the interaction between learners and the learning materials viewed in their context (Millar, 2004).

The role of practical activity in the teaching and learning science

Practical activity refers to any activities that take place during the science lesson in which learners are given an opportunity to experience science first-hand through hands-on, minds-on and words-on practical activities (Maselwa & Ngcoza, 2003). This entails that learners be fully engaged in the activity by interacting with the substances involved. Consequently learners should be able to explain their predictions and observations.

A study conducted by Maselwa and Ngcoza (2003) indicates that practical activities can enhance learning in science if it is organized in such a way that learners have an opportunity to predict the possible observation before they engage in the practical activity. Similarly, after the activity they should give reasons for what they observed. Writing of these predictions and observation is very important as a strategy to enhance meaning making Latzke and Canaday (2002). If a practical activity is well premeditated and presented to learners, it is likely to achieve the general aim of the activity. It should be borne in mind, however, that involving learners in the practical activity does not automatically mean that the practical activity has satisfied the aim of science curriculum. That is, there is a tendency for science teachers to equate activity with learning. This suggests that for a practical activity to benefit learners, it should be planned in such a way that the focus is on key scientific concepts to be developed.

Practical activities play a particular role in both learning and teaching of science and in our everyday life in general. The accomplishment of the practical activity depends on the way in which it is designed and made accessible to the learners. In a science classroom, for example, practical activities play a major role in conceptual development and understanding as well as the attainment of experimental skills. In addition, the accomplishment of experimental skills can only be attained if practical activities are designed with a specific purpose in mind (Hattingh, Aldous & Rogan, 2007). Practical activities can also promote scientific literacy among learners and encourage accurate observations and description of the phenomena under study (Hodson 1990).

Through interacting with the learning materials learners could come to view a phenomenon as more concrete that initially appeared abstract. For example, in the context of this study, learners' understanding on the formation of the rainbow can be made more concrete by investigating the bending of light through a triangular prism. Practical activities can arouse and maintain interest of learners towards the subject. Furthermore, practical activities could help teachers to explain abstract ideas (Millar, 2004/2009).

It is further believed that when learners act on the world, they are likely to create their own knowledge and understanding. Furthermore, Oloruntegbe and Ikpe (2011) argue that learners are likely to create a link between the science in the classroom and its significance in everyday life. It is evident that when learners are actively involved in practical activities which are hands-on, minds-on and words-on as espoused by Maselwa and Ngcoza (2003), there is a high possibility for them to remember what they have done during the practical activities. According to Maselwa and Ngcoza (2003), words-on refers to written explanations of scientific concepts and they believe that this can enhance meaningful learning.

In an attempt to explain how practical activities could be designed to benefit learners, Hattingh, et al. (2007) suggested four levels of complexity in a practical activity. The first level of complexity deals with the teacher demonstration and the use of specimens found in the local environment. This type of practical activity is assumed to help in the conceptual development. In the second level, the teacher uses teacher demonstration, while learners are involved in the planning and demonstration of practical activity and use tables to communicate data. At this level of practical activity, learners are involved in the enquiry form of learning and follow instruction provided to them. In the third type of practical activity, learners are involved in the planning of the practical activity; they further perform guided practical activities in groups and can be able to write down their observations.

Through this type of practical activity, learners can be able to discover information, and generate knowledge in a socially constructive way as they work in small groups (see Section 2.3.2). The fourth type of practical activity outlined by Hattingh, et al. (2007) deals with the involvement of learners in the designing of the practical activity in which they could conduct an investigation independently. Thereafter, they could be able to reflect on their data collection and make changes with the aim of improving their findings.

In the Namibian context, it appears that most teachers end up using levels one and two. However, during the science fair competitions, it is common that learners present practical investigations in which they show a high level of reasoning and practical skills which are very rare in the classroom.

If teachers could use all the types of practical activities outlined above, then we could claim that the practical activities that we conduct in schools provide learners with scientific understanding of the world via the scientific perspective (Millar, 2009). In addition, we could enhance conceptual understanding, attainment of skills, attitude and mobilization of science as an educational discipline.

Practical activities in which learners manipulate materials and note down their observations enable them to remember what they have done when prompted later. The quality of scaffolding tools (Vygotsky, 1978) associated with practical activities determines the effectiveness of practical activity in the science classroom.

Moreover, Maselwa and Ngcoza (2003) argue that well-planned practical activities could enhance learners' understanding of ideas that seem to be abstract. Many studies indicate that not all practical activities done in the classroom result in the attainment of experimental skills and acquisition of scientific skills (Maselwa & Ngcoza, 2003; Millar, 2004; Gott & Duggan, 1996). However, when clear instructions are provided and learners are given a fair chance to interact with the learning material through the 'predict-explain-explore-observe-explain' (PEEOE) approach, learners will be able to conceptualize the scientific ideas within the learning matter (Maselwa & Ngcoza, 2003).

That is, instead of following the guideline instructions outlined in many science textbooks, it would be useful if learners could be able to predict-explain-explore-observe-explain which are among the basic scientific skills that should be mastered by any science learners (Rivard & Straw, 2000) Even if the result of their experiment is similar to what is outlined in the textbook, this approach would give learners a sense of experimental skills.

Through using the PEEOE approach in the science classroom, learners would be actively involved at all levels of the lesson in general. If a learner misses out a chance to give his/her prediction, he/she might still get a chance either to explain or to observe within that particular task. According to Maselwa and

Ngcoza (2003), by adopting the PEEOE approach, learners and teachers would find science enjoyable and meaningful to their everyday lives.

In the case of the Namibian education system, the PEEOE approach could be adopted to serve as one of the modes of implementation of the learner-centred approach (LCA) which seems to lack the mode of implementation at the moment. The LCA is the framework that was adopted immediately after independence, yet many science teachers still find it quite challenging to implement it in their classrooms as they lack skills for administering different teaching and learning strategies (Nyambe, 2008) - as is also the case in South Africa (Hattingh, et al., 2007).

Although the emphasis of the learner-centred education in Namibia requires learners' active involvement in learning (Namibia. MoE, 2003), there is no clear mode of implementation showing how exactly learners should be actively involved in the learning and teaching activities in the classroom. For instance, practical activities should not focus only on the knowledge attainment needed for examination or assessment purpose in general but should also provide learners with lenses that could be used beyond the classroom level (Gott & Duggan, 1996) and be linked to their prior knowledge (Roschelle, 1995).

A study conducted by Hodson (1990:34) indicates that "practical activities can motivate by stimulating interest and enjoyment, teach laboratory skills, enhance the learning of scientific knowledge, give insight into scientific method and develop certain objectivity and willingness to suspend judgment". Gott and Duggan (1996) indicate that a good practical activity should aim at motivating science interest which leads to developing skills.

As other studies have indicated, Hodson (1990) argues that teachers need necessary skills in order to conduct and provide practical activities that meet the aims of the science curriculum. That might be true but when teachers are not empowered as is frequently the case is in Namibia, there is no way we can expect to observe changes in their learners' performance (Millar, 2004; Henze, Van Driel, & Van Loop, 2007; Abell, 2008).

Woodley (2009), for example, posits that a good practical activity should be able to achieve its aim of effective motivation of ideas. Woodley further categorizes practical activities as core activities and directed activities that are believed to shape students' understanding of the scientific concepts and

phenomena. According to Woodley (2009), examples of directed practical activities that are believed to provide valuable first-hand experience for students include; teacher demonstration, experiencing phenomena, designing and planning investigation and the use of Information Communication and Technology (ICT). Woodley (2009) further outlines that a good practical activity can engage students and help them to develop skills and understanding of the scientific process.

This suggests that teacher empowerment should be an on-going process in order for teachers to be updated with the latest approaches for implementing the science curriculum. A study conducted by Hattingh, et al. (2007) indicates that lack of resources is one of the factors hindering the use of practical activities in science, a view supported by Kriek and Basson (2008). As a result, some teachers claim that they do not conduct practical activities in their teaching due to lack of resources in their schools. However, the effectiveness of practical activities is highly influenced by the teachers' ability to scaffold learners through practical activity (Barab & Luehmann, 2003).

Implications for practical activities in the science classroom

The impact of practical activities on teaching and learning science is determined by its quality (Woodley, 2009; Gott & Duggan, 1996; SCORE, 2009a). Hodson (1990) argues that practical activities in most schools are ill-conceived, confused and unproductive. I agree with Hodson's argument outlined above but looking at what causes teachers to approach practical activities in an unproductive way it seems this lies in the situation they find themselves in. This situation includes the lack of relevant skills for making use of practical activities in a productive way, lack of content knowledge or lack of understanding the value of practical activities in enhancing learning in general.

The general understanding among the science teachers is that practical activities enable learners to acquire skills and this is one reason for teachers' doing practical activities. Nevertheless, a study carried out by Hodson (1990) further revealed that even learners who engaged in practical activities for a number of years could not perform simple laboratory procedures. This is true for schools in Namibia because most teachers only teach for examination purposes and not for the purpose of lifelong learning – a problem which is compounded by the fear of failing learners during the standardized end of year examinations.

As I outlined earlier on, lack of skills and understanding of the role of practical activities could put teachers in the position of instruction followers. This brings us to the idea that practical activities should aim at engaging learners meaningfully so as to provide them with certain necessary skills (Hattingh, et al., 2007).

2.5 Concluding remarks

In this chapter I started by addressing curriculum issues in which I focused the discussion on the curriculum in Namibia. I also drew on experience on the curriculum of education, particularly, South Africa. The discussion on the curriculum provided me with the insight that both Namibian and South African curricula are largely influenced by the past history of those two countries. As a result, the implementation of the curriculum in these two countries does not work out according to plan (Nyambe, 2008; Stears, Malcolm & Kowlas, 2003). For example, implementation in both countries is hindered by the lack of skills for implementation among educators resulting in constant amendments of the curriculum documents.

In the second part of this chapter, I discussed the theoretical framework that informed my study. I foregrounded constructivism, in particular, the socio-cultural perspective and social constructivism, as theories that underpin my research study. These served as tools that I needed to understand what exactly happens when learners learn in a social set up and the relevance of practical activities as well as learners' prior experiences in teaching and learning in science. In the same part of this chapter, I also discussed the implications for using practical activities and learners' prior everyday knowledge.

In the next chapter, I present the research methods and methodology that I employed in my research.

Chapter Three

Methodology

Qualitative case study is an approach to research that facilitates investigation of phenomena within its context using multiple data source. This warrant that the issue is not explored through one lens but a variety of lenses which allows for multiple facets of the phenomenon to be revealed and understood. Qualitative case study methodology provides tools for researchers to study complex phenomena within their context (Baxter & Jack, 2008, p. 544).

3.1 Introduction

The goal of this study was to investigate how the grade 10 learners make sense of concepts on refraction of light through exploring their cultural beliefs/everyday experiences about the rainbow. As indicated in the epigraph above; this chapter describes the research orientation that guided my research process in this study. I also discuss the reasons that informed the selection of the interpretive paradigm and qualitative case study as approaches that led to the attainment of my research goals. I also discuss the research goals, objectives and research questions that guided the data gathering process.

Furthermore, this chapter deals with issues such as my role as a researcher during the research process and how the data were gathered, and triangulated. I also give a brief outline of how I came up with the themes, analytical statements and how my data were analysed. The issues of validation, trustworthiness, ethical considerations and limitations are also outlined. This chapter is concluded by summarising what emerged through its course.

3.2 Research orientation

Research orientation is also known as research paradigm or philosophical orientation (Merriam, 1998). Research paradigm is therefore a framework that guides how research should be conducted, based on people's epistemological and ontological world views (Babbie & Mouton, 2001; McMillan & Schumacher, 2010). Thus, McMillan and Schumacher (2010) contend that a research paradigm aims at providing specification on the plan for general empirical evidence that will be used in answering research question. My research is a qualitative case study, located within the interpretive paradigm.

3.2.1 Interpretive paradigm

The interpretive paradigm aims at understanding the subjective world of human experience and it is concerned with the individual's actions or interpretation during a certain process (Cohen, et al., 2010). This paradigm was most appropriate for this research study because the focus was on meaning making of learners' ideas with regards to the use of their cultural beliefs/experiences on the rainbow. Furthermore, the interpretive paradigm was suitable because it facilitated access to descriptive data that was gained through the use of multiple-data sources. This enabled me to understand learners' cultural beliefs/experiences about the rainbow which I subsequently used in teaching refraction of light.

3.2.2 Case study

A qualitative case study is defined by Baxter and Jack (2008:544) as “an approach to research that facilitates exploration of phenomenon using a variety of data sources”. Qualitative case study therefore depends heavily on multiple data sources.

Within the interpretive paradigm, I adopted a qualitative case study approach. According to Baxter and Jack (2008:544), “qualitative case study is an approach to research that facilitates exploration of phenomenon within its context using a variety of data sources”. To support this view, Joubish, Khurran, Ahmed, Fatima and Haider (2011) posit that through interpretive qualitative case study, data sets are not generated through the use of one method but through the use of different methods. In addition, I adopted a qualitative case study underpinned by a socio-cultural perspective with a focus on making meaning through social interactions.

Furthermore, Babbie and Mouton (2001) elucidate that the distinctive feature of qualitative research is that it focuses on process rather than on outcomes and tends to provide description and insight in understanding of actions. Creswell (2003) argues that qualitative research provides a platform for the researcher to interact with the research participants. Hence, Denscombe (2007) adds that a case study approach enables a researcher to grapple with the relationships and social processes in a way that it was impossible with other research methods. Denscombe further asserts that a case study research allows for data validation through triangulation.

Therefore, my case study investigated how the grade 10 learners make sense of concepts on refraction of light through exploring their cultural beliefs/experiences about the rainbow. A case study approach was suitable for this particular study because it provided rich data Hamilton (2011). The use of multiple data sources in a case study leads to the clear picture of the case under investigation.

3.3 Research goal, objectives and research questions

The main goal of this study was to investigate how grade 10 learners make sense of concepts on refraction of light through exploring their cultural beliefs/everyday experiences about the rainbow.

Therefore, the objectives of this study were to:

- explore how learners' cultural beliefs/everyday experiences about the rainbow enabled or constrained learning of concepts on refraction of light;
- teach and engage learners in practical activities associated with the rainbow to facilitate meaning making of refraction of light; and
- clear contradictions and tensions between learners' cultural beliefs/everyday experiences and scientific knowledge on the natural phenomenon of the rainbow.

To realize the goal and objectives of this study, the following questions were asked:

3.4 Research questions

1. What are learners' cultural beliefs/everyday experiences about the rainbow?
2. What are community members' cultural beliefs/everyday experiences about the rainbow?
3. Does the mobilization of learners' cultural beliefs/everyday experiences about the rainbow enable or constrain learner engagement?
4. What are the contradictions and tensions between learners' cultural beliefs/everyday experiences and scientific knowledge of the rainbow as natural phenomenon?
5. Does teaching and engaging learners in practical activities associated with the rainbow facilitate meaning making of the topic on refraction of light?

To answer the above questions, I used the following approaches:

The first research question in this study was addressed through using a brainstorming session to explore learners' cultural beliefs/everyday experiences about the rainbow. To answer the second question, learners were tasked to go into the community to find out what community members' believe about the rainbow. To answer the third research question I observed the extent to which learners were participating in the research lessons. For example, how they engaged with the discussions, the questions they asked and the presentation that took place during the group presentations. The fourth question was answered by analysing the learners' cultural beliefs/everyday experiences and through focus-group interviews. The last question was answered by engaging learners in practical activities associated with the rainbow, analysing learners' written work as well as focus-group interviews.

All the lessons in this study were audio and video recorded during this research process. But I decided to use data from the audio device because it was clearer than the video footage. Therefore, I depended heavily on the transcriptions.

3.5 Research site and participants

Initially, this research study was scheduled to take place at a government school. However, in January 2012, I resigned from the government school to teach at a private school which is located outside the newly proclaimed town of Nkurenkuru (see Figure 1.5 in Chapter One) in the Kavango region. I decided

to conduct my research in the environment where I am working to avoid expenses and inconveniences that might crop up in using other schools. Initially, my intention was to include everyone in the class but due to unforeseen issues that happened during the course of my data gathering process, I decided to focus on a few learners who shown interest in this study. This is how I avoided bias in my study.. The private school chosen for the case study lies in the Kandjimi circuit in the *Kavango* Region of Namibia, at *Munhena-Nhena* (pseudonym) High school where I teach. The school has an enrolment of 320 learners ranging from grade 8-12 and a staff compliment of 17 teachers. Thus, the teacher- learner ratio is 1-18.

My research participants were my 32 grade 10 learners. Apart from learners who participated in the research study, I also invited my fellow teacher who teaches Agricultural Science and Life Science to observe and reflect on my lessons. I did this because it is impossible to observe your own practice. Since the focus of my research was based on the learners’ cultural beliefs/everyday experiences about the rainbow, I decided to choose a teacher who is from the same background as the learners with the hope that he would be in a position to understand what the learners would be referring to when they discussed their cultural beliefs/everyday experiences about the rainbow.

At the end of my lessons, I also decided to make the video operator one of the research participants because I believed that he had primary experience on the approach that I used through videoing. At the time of this study the video operator was doing grade 12 because I could not get a teacher to do it for me.

3.6 Data gathering strategies and the steps of the data gathering

A range of data gathering strategies were used in different stages of this study. The following table documents what data was gathered, how it was gathered and the purpose for gathering that data.

Stage	Method used to gather data (techniques)	Data to be gathered	Purpose
Stage 1	Brainstorming and discussion. (The lesson was video-taped and a critical friend was	Learners’ cultural beliefs/everyday experiences about the rainbow.	To get a picture of the cultural beliefs/everyday experiences that learners have about the rainbow.

	invited to observe). Formulation of questions in preparation for learners to interview community members on their cultural beliefs about the rainbow.		To ensure that the learners asked relevant questions for my research project.
Stage 2	Learners conducting interviews in the community.	Community members' cultural beliefs/everyday experiences about the rainbow.	To establish whether what learners believe is similar or different to what community members believe about the rainbow.
Stage 3	Learners report back on their findings from the community. (The presentations were captured and a critical friend was invited to do participant observation)	Community members' cultural beliefs/everyday experiences about the rainbow.	To compare and contrast learners' and community members' cultural beliefs/everyday experiences about the rainbow. To capture the whole lesson for data analysis.
Stage 4	Analysis and evaluation. This was done by me. (Develop the lesson for Stage 5)	Analyse the data gathered by the learners and the cultural beliefs/everyday experiences that emerged in stages 1 and 3.	To establish the contradictions and tensions between learners' cultural beliefs/everyday experiences and scientific knowledge on the natural phenomena rainbow. Prepare lessons for stage 5.
Stage 5	Teaching and doing practical activities on the refraction of light. Three practical activities were conducted.	Learner engagement, meaning making and conceptual development.	Observing how learners engage with different and sometimes conflicting explanations of this phenomenon. To discover how teaching and

	<p>These lessons were presented from the perspective of conventional science and I also incorporated learners' and community members' cultural beliefs/everyday experiences about the rainbow.</p> <p>The lessons were video-taped and a critical friend was invited to do participant observation.</p>		<p>engaging learners in practical activities can enable or constrain conceptual development of refraction of light.</p> <p>To capture the whole lesson for data analysis.</p>
Stage 6	<p>Analysis and evaluation.</p> <p>This was done by learners in groups.</p>	<p>Analyse the data gathered by the learners and the cultural belief/everyday which emerged in stages 1 and 3.</p> <p>Characteristics of each :</p> <p>The cultural explanations of the phenomenon and the scientific explanation of the phenomenon.</p>	<p>To establish the contradictions and tensions between learners' cultural beliefs/everyday experiences and scientific Knowledge on the natural phenomenon of the rainbow.</p> <p>To induct the learners into making comparisons and analyse characteristic of different views on phenomena.</p>
Stage 7	<p>Focus group interviews</p> <p>Main question:</p> <p>What do you feel about confronting and working with cultural and scientific explanations of this natural phenomenon rainbow?</p>	<p>Learners' views on the use of cultural beliefs/everyday experiences in teaching and learning science.</p> <p>Learners' views on the use of practical work in teaching the refraction of light.</p>	<p>To establish learners' views and feelings about approaching science from the indigenous point of view and how the use of practical work enabled/constrained their conceptual development.</p>

Table 3.6 showing the tools, methods and the purpose for the gathered information

3.6.1. Outline of the different stages presented in the table above

Stage 1: Brainstorming and discussion session

Brainstorming is an exploratory technique that is open to the creation of new ideas (Bezzi, 2011). During the brainstorming session, learners were divided into six groups with five to six learners per group. Learners were then tasked to discuss their cultural beliefs/everyday experiences about the rainbow.

The groups were actively engaged and they discussed what they heard from their communities and their own experiences. The discussions were mainly in English but learners decided to discuss in their vernacular language that is Rukwangali because they did not have words in English to explain what they wanted to say. For example the names of trees (see Table 4.2). Through the group setup, learners interacted and were able to share a range of everyday knowledge across domains and epistemologies including cultural practices, community, theoretical, spiritual and experiential knowledge (Stears & Malcolm, 2005).

Furthermore, Babbie and Mouton (2001) establish that group discussions offer direct evidence about similarities and differences in the participants' opinions and experiences. The results of the discussions were written on newsprints using mind-maps and these were presented to the whole class. During the presentations, learners were allowed to ask questions where they needed clarification. At the end of the presentations we decided to construct the questions for the learners' interviews in the community. The main aim of the interview was for learners to get the community members' cultural beliefs/everyday experiences about the rainbow.

The main question that they had to ask was **“What are your cultural beliefs about the rainbow?”** and this would lead to the follow-up question that could be asked while the interview was in process. Also learners had to find out: **Where did the community members hear about those cultural beliefs/everyday experiences? What did they think of those cultural beliefs/everyday experiences and why?** These questions were all formulated in English and translated into Rukwangali so that learners could obtain in-depth information from the community members. The framing of interview questions was

done in preparation for the research lesson which was scheduled to take place in the community (see Table 3.1. Stage: 2).

During the research lessons, I used both the voice recorder and the video camera with the view to capture everything that transpired. I decided to use both these devices as a back-up in case something went wrong with one of them. This came from my experience during pilot study. During pilot study, I learned that having one recording electronic device during the interview can have a negative impact on the data collection process if it runs out of power source or if the operator is not experienced enough to capture everything.

Stage 2: Learners conducting interviews in the community

At this stage of my research study, learners conducted interviews in the community on their cultural beliefs/everyday experience about the rainbow. Before the interviews, I advised learners to use their cultural approach when dealing with adults in the community. By “cultural approach”, I refer to the way they greet and approach adults in the community. This was done to avoid tensions that might arise due to inappropriate approaches to the adult interviewees.

The school offered to take learners with a truck to the community as the community is more than one kilometre away from the school. I accompanied the learners into the community and this was done to ensure that learners remained focused on the task. Secondly, I wanted to ensure that all learners were safe during their field trip and return to school before 5:00pm so that they could attend the evening devotion and supper since this is a boarding school.

On arrival in the community, groups of learners split up in to six groups to go to different houses. I was only able to follow one group to one house so as to get a view whether learners really knew what they were expected to do. During these interviews, learners recorded their findings on the loose separate sheets which they later used to present to the rest of the class in the following lesson.

Stage 3: Learners' feedback on the community interviews

After conducting the interviews in the community, learners presented their findings to the rest of the class. This stage (stage three) of my data gathering process did not work out well because the lesson was poorly attended. I think learners were only interested in lesson one and lesson two because they knew that they were going to conduct interviews in the community and they wanted to be seen doing that by members of the community and by other learners who were not part of this research study. Since they knew that in lesson three, they were only going to present their findings, some learners decided to stay away because every Wednesday is a cleaning day and they are not used to do any academic activities on Wednesday afternoons.

I decided to carry on with the lesson anyway because most groups were represented. I provided learners with coloured Koki pens and manila (news) prints to present their discussions in the form of mind maps. Learners were given opportunities to ask questions of one another based on what they had found during their interviews in the community. The presentation sessions were longer than I expected because learners had many questions to ask each other as they presented (see Table 4.2).

Stage 4: Analysis and evaluation of the cultural beliefs/everyday experiences about the rainbow

Data gathered in stage one, two and three were analysed by me and learners as they were reporting their findings to the rest of the class. This was done to establish the aspects of cultural beliefs/everyday experiences about the rainbow that were scientific and those that were non-scientific. During this stage I did not ask learners to write their evaluation because most of what they put on their sheets appeared to be cultural beliefs and they were similar for all the groups. By analysing learners' cultural beliefs/everyday experiences, it became clear to me that these could be scientific and non-scientific. Furthermore, analysing and evaluating the data provided me with an insight on learners' cultural belief/everyday experiences that needed to be considered in preparation for teaching the topic on refraction of light and the possible misconceptions that might emerge before moving to the next stage of data gathering process.

Lastly, I believe that the analysis of the cultural beliefs/everyday experiences made me understand what learners already knew so that I could use their cultural beliefs/everyday experiences as the point of

departure in my teaching of the topic on refraction of light. Nevertheless, I think learners were supposed to write down their classifications on the mind maps so that I could clarify what is scientific and non-scientific amongst the views that emerged from the brainstorming session. I could have done this before presenting to the entire class. That could have helped me distinguish the beliefs that are scientific from the non-scientific ones.

Stage 5: Practical activities

Three practical activities were used in teaching the concept of refraction of light. Practical activities were used to illustrate the formation of the rainbow and the bending of light. A practical activity was adopted so that learners could validate the theory that was learned (Hattingh, et al., 2007). In the first activity, learners observed a bending pencil in a clear glass filled with water. In the second activity, learners used triangular prisms to form the spectrum of colours. On the last activity, learners used a hosepipe to create a rainbow.

Through practical activities learners were able to see that the formation of the rainbow was actually the result of bending of light as it passes through a triangular prism. According to Millar (2004), when a practical activity is well designed, it is likely to scaffold learners in making connections between their everyday experiences with the nature of science. This helps learners to learn from concrete to abstract.

Stage 6: Analysis and evaluation

After the brainstorming exploration of both cultural and scientific explanations of the rainbow and teaching through the use of practical activities, together with learners we analysed and evaluated data gathered in the different stages. The evaluation and analysis were based on scientific and non-scientific explanations of the rainbow. By doing this, learners were able to see if there was any alignment between their cultural beliefs/everyday experiences and the scientific explanations about the rainbow. Lastly, the idea of getting learners to evaluate and analyse at this stage provided them with analytic skills that seemed to be beyond the scope of learning refraction in the classroom.

Stage 7: Focus group interview

A focus-group interview is a technique involving the use of in-depth group interview in which participants are purposively selected (Rabbiee, 2004). At this stage, I selected six learners to take part in the focus-group interview. The focus group consisted of six learners chosen from all groups who actively participated in the group discussions and presentations of their findings. I had hoped that by choosing those learners who were active throughout the research lessons they would provide me with the information that I wanted to get from them. Given (2008) argues that by using purposive sampling to choose focus-group participants, a researcher would be able to obtain relevant information from the participants.

Rabbiee (2004) further argues that a focus-group interview can provide information about a range of issues, as well as illuminating the difference in perspective between groups of individuals. However, Cohen, et al. (2007) contends that despite the role of the focus-group in revealing individual's views on the phenomenon, it is believed that the participants can influence one another's views. In these interviews, I explored learners' views and feelings about confronting and working with these two explanations about the natural phenomenon of the rainbow. The discussions at this stage of my research were recorded using an audio recorder.

Stage 8: Observation

According to Simpson and Tuson (2003), "observation can take different forms such as participant and detached/structure" (p. 46). Simpson and Tuson further emphasize the significance of participant observation since that observer will be able to interact with the research participants. In the case of this study, the observer was passive because he did not interact with the other research participants.

In this study, I invited a life science teacher to be my critical friend during my lessons. Things did not work out according to plan because the teacher whom I had invited to attend my lessons could not attend them due to a funeral that took place during the weekend. However, he suggested watching the video with me and giving his views on the whole range of activities. This plan could not materialise either and I noted this as a methodological dilemma that I have discussed it in detail in my reflection chapter.

In addition to this, the lessons were videotaped in order to have a broad picture of what happened. However, data that I obtained from the video were not my major source as I opted to transcribe data from the audio recorder because I could follow it clearly.

3.7 Data analysis

In the first stage of my data gathering, I did a preliminary analysis with the view to realise the possible themes for my research. The data that I obtained from the brainstorming session, learners' interviews with the community members and the focus-group interviews were transcribed. After going through my transcriptions and learners' written work, I constructed with ten themes that I coded with capital letters from A to J. After going through the ten themes, I realised that these themes were too broad and I then decided to combine common ones into five major themes which I coded using colour codes. The different colour codes that I used and their corresponding major themes are summarised in the table below.

Colour code	Theme
Purple	Curriculum issues
Green	Learner engagement
Blue	Beliefs/experience about the rainbow
Red	Practical work
Yellow	Contradiction in teaching refraction of light

Table 3.7. Shows the colour codes used for themes

Going through my data I managed to identify the themes that appeared most and this is how I validated these themes (See Appendix). In this way, I managed to organise my data in a way that I could engage with. Regarding organising data, Denscombe (2007) explains that when data are not organized before analysing, it might be difficult to engage with, because raw data comes in a range of different forms such as field notes to audio form. Data analysis in this qualitative case study was aimed at revealing the commonalities, differences and similarities (Cohen, et al., 2007) between scientific and cultural beliefs on the rainbow. By surfacing the similarities and the differences, it became quite easy to identify the themes that were relevant to my study.

3.8 Validity and trustworthiness

The validity of a research instrument is the extent to which the instrument measures what it is intended to measure (Leedy & Ormrod, 2010). Validity is important in any research as it provides insight about the study (Cohen, et al., 2007). This can be shown by the number of research methods that I had used in data gathering and hence triangulation (Aldous & Rogan, 2009; Cohen, et al., 2007). Using multiple-data gathering strategies can give a researcher an opportunity to grasp the information which one method fails to provide (Leedy & Ormrod, 2010). The number of research methods that I have suggested in Section 3.6 of this chapter had thus ensured validity in this study.

3.9 Ethical considerations

Before the implementation of this research study, I wrote letters requesting permission from the school principal (management) to conduct research at the school which permission was granted (see **Appendix A and B**). I also wrote consent letters to the parents of the learners informing them about the aim of the research and asking for permission to involve their children in the study (see **Appendix C**). Diener and Crandall (1997) argue that informed consent is a procedure in which individuals choose whether to participate or not. I also informed the participants on the aim of the study as they had the right to know why they were taking part in it. The responses from the parents indicated that 32 out of 33 parents allowed their children to take part in my research study while one parent did not allow his child to take part without giving a reason.

As a researcher I expected both positive and negative answers from parents and could not force that learner to take part in the research lessons. However, the lessons that I presented in the afternoons were repeated in the morning sessions for all learners to benefit even though the set-up of these lessons were not exactly the same as the ones used for research. The research was part of normal teaching but it was stated in the consent letter that the lessons for my research were planned to take place in the afternoons only.

Denscombe (2007) posits that people should not be forced or coerced into helping or participating in research. As a result a learner who was not allowed to participate was asked to stay away from the research lessons and he did not resist because he understood the circumstance surrounding his denial of

consent by his parents even though he did not give any reason for that. Throughout the data analysis and discussion, during the course of implementation, I also kept in mind the issues of confidentiality and anonymity of the participants and research sites (Leedy & Ormrod, 2001). Therefore the written work and letters that contained learners' names and the institution are deleted with a black Koki pen before being attaching to the appendix.

3.10 Limitations of the study

The results of this research study were limited to the *Nkurenkuru* community and Munhena-Nhena school therefore it cannot be generalized to the whole region or country at large. In my opinion, also, I think the presence of the video camera and its operator in the classroom might have changed the natural interaction among learners although literature says that, often learners after a while forget about the presence of a video camera (Cohen, et al., 2010). Nonetheless, I tried everything possible to promote usual interaction in the classroom.

The idea of including the entire class worked well in terms of lessons that explore learners' cultural beliefs about the rainbow and the one for conducting interviews in the community but it could have been more meaningful if I had a focus group throughout this study. That could have made video footage relevant because I could have focused on a smaller group.

3.11 Concluding remarks

In this chapter I have outlined the research orientation in which I highlighted the methodology that informed this study. The research methods and the coding methods which I have used in data analysis are also outlined in this chapter. Finally, this chapter also provided explanations regarding the validity and trustworthiness of this research, ethical consideration and limitation of this study.

In the next chapter, I present the findings that emerged from the pilot study- that is, the brainstorming session and learners conducting interviews with the community.

Chapter Four

Data presentation: Phase One

Some researchers feel that it is important to keep the flavour of the original data, so they report direct phrases and sentences, not only because they are often [more]illuminative and direct than the researchers' own words but also because they feel that it is important to be faithful to the exact words used (Cohen, et al., 2010, p.462).

4.1 Introduction

In this chapter, I present the data obtained from the brainstorming sessions and learners' interviews conducted in the community. As indicated in the epigraph above, I included as many extracts from the original data source as possible in order to keep the participants' words in their original state. As I was working on my data gathering process I did preliminary analysis that gave me an indication on what to present and how to present it in this chapter. The data describes what emerged from the learners' and community members' cultural beliefs/everyday experiences about the rainbow.

The data presentation used the following analytical categories: results from my pilot study done on the same topic, brainstorming session, learners' feedback from interviews with the community members. Each of these categories provided evidence of what exactly happened during these lessons.

4.2 What emerged from my pilot study on the same topic?

A pilot study is a 'try-out' carried out before a research design is finalised to help in defining the research questions (Thaban, Ma, Chu, Cheng, Ismaila, Rios, et al., 2010). A pilot study is important in research because it allows a researcher to gain comments from the participants or critical friend on the approach. In addition, Breen (2006) suggests that a pilot study can enable researchers to reflect on their own practice and make possible changes when they conduct their main research.

A pilot study was relevant for this research study because it gave me an opportunity to test my research tools and I subsequently made relevant changes when I implemented my research study. Therefore, a pilot study was conducted at a different site but in the same educational region. The difference between the two

sites is the geographic location only. The site for my pilot study was miles away from the Kavango River whereas the site for my main research study was along the Kavango River. Hence, the geographic location played the major role in the type of data that I collected. From the pilot study, learners and parents in that community believe that a rainbow lives in the hollows of trees which hold water and live by sucking blood or juice (sap) from particular trees. Even though these learners also mentioned the issue of the rainbow vomiting fish into the river, they did not have confidence in how they presented their arguments compared to my main research participants. In addition, learners in the pilot study mentioned that a rainbow vomits fish but could not ascertain the specific type of fish which the rainbow vomits. The general idea here was that the rainbow is a living thing in a form of a snake that can live both on land and in water. It is believed to be a very big snake that can kill people by sucking blood from them. It always appears in a number of colours but learners emphasize that when the rainbow comes down on the ground, red seems to be more observed than other colours.

During the pilot study too, one of the adult participants made it clear in his vernacular that;

Ekongoro lyene-lyene kuvhura likare asi kutupu ko. Nye eli epuliro kokakuru lyatunda yiyo ava lilitambagura kutunda epupi yize epupi mokatji kovakwangali. (Freely translated: A rainbow might not really exist but these beliefs have been passed on from generation to generation among the Vakwangali tribe of Namibia).

He gave an example about beasts that are haunted that lived a long time ago in many of the traditional stories within the area. He further said that like a rainbow, these are just things that people believe but in reality they do not exist at all. He also pointed out that as Christians, the Bible instructs us to believe that a rainbow is a covenant that God made after the biblical deluge that God used to punish sinners of that time.

4.3 Brainstorming session: Learners' cultural/everyday beliefs about the rainbow

A class of thirty two learners was divided into groups of five or six before the lesson was introduced to them. Posters and koki pens (learning and teaching support materials) were distributed to learners and they were instructed to discuss and brainstorm their cultural beliefs/everyday experiences about the rainbow. Learners were engaged in discussions in their various groups and wrote down the results of their discussions in the form of mind maps which they later used for presentations.

The discussion session was also captured with a video machine and at the same time there was a voice recorder. This was done to capture voices as learners were discussing. When it was time for presentations, a voice recorder was placed on the table in front so that it would be closer to learners while they were presenting their findings. The results from their brainstorming were then transcribed and summarized in the table below. Using this approach, I learned that it could have been very interesting if I had instead opted to focus on a single group when I could have captured a single group's entire talk and gestures instead of moving the devices from one group to another during the brainstorming session.

Learners collected information from the community and translated it as they were recording. When they reported to class, they only had notes which were written in English and did the presentation in English except terms which they did not know in English.

Group	Learners' cultural beliefs/everyday experiences about the rainbow.
1.	A rainbow is a big snake with horns like a kudu. There are three types of rainbows: there is one that lives in water, and there is another one that lives on land and another one that lives in the caves. The rainbow in the river can cause a canoe to drown. If you are caught by the rainbow while you are crossing the river in the canoe, you must cut yourself on the finger so that blood drops in the water for the rainbow to leave you. It is believed that the rainbow vomits fish in the Kavango river. When you get hold of the rainbow scale and place it under your pillow, the next morning when you wake you will become very rich. They also believe that...that if the rainbow chases you, you must smash the <i>uguva (Kiaat)</i> (very tall tree that release reddish juice when a cut is made on it) tree, I do not know how to mention it in English because it sucks blood.
2.	If a rainbow swallows you, it will vomit you in a beautiful land. There are people who live inside the rainbow. It is a big snake with the diamond on its forehead. When a python is old enough, it goes in the river and starts developing horns and finally changes into a rainbow. Also when chiefs or kings pass on they are believed to change to the rainbow. As a result, most royal families in the region are buried closer to the river so that when they change into rainbows, they will not destroy other peoples' graves. If it

	<p>finds you in the forest, you must scratch a tree called <i>uguva</i> that excrete a reddish liquid [sap] because it is believed that the rainbow sucks blood. By doing that, it will think that it is sucking blood from you. When you come closer to a rainbow while wearing a red shirt you must always remove it because it might think that it is blood. “Maybe you had sex, you committed adultery like if you are not married and make sex with someone’s husband, the rainbow will kill you”</p>
3	<p>It is big snake that lives in the water. A rainbow vomits fish and can make water in the river to rotate. It drills holes in the river which makes some places in the Kavango river deeper than the other places. The rainbow that appears on the sky prevents heavy rainfall. If you approach places where there is a rainbow, you will feel hot and you will be surrounded by the colour red.</p> <p>“We believe that the....when a king deceases, he is turned into the rainbow, we also believe that the when you get into the stomach of the rainbow you will find shops and nice things”</p>
4	<p>Some people believe that a rainbow is not a living thing but is a covenant that God made to people on earth that he was not going to kill people with water again but with fire. It is also a big snake that can swallow people. Some times when it appears on the sky is an indication that it will take time for the rain to come. Women must not cross any running water when the rainbow appears on the sky. It likes anything that has a red colour. It likes Christians and provides fish in the river. However it can also be dangerous to people as it sucks blood when it gets you.</p> <p>We also believe that the one we see on the sky is not a living thing. The living thing is the one that lives in the river.</p>
5	<p>An old python changes and goes into the rainbow and develops horns. It drills holes in the river where it lives. There are people who are live in the rainbow. When a chief or a king dies, he/she turn to a rainbow and goes in the river. Also some people believe that a rainbow is a covenant that God made that he will not destroy live on earth with water as he did during the time of Noah in the Bible. It vomits fish in the Kavango river but can be dangerous to people as well. It hates a person who belongs to the cattle and vulture clan. If you are caught by the rainbow, cut yourself and make the blood to dribble so that it can let you go.</p>

Table 4.3. Data from the brainstorming session as extracted from the mind maps

During brainstorming session, it came out strongly from all the groups that when a python becomes very old, it develops horns and moves from land to settle permanent in the river where it remains in deep places until it matures into a very big snake known as rainbow. Most of the groups described a rainbow as a big snake that lives in water and provides fish in the Kavango River. One group claimed that a rainbow does not exist but what is described as a rainbow by the Vakwangali is a covenant which God made that he will not take too many lives at once using water after the famous flood of the Old Testament. Learners also reported on the mechanisms that can be used to escape from the rainbow.

4.4 Learners' findings from the interviews with the community members on their cultural beliefs about the rainbow

The community members believe that there are two kinds of rainbows. There is a rainbow that lives in the Kavango River and there are rainbows that appear sometimes on the sky. Generally, the community members too believe that a rainbow is a very big snake that lives in water. It could be in the river, in the lake or in hollows of big trees in the forest.

The community members also believe that rainbows are formed when a tribal chief dies, when he or she will turn into the rainbow. Again they believe that rainbows are formed when old pythons develop horns and move from land to water, in particular, in the Kavango River. In the river, the rainbow provides fish and makes water to rotate at some places within the Kavango River known as *mbiga* (whirlpools in the river). It also drills holes in the river where it lives.

Some people believe that there are people who live in the rainbow. When it swallows you, it will take you to where those people are so that you become their slave in the body of a rainbow. If you are very fortunate, a rainbow will swallow you and take you to some beautiful places where you will have access to many things. Sometimes, it can swallow you and vomit you back alive even after staying in the rainbow's stomach for a number of days.

Despite the role of the rainbow in providing fish in the Kavango river, the community members believe that a rainbow can also be dangerous to people. It can cause the canoe with everyone on it to sink in the river. Sometimes it can just take hold of the canoe and throw it out of the river. In the process of throwing the canoe out of the river, people can be hurt or even killed.

Some people believe that the rainbow in the water fights with the rainbow in the sky. As a result, the colour of the rainbow appears on the water surface (commonly observed during the rainy season in Kavango). During the fight the rainbow might lose scales which if found will make you very rich.

A rainbow also kills by sucking blood from people. When you are caught by a rainbow, you will not be able to move but you will just be surrounded by the red colour. There are measures that can be taken so that the rainbow releases you. You can make a cut on your finger so that the blood drops in the water. It is believed that when you do that, the rainbow will leave you and concentrate on the drop of blood. If you are in the forest, there are certain trees e.g. *Uguva* (kiaat) that you need to cut so that the rainbow sucks the reddish sap that comes from the tree and leave you to go home. Some people believe that when you realize that you are caught by the rainbow; you can talk (incantation) to your ancestors by pleading to them to rescue you.

When the elderly members were asked if they had seen the rainbow (snake), most of them said they never saw it but explained that it is a real thing that exists but was not commonly seen. Conversely, they also informed learners that they in their turn had heard those beliefs from their parents. A few parents told learners that they once had come across the rainbow and they cited names of those in the community who were once the victims of the rainbow. They also believe that when you find yourself within the red colour of the rainbow, it feels hot on the skin and that is a sign that you are in danger.

Below I have included part of the extract from the transcription from learners' findings from the interviews with the community members.

Group 1:

We went there; they told us that there are two types of rainbows. There is the one that lives in water and the one that we see on the sky. The one that lives in water use to vomit fish, the one that use to provides fish in the river. The one in the river is very big and dangerous. It can destroy all houses and buildings. It got horns and ...and it stops rain. The one in the sky can stop rain from and if it finds you, you must cut yourself and let the blood fall in the water. It won't leave you there but it will throw the canoe. If you did not do that it will suck the blood. Some people told us that it can take you but they do not know where it will take you. It appears in the day and in the evening. During the day, the one in the water does not appear. And they told us that this snake that lives in the

water is a python. It is the one that turns into the rainbow and if you are passing by like in the morning or in the evening, the water will be like boiling and is very dangerous. That is all they told us.

Teacher: Any question? Any question on what they just presented? Those are some of the beliefs that they obtained from the community, questions? You cannot let them go like that. Learner X (referring to learners' name).

Any question? You can't let them go, question that side?

Learner question: How many rainbows are there?

Answers: There are two.

Learner question: What will you use to cut yourself?

Answers: I really don't know but any sharp object.

Learner question: When it comes to the community beliefs, did they tell you which type of fish does it vomit? a specific?

Answers: They just said it use to vomit fish, that's all.

Learner Question: Did they specify how long or big the rainbow is?

Answer: They just said it is big.

Learner question: Did they specify what the blood use to formulate in the rainbow?

Answer: I don't know but they just said that even if it catches someone, you must not get closer to it because it is dangerous. The moment you come closer it will catch you.

Learner question: Which of the two rainbows is visible?

Answer: The one that is not visible is the one that is in the water you cannot just see it like that. The one on the sky is visible because it has colours. The one in the water you can only see if something has happened it is like if the pregnant woman cross the river but you...you can just see it like that you will see like water is boiling.

Learner Question: When it comes to changing from python, do you think at the point of aah... mmh... the size of a rainbow, do you think that a python really change into a rainbow?

Answer: In my own opinion I think but in... but in my beliefs I don't believe it other people they believe it but for me not yet.

Learner Question: Mmh...I 'm also realized that if it appears in the place, it will destroy houses how will this happen?

Answer. If your our house is built near the river, maybe the accident happen near your house it will destroy everything in your house.

Teacher: Okay thanks. Can we give them hands? Next group please!

Group: 2

“On Wednesday, we went aah ... in the community to find out what they beliefs about a rainbow. We like had some points we had ah...ahh asked questions about the rainbow. So when we reached there, we interviewed three people. They believe that the rainbow fights lightning, they said that there are two types of rainbows, one lives in the water and the other lives in the sky. The one that lives in the water has scales, and they believe that the one that lives in the sky prevent bad rain falls from falling they also believe that the one in the river has scales when there is lightning they believe that the one in the river can also light, so which means that if lightning strikes more than three times, what will happen is that ahh... they told us that there is a conflict between the two types of rainbows.

The community people they told us that the one in the water wants to prove that it is strong. If you get this scales, will be full of fish but it's just one type. Sometimes if you catch one type of fish, you must take care, if that type of fish it will release a second type, meaning you must be careful it will be angry because it's like you are finishing the fish. And also they told us that it sucks the blood and the reason why it sucks is because it is adding to its red colour. If it appears in the place, the witch doctor has to apply something on their face, and talk to their ancestors.

They also believe that the old python enters the river and settles there for months or years. They said before changing into a rainbow first it must grow horns like for kuduk like that it is in the process of changing in to a rainbow. If it appears and you will be close to it, you will feel very hot because that colour is red. Truly speaking they told us there is no one that saw the rainbow from the sky. The other one in the...the river many people have seen it. We even came across a person who went across the rainbow. They told us that there was a day when he and his friend went. There is a day and they were two and wanted to look after the cattle. They relaxed and the rainbow started. They saw the one on the sky appearing within a while the rainbow which was on the trees closer to where he was standing. So they just realized that the cattle's started running and realized that the thing that was far from them had just come closer, so they started running. They told us that one was faster than the other one. So it came closer until it got in contact with one that was slow. So, the one who was caught told the other one that “just go”. They told the other one to run and tell parents at home.

After a while he managed to escape and ran. The one which is in water makes a big hole, it rotates water based on the power of the rainwater which means if you do not know anything about the rainbow and you clips in the canoe and you are trying to cross the river, if you reach that point your canoe will stop moving but rotating at the same place. The community members told us if that happens to you, in order for you to survive you must cut yourself and drop blood in the river. That moment you must be a real man. You must hold because it will throw your canoe either back to Angola or Namibia. Throw a metal in the water for it to release you. They also said...said that when the rainbow is chasing you...you must run until to get some milky tree and cut them when the rainbow come there and suck. When a whole, lake or stream has rainbow it will always have water. No matter how small it is it fill a big bucket. They said that if you fetch and hear a sound like *bwi ... bwi* (imitating sound from the liquid) like that

its angry that you are finishing the water it's producing for itself bwi... bwi the water becomes more and more until it kills you. It can catch you because the whole place will be full of water. According to what they told us that the one in water remains in the form of snake and it is the source of light. If you keep the scales in your room it can also give light at night".

Group 3:

Learner: About the rainbow from the community.

Teacher: How did you get the information from the community?

Learner: We did a research

Teacher: When?

Learner: On Wednesday.

Teacher: How many people have you interviewed?

Learner: Three.

Teacher: Okay.

Learner: It swallows people if it finds you in the river and puts you under the *etondo* [hole] it digs hole. It keeps people under the water and those people pounds.

Teacher: They use to pound?

Learner: Yes, It has horns and it's like a snake you don't find it anywhere but during the rain.

It stops rain and sucks blood. When it swallows you.

Teacher: Did you ask them to tell you where they get these beliefs.

Answer: They said from their grand, grandparents.

Learner Question: Did you asked them to tell you if they had any experience where rainbow caught... caught someone?

Answer: They said that if it finds you in the bush you must cut *uguva* (kiaat) if you have something sharp so that the liquid (sap) can come one for it to suck while you run away. If you get the scales you will become rich.

Answer: The rainbow in the sky is the one for God but the one in the river is like magic, it is for black people ... like

Question: X (referring to a learner): The point that you said that the rainbow fights with God.

Answer: It will take you.

Learner Question: You said that it sucks blood and takes you are taken somewhere and you will be pounding. It means it will not kill you it will just take you somewhere.

Answer: Yes it will take you...you will be pounding and hear celebrating li li li li li Ms I don't know people will be pounding and they gave an example of Oshikoto lake that's why you see if you throw something it will be back at you.

Teacher: You mean it will come back to you?

Answer: No! Ms. It will just fall in the lake and they said there is a rainbow.

<p>Teacher: They...did they said anything about how you will know that at this place, there is a rainbow? A: Yes they said in the river the water will be boiling but in the bush it will just be red.</p>
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Table 4.4. Learners' findings from the community

From the learners' findings, it emerged that community members too believe that a rainbow is a big snake that lives in water. They also reported that when a python become old, it turns into a rainbow. Learners also found out that a rainbow can be dangerous to humans; it kills people by sucking blood and can also destroy houses. In addition, learners also reported on incidents when their interviewee encountered the rainbow. To be freed by a rainbow, learner reported mechanisms that indigenous people in this community use. These include making a cut on the finger in order to drip blood into the River and making a cut on *Uguva* (kiaat) certain tree that releases a reddish sap.

4.5 Concluding remarks

This chapter presents data that I obtained from my pilot study, the learner's brainstorming session and from community members' reported cultural beliefs/everyday experiences about the rainbow. I have included part of my transcription to strengthen my presentation and display the themes that emerged from this data to be further discussed in Chapter Six. In the next chapter, I present the data from document analysis, practical work and focus group interviews.

Chapter Five

Data presentation: Phase Two

There is no one single or correct way to analyse and present qualitative data; how one should present qualitative data should abide by the issue of fitness for the purpose (Cohen, et al., 2010, p. 462).

5.1 Introduction

This chapter presents data from the second phase of my study. I decided to separate culturally oriented data of Chapter 4 from the other forms of data. The main data in this chapter thus came from document analysis, practical activities and the focus group interviews.

In the first part of this chapter, I present the findings from document analysis of the National Curriculum of Basic Education (NCBE) and the Physical Science grade 8-10 syllabus. This was done to understand the expectation of the curriculum on teaching and learning methods in general and physical sciences in particular. In the second part of this chapter, I present data that emerged from the three practical activities that were conducted during the course of my research. In this chapter I also present the results from the focus group interviews.

5.2 Document analysis

A brief summary is presented below of my findings after examining several Namibian National Curriculum documents:

5.2.1 National Curriculum of Basic Education (NCBE)

The National Curriculum of Basic Education, Namibia. MoE (2009) emphasises that teaching and learning should be done in a learner-centred approach. In the learner-centred approach, the assumption is that teachers should make learning relevant to learners' everyday life. In addition, learners are expected to construct their own knowledge under the supervision of the teacher who is expected to facilitate learning.

The curriculum acknowledges the importance of learners' prior everyday knowledge and thus encourages teachers to make use of the local experiences and knowledge in making learning content relevant to learners' everyday life. It is clearly explained that learners should be competent in what they already know and do in order for new learning to take effect (Stears & Malcolm, 2005). However, Rennie (2011) posits that considering learners' prior experiences in teaching will help teachers to identify the misconceptions that may result from learners' experiences and do corrections as thus may hinder conceptual attainment.

5.2.2 The Namibian Physical Science syllabus grade 8-10

In the rationale and aims of the physical science syllabus grade 8-10, Namibia. MoE (2006) it is outlined that the syllabus content is based on the Namibian context. However, topics are carefully selected to meet international standards. Therefore, teachers are urged to use local examples in explaining the concepts. In the case of refraction of light in nature, for example, the following excerpt from the syllabus gives the basic competencies for grades 8-10: (p 59)

At the end of this chapter, learners should be able to:

- *investigate examples of the refraction of light in nature such as the rainbow; size and position of objects under water and mirages to explain;*
- *the passage of light through a prism (dispersion) and identify the colours of the spectrum produced from white light; and*
- *how rainbows can be formed by the internal reflection of light in water.*

Looking at these basic competencies, it appears that the local context is not covered as one of the basic competencies. I understand the need for generalizing the syllabus content to avoid catering for individual ethnic groups' interest. As a result, teachers who do not appreciate the need for including learners' prior everyday knowledge and experiences are likely to focus exclusively on the outlined basic competencies in the syllabus, so neglecting learners' prior everyday knowledge and experiences.

5.3 Practical activities on refraction

During practical activities, the planned number of learners was reduced to 10 but some learners from the other class insisted that they wanted to be part of the lesson too. That brought the number of participants close to 15 learners. I divided the learners into three groups based on the teaching and learning materials that I had brought to class.

I introduced the lesson to the class and explained what I wanted learners to do before touching any of the teaching and learning materials. During this lesson I planned to use three different activities.

Activity one: learners investigated the appearance of a pencil in a beaker filled with water. Activity two: learners were expected to observe the path of light through a triangular prism. Activity three: learners were expected to use a hosepipe and water to form the colours of the rainbow. The observations of these three activities are summarized separately below:

5.3.1 Activity one: Water in a glass and a pencil

First, learners were asked to predict the possible observation on the activity. They took a long time since they seemed not to understand what to do. I explained and moved around to ask probing questions that would stimulate their thinking. After a while, they managed to come up with something in their various groups. After these predictions, I allowed learners to put the pencil in the beaker filled with water and observe. The three groups did the activity and they wrote their observation in their worksheets. As they were working on the activity, they seemed not to understand what to predict and some learners asked me what they were supposed to do. After explaining to them what they were supposed to do, they came up with something on their worksheets. The result of this activity is summarized in the table below.

Group	Predictions	Explanation	Observations
Group 1	<ol style="list-style-type: none"> 1. It will look big 2. The water will increase 3. It will look short 4. The pencil will look bent. 	The glass look as if it is a rectangular prism, it makes the pencil look big because the light in the glass and water. (I suspect this was made after the triangular prism activity)	<ol style="list-style-type: none"> 1. Pencil bend at water level 2. Water level increase.
Group 2	<ol style="list-style-type: none"> 1. It will look big. 2. Water will increase. 	Because the object will occupy the space	<ol style="list-style-type: none"> 1. Pencil bend 2. Part of the pencil under

	3. It will look as if it bend	in the water. Because it depend on the liquid in the water	water looks bigger than the part outside water. 3. Water level increase.
Group 3	1. It will bend 2. The water level will increase 3. It will look bend	Because of the heaviness of the pencil.	1. The pencil looks bend 2. The water level increase

Table.5.3.1. Showing learners’ predictions and observations from activity 4.2.3.1

5.3.1.1 A brief summary of what emerged from the water in a glass and pencil activity

It emerged from this activities that learners were able to predict that the pencil in the glass will appear as if it is bent, broken and bigger. They also predicted that when a pencil is placed in water, it will cause the water level to increase. All three groups gave different reasons for the predictions made. For example group two learners explained that the expected observations would be due to the space occupied by the object (pencil) in the water.

5.3.2 Triangular prism activity

This activity took place outside the classroom in the afternoon and the sky was partly cloudy. I asked learners to predict what will happen when I passed light rays through the triangular prism but they seemed not to have ideas at all. Instead, I observed learners trying to place the prism on their eyes assuming that they would see something in the prism itself. I had five triangular prisms which I gave to learners to try to focus the sunrays on the wall. Some learners tried to look through a triangular prism and claimed to see colours. We spent some time outside trying to focus the rays on the wall and the ground until the sun appeared on the sky from the clouds.

The video footage shows how learners were excited to learn that the colours of the rainbow appeared on the ground exactly as they appear on the sky during the rainy season. Learners decided to focus the

colours on the other learners' shirts to see if all the colours would appear. They kept focusing the colours on different shirts to observe what happened when different coloured shirts were used, they also made comments on changing to the opposite sex after projecting the colours on their shirts. Learners enjoyed doing this activity because they all had time to touch the prism and focus the colours on different surfaces before going back to class for discussions.

In the classroom, I asked questions based on what happened outside. I explained what happens to light when it enters the prism and I used the chalkboard to show a path of light through a triangular prism. We had a short discussion before going for the next activity which was also designed to take place outside the classroom. This part of the activity did not require learners to do any predictions since this topic of refraction is only introduced in grade 10, and I assumed that learners would not have ideas on the topic. As a result, I excluded the step of prediction. However, after presenting the lesson I realised that it would have been meaningful for me to see what learners think about refraction of light.

5.3.2.1 A brief discussion on what emerged from triangular prism activity

In the first place, I observed that learners did not have any idea on what they were expected to see or to do. I observed this from the way some learners were holding the triangular prism. After giving them a hint on how to hold it and focus, learners started to observe the colours of the rainbow on the ground and on the wall. Learners were engaged in the activity and they even started to focus the colours on different shirts with different colours to see if all the colours would appear. While they were busy making colours of the rainbow, some asked each other if they changed into the opposite sex after colours were projected on their shirts (Table 4.3). I also noted that during this activity, learners started to realise the difference between the myth and the scientific ideas because they started asking each other if they changed into an opposite sex.

5.3.3 Hosepipe activity

This activity took place at the principal's garden because there was no other hosepipe available in the school. Individual learners were given worksheets and asked to write down their predictions on what would happen when water is sprayed in the direction of the sun. Learners wrote their predictions on their worksheets before experimenting with water and the hosepipe. They all wrote that the rainbow would be

formed in the sprayed water. One learner even said that the same can happen if you put water in the mouth and spray it in the direction of the sun. Unfortunately, I did not ask any learner to demonstrate this because I feared they would get wet in their school uniforms and would be laughed at by their classmates. Their findings are presented in the table below.

Learner	Prediction	Explanation for their prediction	Observation
1	According to what I have experienced, colours will appear rainbow colours will appear in mist.	No reason given.	The sun reflects or passes through the water droplets then it forms a rainbow.
2	I think rainbow will appear.	Because the mist is made out of water and when you do the practical in the direction of the sun it will reflect and form a rainbow.	Rainbow colours. Reflect the sun to form colours.
3	I think the rainbow will appear.	Because the sunlight is hitting the water which is like the triangular prism.	I saw different types of colours of the rainbow.
4	I think it will appear in the colour of a rainbow.	Because the sunlight is hitting the water which is the light.	It made a thin mist with water in the direction of the bright sun, I saw different colours appearing.
5	I think the colours will appear.	Because the sun will be reflected by water so the rainbow will appear.	The rainbow formed on the mist with its different colours. When the sun was reflected by water.
6	According to what I have seen before, colours will appear in the mist.	This is because of the direct sunlight being reflected by the mist.	Different colours occurred in the mist. This is because of the light being reflected.
7	A rainbow will appear.	Because the mist is made out of water meaning when the sunlight reflects on the water	In conclusion, I saw a rainbow appearing as the sun rays went

		and it will display a range of colours also known as the rainbow.	through the mist.
8	I think the rainbow will appear.	Because the sunlight is hitting on the water and produces the colour of the rainbow.	The colour of the rainbow appeared on the water.
9	I think it will make a rainbow.	Because of the sun. So the colour will appear for the rainbow because of reflection.	What I see when we did an experiment is different types of colours like for a rainbow.
10	I think it will display or show the colours of a rainbow light from the sun.	Because the water is formed to pass in a little (small) space with the presence of water.	A rainbow appeared, because the more the water is forced to pass through a hosepipe, the rays penetrate through the water forming a rainbow of colours.

Table 5.3.3. Learners' predictions and observations on hosepipe activity

5.3.3.1 A brief summary of what emerged from the hosepipe activity

From this activity, all the participants predicted that the rainbow colours would appear and mentioned the presence of water and sunlight as the main reason for their prediction. As they were working on the activity, some learners referred to other ways of making the rainbow such as blowing water into the air on a sunny day.

5.4 Focus-group interviews

The focus-group interviews consisted of seven learners. All the learners sat around one big table in class where the interviews took place. I explained the procedure of the interviews and informed them that the interviews were going to be recorded both on paper and using electronic devices such as the video camera

and the voice recorder. The main tool that I wanted to use was the audio recorder but I decided to use the video recorder as a backup in case anything went wrong with the audio recorder.

Group interviews can be a useful tool as it encourages interactions among members of the group. Cohen, et al. (2010) too contend that group interaction is encouraged during group interviews and even more so amongst learners than from an adult. In the context of my study, I believe that the focus-group interview made learners feel free as they were afforded an opportunity to interact with their peers.

The notes which I took while the interviews were in session made it possible for learners to check the most important aspects of our conversations. At the end of the focus group interviews with individual learners, I gave them the recorded information on paper to see if I had captured exactly what they wanted to say. During this process, the first participant pointed out that I had not included a point that she made when she said that *“I was happy to do this research because I did it for someone, I love”*. When this statement was made, I thought it was not necessary to include it in my notes. However, when I asked this girl to confirm if I captured what she said, she pointed out that I had left out something that she said and she pointed it out.

During the focus group interviews I asked six questions of individual learners and their responses to these are re-presented in the table below:

Interview Questions	Learners' responses
<p>1. How do you feel that the lesson on refraction of light started by considering your cultural beliefs/ everyday experience?</p>	<p>L1- I feel or I thought that maybe I'm going to learn something.</p> <p>L2-I really felt very good. I was happy about it; I thought I was very hungry and thirsty of knowing. It was very interesting it a smile on my face when I heard that we were going to it.</p> <p>L3- I feel good and happy and I was adding to more knowledge to my brain and I knew many things about the rainbow.</p> <p>L4-I felt good.</p> <p>L5-I felt good because it was even my first time to experience it.</p> <p>L6- I feel good and comfortable.</p> <p>L7- could not say anything.</p>

<p>2. What did you like or not about conducting interviews with the community members?</p>	<p>L1- I liked it when we asked elders, they told us a lot of information and it was interesting. I also met new people.</p> <p>L2- Mostly when it comes to my cultural beliefs, I wanted to know the cultural beliefs and the science of the rainbow. I wanted to know what my community beliefs are on the rainbow and a lot of ideas were given to us.</p> <p>L3-I liked it when we interviewed people; I like the stories that they told us. I did not like it when we waited for other people.</p> <p>L4- I wanted to know what the rainbow is.</p> <p>L5- Everything I liked it because they told us a lot of stories which they have experienced.</p> <p>L6- I like the stories</p> <p>L7- I liked what they told us.</p>
<p>3. How did you feel about using practical activities to learn about refraction of light?</p>	<p>L1- I feel so successful</p> <p>L2- using practical activity really made me understand. Without any practical it might have confused me if we could just talk about it without any practical work carried out.</p> <p>L3- I learned that there is a traditional rainbow and a natural rainbow because I did not know much about the rainbow.</p> <p>L4- I learned about the one that appear on the sky, if it will happen to me I will not be scared.</p> <p>L5-I felt good because I got ideas from the others.</p> <p>L6- It made me understand.</p> <p>L7- By using triangular prism and experiencing the formation of the rainbow.</p>
<p>4. To what extent did the practical activities help you to understand the concept of refraction?</p>	<p>L1- Ms. the practical work made me understand how the rainbow is formed.</p> <p>L2- Aah ... it helped me understand. it really made me understand....aah because when we used the materials we can observe different colours of the rainbow so which means for both of us who saw it , it was really impressing because I was still in the belief of the cultural that says if you pass on the colours of the rainbow you will change to a woman. When I came to the instance of understanding, the colours were placed on my fellow learner to see if something will happen but nothing really happened but it gave me an aah... impression that nothing really happens you will remain the same it is just the reflection of colours.</p> <p>L3- I knew how a rainbow is formed and I knew how a rainbow was formed and I knew that a rainbow is a refraction of light.</p> <p>L4- I learn that the one that that will appear in the sky. If it happens to me I will not be scared.</p>

	<p>L5- I felt good because I got ideas from the others. I like it because I learn when I touch things, that how I learn.</p> <p>L6- It helped me to understand.</p> <p>L7- By using rectangular prism and by experiences it.</p>
<p>5. To what extent did the practical activities constrain your understanding of the concept refraction?</p>	<p>L1- I was confused when you said that that it is formed by a triangular prism. I thought a triangular prism will make a living ...a real one. I did understand how a rainbow is formed because at first I thought it was a real living.</p> <p>L2-Aah ... it helped me understand. it really made me understand....aah because when we used the materials we can observe different colours of the rainbow so which means for both of us who saw it , it was really impressing because I was still in the belief of the cultural that says if you pass on the colours of the rainbow you will change to a woman. When I came to the instance of understanding, the colours were placed on my fellow learner to see if something will happen but nothing really happened but it gave me an aah... impression that nothing really happens you will remain the same it is just the reflection of colours</p> <p>L3- There was no any confusion.</p> <p>L4-(quite)</p> <p>L6-.....(quite)</p> <p>L7- I only understand and practice.</p>
<p>6. What is a rainbow?</p>	<p>L1- A rainbow is a....a reflection of sun' rays.</p> <p>L2- Is the bending of light in the atmosphere in the combination of water droplets to form colours in the sky.</p> <p>L3- It is a refraction of light; it is not really something that sucks blood, and that kills people. About the Christianity thing, it is a promise of god.</p> <p>L4- : Is the bending of light in the atmosphere in the combination of water droplets to form colours in the sky.</p> <p>L5- A rainbow is the bending of the light due to water.</p> <p>L6- is the bending of light.</p> <p>L7- The formulation of colours in the atmosphere in the pressure of the water vapor.</p>

Table 5.4. Showing individual learners' responses to focus group interview questions

From the focus-group interview, it came out clearly that learners approved of the approach I had used during this research. This was supported by the reports from individual learners that they liked the idea of working with community members. It also came out that some learners appreciated the idea of learning from community members while others enjoyed the stories about the rainbow from the elderly community members.

Some participants appreciated the experience that using practical activity made them understand the concept of refraction. However, one learner expressed that she was confused with practical work because she thought we were going to make a real rainbow which she believed to be a big snake. Learners also defined a rainbow as mere refraction of light even though they were confusing the term refraction with reflection. However, it should be recognised that people are able to see a rainbow as a result of both refraction and reflection of light (Sakuranda & Nakamura, 2002). As I was doing member checking, one learner pointed out a point that she mentioned that “I feel good because I did this for someone I love” which I had left out as I was taking notes.

5.5 Concluding remarks

This chapter presented qualitative data that emerged from different data gathering techniques including document analysis, practical activities and focus group interviews. Data from the document analysis of the national curriculum of education informed me on the assumption made at the curriculum development level on how teaching should be approached even though there is no specified mode to be followed by the implementers. The syllabus provided me with information on how the particular topic of refraction of light is presented.

Data from practical activities informed me on how practical activities can enhance or constrain conceptual attainment in learning science. Finally, data from the focus group interviews summarized learners’ feelings and experiences towards the research approach. It also suggested some mind shift from what they believed about the rainbow before the lesson and what they understood what a rainbow was after a series of lessons. In the next chapter, I analyse, interpret and discuss the findings from different data sets presented in Chapters 4 and 5.

Chapter Six

Analysis, interpretation and discussion of findings

Data analysis is the process of systematically searching and arranging the interview transcripts, field notes and other materials that you accumulate to enable you to come up with findings (Bogdan & Biklen, 2003, p. 147).

6.1 Introduction

In this chapter, I present and discuss the themes that emerged from my data and findings of this research study. In the previous chapter, I highlighted the techniques that I used to obtain answers to the following research questions:

- What are learners' cultural beliefs/everyday experiences about the rainbow?
- What are community members' cultural beliefs/everyday experiences about the rainbow?
- Does the mobilization of learners' cultural beliefs/everyday experiences about the rainbow enable or constrain learner engagement?
- What are the contradictions and tensions between learners' cultural beliefs/everyday experiences and scientific knowledge on the natural phenomena rainbow?
- Does teaching and engaging learners using practical activities associated with the rainbow enable or constrain meaning making of refraction of light?

In this chapter, I gave a brief outline on how the themes and the analytical statements were developed from the data I presented in chapter four and five. I also present the interpretation and discussion of findings based on my analytical statements. Based on my findings, I also discuss the implications for considering learners' cultural beliefs/everyday experiences in teaching science. This chapter ends with some concluding remarks.

6.2 A brief outline on how the themes were developed in this case study

As I was collecting data, I was simultaneously engaged in the preliminary qualitative analysis. “Qualitative data analysis is a relatively systemic process of coding, categorizing and interpreting data of a single phenomenon of interest” (McMillan & Schumacher, 2010:367)). The preliminary qualitative analysis gave rise to themes that I needed to analyse both inductive and deductively. With inductive analysis I refer to those themes that emerged from my data; while deductive analysis refers to the themes that form part of my theoretical framework. According to McMillan and Schumacher (2010: 367), inductive analysis is “a process through which the qualitative researchers synthesize and make meaning from the data, starting with specific data and ending with categories and patterns”. On the other hand, deductive analysis refers to the process through which researchers make meaning from the data starting from the more general to more specific (Burney & Mahmood, 2006).

After all the verbatim transcriptions of the audiotape-recorded data and learners’ written work, I came up with a total of ten broad themes. Transcriptions can be defined as a process of converting audiotape data into a format that facilitates data analysis (McMillan & Schumacher, 2010). Therefore, the emerging themes were coded using alphabetic codes A to J. I decided to code the emerging themes so that I could be able to see the individual themes that emerge from my data.

Data coding involves a name or a symbol that is used to provide meaning to the elements of data (Denscombe, 2007; McMillan & Schumacher, 2010). When I revisited these themes, I noticed that some of them were closely related to each other. As a result, I decided to regroup the common themes into four major themes. To make a distinction between the broad themes and the major themes, I used colour codes for individual major themes. The colours that I used were purple, red, blue, green and yellow. This time around I used the colour codes because I wanted to distinguish the new combined themes from the earlier letter-coded themes.

The table below shows the ten broad themes that emerged from my data and their identifying codes.

Initial codes	Themes
A	Curriculum issues
B	Learner engagement
C	Learners' cultural beliefs/everyday experiences about the rainbow
D	Community members' cultural beliefs/everyday experiences about the rainbow
E	Scientific and non-scientific beliefs about the rainbow
F	Beliefs that are Christian oriented about the rainbow
G	Beliefs that are mythological oriented about the rainbow
H	Practical activity: its role in conceptual attainment
I	Contradictions in teaching refraction of light
J	Learners asking questions

Table 6.2(a) shows the themes that emerged from my data

The table below shows the regrouping of my themes into four major themes that I subsequently discuss in detail below.

Colour code	Major theme	Components
Purple	Curriculum issues	A
Green	Learner engagement	B & J
Blue	Cultural beliefs/everyday experiences about the rainbow	C; D; E; F; G
Red	Practical activity: its role in conceptual attainment	H
Yellow	Contradictions in teaching refraction of light	I

Table 6.2(b) Shows the colour codes, major themes and the components that constitute each of the major themes

6.3 Analytical statements that are pertinent to my research study

From the five major themes developed to formulate analytical statements that would guide me through during the discussion of my findings. Those are:

1. Curriculum assumptions on pedagogical approaches to teaching and learning in general.
2. Factors enhancing learner engagement during science lessons.
3. Learners' cultural beliefs/everyday experiences: their role during teaching and learning science.
4. Practical activity: its role in conceptual attainment.
5. Implications for considering learners' cultural beliefs/everyday experiences in learning concepts in science.

In an attempt to visualise the process of my data analysis, I established a table where I highlight the data source that led to the specific theme and link to analytical statements I developed in relation to my research questions.

Data source	Theme	Analytical statement	Research question(s)
Document analysis	Curriculum issues	Curriculum assumptions on teaching and learning approach	3 and 5
a) Brainstorming session b) Learner conducting interviews c) Practical activities	Learner engagement	Factors enhancing learner engagement during science lesson	1 and 2
a) Brainstorming session b) Learners conducting interviews in the community	Beliefs/experience about the rainbow	Learners' cultural beliefs/everyday experiences: their role in teaching and learning science.	1 and 4

c) Focus group interviews			
Practical activities a) Pencil in a glass of water. b) Triangular prism and sunlight activity. c) Hosepipe activity d) Focus group interviews.	Practical activity	Practical activity: its role in conceptual attainment.	5
a) Focus group interviews. b) Brainstorming session. c) Interviews with the community members.	Contradiction in teaching refraction of light	Implications for considering learners cultural beliefs/everyday experiences in learning concepts in science.	4

Table 6.3 Summary on how I came up with the analytical statements

6.4 Interpretation and discussion of findings

6.4.1 Analytical Statement 1:

Curriculum assumptions on pedagogical approaches to teaching and learning in general

To obtain data for this part of my research, I analysed and interpreted the National Curriculum of Basic Education document and the Physical Science syllabus grade 8-10.

6.4.1.1 National Curriculum of Basic Education document

In the Namibian context, the Namibia MoE (2009) document is viewed as a guideline that informs all stake holders on the national expectations in terms of the quality of education in the country. What I

learned in this document is that it is suggested that learning should start with what learners already know (Namibia. MoE, 2009). In addition, the national curriculum document outlines that the content to be taught should be made relevant to learners' everyday lives. That is, the goal of education in Namibia is to empower learners and transform the nation into a knowledge-based society. Furthermore, it is clearly stated in the document that "the concept of knowledge embraces indigenous knowledge and local and national culture as well as international and global culture" (Namibia. MoE, 2009:7).

Generally, the curriculum presents issues to be considered such as developing learners' research skills, understanding and recognition of cultural beliefs, values attitudes and so on. From my understanding, the suggestions made in the curriculum are too broad even considering that they are meant to accommodate curriculum implementers from all the corners of Namibia.

In the same document there is a section where specific basic competencies are briefly outlined. These refer to what learners should be able to do at the end of a certain phase. Under natural sciences, however, there is no basic competence that talks about values that are attached to cultural beliefs. A study conducted by Aikenhead and Jegede (1999) outline that learners experience difficulties in aligning what they learn in science with their prior everyday experiences. To acquire science content in the classroom, Aikenhead and Jegede further contend that students must travel from the "life world" of their everyday experiences to the "science world". They warn that when learners' cultural beliefs/everyday experiences are not harmonised with the science which is presented in the class, learners' knowledge acquisition can be interrupted.

In terms of pedagogical issues, the curriculum acknowledges the fact that learners do best when they are actively involved in the learning process. Thus, teachers are urged to be creative in making learning meaningful to learners. To support this view, Henze, Van Driel and Verloop (2007) suggest that teachers' knowledge comes from multiple sources such as everyday activities as well as post formal schooling. With the knowledge teachers have on subject content (Shulman, 1987), they are likely to facilitate effective learning that moves learners from their everyday experiences to what they are presented with in the science classroom (Abell, 2008).

From my experience in the Namibian context, the issue of the inclusion of learners' everyday experiences is well presented in the Namibia MoE (2009) document. However it is another issue whether teachers at

the implementation level of this document have the skills to incorporate such knowledge in their teaching without hindering learning. It is against this backdrop that I decided to engage in this study.

6.4.1.2 The Physical Science syllabus grade 8-10 (2006)

Like the Namibia MoE (2009) document, the syllabus for Physical Science Namibia MoE (2006) assumes that teaching approaches should be adjusted by the teachers in order to consider learners' cultural beliefs/everyday experiences during teaching and learning of science. Such statement appears under the rationale but when it comes to basic competencies, the issue of cultural beliefs/everyday experiences is not made explicit. Also, the document does not specify how cultural beliefs should be considered and this could have a negative impact on both teachers and learners. Since there is no mode of implementation, teachers are likely to ignore the part of learners' cultural beliefs/prior everyday experiences in teaching science. In terms of teachers, if they are not trained to teach using learners' prior knowledge, they may not see the need for using learners' prior knowledge. Consequently, learners might feel that their prior knowledge does not have a role to play in their school. It could also happen that learners will not see the value of school in their everyday life.

6.4.2 Analytical Statement 2:

Factors enhancing learner engagement during science lessons

During this research, I learned that the nature of activities that we engage learners in the science classrooms determine the level of learner participation. For example, when learners were given an opportunity to brainstorm their cultural beliefs/everyday experiences about the rainbow in this study, I observed that there was a high level of participation. Even those learners who hardly participated during my lessons were actively debating giving their own experiences and beliefs about the rainbow. Roschelle (1995) suggests that considering learners' prior knowledge in the lesson can motivate learners to participate in the lesson.

It was again noted that giving learners an opportunity to work in small groups encouraged them to talk freely because they were working within their comfort zone. A study conducted by Stoddard, Pinal, Latzke and Canaday (2002) suggest that when learners are involved in exploration activities, they are

likely to attain language skills. A study conducted by Rivard and Straw (2000) on the effect of talk and writing in learning science in Canada revealed that these enhance retention of science knowledge. In addition, when talking is integrated with writing in science, individuals can make sense of their social context (Rivard & Straw, 2000). This occurs as learners engage in discussions within their community of practice.

In this study, learners also asked questions to each other during the presentation session. This shows that they did not only participate in the group discussions but also paid attention while the group presenters were presenting to the rest of the class. Worth noting is that learners talked about the rainbow with confidence because it is a common phenomenon and they viewed this lesson as relevant because it is directly focused on their context. Stears, et al. (2003) posit that learners' everyday experiences can be used as a reference point for thinking and as a context for applying scientific ideas and skills. To support this view, Rennie (2011) echoes that using learner' prior experiences in teaching and learning science can help learners to view the importance of school science in their everyday life.

Learners were happy to conduct the study in the community because it gave them an opportunity to interact with their community members. From my informal observation, learners enjoyed doing the interviews in the community and they managed to gather information which they presented to the rest of the class. As was the case with learners' brainstorming session, learners actively discussed their findings in groups before reporting to the entire class.

Other activities that produced learner engagement were the practical activities. Learners were asked to predict their possible observation and explain their prediction first. This idea is supported by Maselwa and Ngcoza (2003) believing that by using the PEEOE (see Section 2.4.2) learners can benefit from practical activities in the science class. In these tasks, however, learner engagement was low compared to when the learners were engaged during the brainstorming session. From my own view, learner engagement was low at this stage because learners did not have ideas on what I expected them to do until they started asking follow up questions.

However, when an activity on water and a pencil in the glass was given, learners were actively commenting and gave their predictions. But the level of engagement decreased when it was time for learners to predict what would happen to light when it was passed through a triangular prism. The reason

for such decrease in participation could be that learners were not familiar with the learning materials, unlike when they had to talk about their cultural beliefs/everyday experiences about the rainbow.

Aikenhead and Jegede (1999) support the idea that learner participation is highly affected by the gap that exists between cultural beliefs/everyday experiences and science. In addition, Roschelle (1995) contends that learners become active when the content presented to them is relevant to their context. At this stage, learners might not have thought of a rainbow as colours such as could also be produced when light passes through a triangular prism.

When learners were instructed to project the sunlight through a triangular prism onto different surfaces, I also observed a sudden increase in participation. Learners became very active and excited when they made colours appear on the surfaces. Thus, it could be argued that the effectiveness of a practical activity depends on the relationship between what learners are expected to do and what they actually do during practical activity (Millar, 2009).

Learners were further asked to predict what they would observe when a thin mist of water was sprayed in the direction of the sun using a hosepipe. Most of them said there would be colours of the rainbow. I asked a follow-up question on why they thought colours of the rainbow would be formed. They responded that the colours usually appear when they water the gardens at their homes. But in their notes some learners answered this question based on the concepts of refraction of light.

6.4.3 Analytical Statement 3:

Learners' cultural beliefs/everyday experiences: their role in teaching and learning science.

For the purposes of this research study, I have used the term cultural beliefs/everyday experiences to refer generally to the type of knowledge about the rainbow which learners brought to class. In Chapter Four, I presented data that emerged from the brainstorming session and the learners' findings from the interviews with community members.

Learners were able to share their cultural beliefs/everyday experiences about the rainbow. All the groups indicated that a rainbow is a living organism that lives in water. They seemed to have a strong position

about the rainbow from their cultural point of views. During this lesson, I found that learners come with rich and well developed knowledge about this phenomenon in their environment. Oloruntegbe and Ikpe (2011) support the idea that learners come with well-developed everyday experiences about the environment in which they live.. They therefore regard it as important to consider learners' prior everyday experience because it allows learners to relate what they learned in school to what they experience at home. The same view is presented by the study conducted by Stears, et al. (2003) in South Africa. That study echoes the idea that considering learners' everyday experience as important in teaching science, promotes learner engagement during science lessons.

The data in this study revealed that most of the cultural beliefs of learners and community members are not scientific. This means it is either mythological oriented or religious oriented (very few). Nonetheless, eliciting learners' cultural beliefs/everyday experiences about the rainbow played a major role in learner engagement and some of their experiences were scientific, for example, watering gardens. It also raised learners' interest in the lesson as they were dealing with issues related to their context even though not necessarily relevant to the content. Consideration of learners' cultural beliefs/everyday knowledge encouraged learners to acknowledge that they can still use elders in their community as sources of information to learn something at school.

6.4.4. Analytical Statement 4:

Practical activities: their role in conceptual attainment

The nature of activities and how they were designed in this study forced learners apply the approach termed PEEOE by Maselwa and Ngoza (2003) which I have discussed in detail in Chapter Two (see Section 2.3.4). I found that learners were not familiar with the idea of making predictions before engaging with practical activities. As a result, learners did not appear to understand what they were expected to do in the initial activity (see pencil and water in a glass activity under Section 2.4.3). However, when I explained what I expected them to do, they managed to suggest some points and these have been highlighted in Chapter 4. The study conducted by Gott and Duggan (1996) support this observation that learners benefit from practical activities when it is planned in such a way that they will be encouraged in critical thinking.

The activity using the triangular prism appeared to be the most exciting of all, because learners learnt that the rainbow was mere colours that appear on the sky. This was evident in the contributions learners made during the activity. Also, during the focus group interviews most learners cited the triangular prism as the practical activity which made them understand how a rainbow is formed. Note that in the pencil and water in a glass activity, learners made accurate predictions, possibly because they had experienced the phenomena in their everyday life and were thus able to come up with what they already know (see Section 2.4.1). That would also bear on the role of prior everyday knowledge.

To support my observation, Abrahams and Millar (2008) argue that the effectiveness of practical activity depends on what learners are expected to do by the teacher and what they actually do. In addition, Hattingh, et al. (2007) posits that the effectiveness of practical work is determined by teachers' interest in conducting practical work. Abrahams and Miller (2008) suggest that teachers should always consider what learners learn in the given practical activity rather than merely assume that the given practical work will enhance conceptual understanding. On the hosepipe activity, learners predicted that the colours of the rainbow would be formed. Some of them referred to their experience from home in making that prediction. (See Table 5.2., L1 and L6). Research has indicated that the prior knowledge learners bring to science lesson needs to be scrutinised to identify possible misconceptions (Stears & Malcolm, 2005; Thompson & Logue, 2006). All learners wrote what they observed individually and added their reasons for the formation of the rainbow. Throughout learners' explanation for the rainbow in the mist (a thin layer of water sprayed into the air), most of them used the term reflection instead of refraction of light (See learner 1,5,6,7, and 10 in, Table 5.2). However, reflection is in fact involved in rainbow formation, along with refraction (Sakuranda & Nakamura, 2002).

A study conducted by Thompson and Logue (2006) on students' misconceptions indicates that they have multiple sources for these misconceptions. This needs earlier identification so that a strategy can be used to help learners overcome the misconceptions. Thompson and Logue (2006) further argue that when misconceptions are left unattended, they are likely to hinder possible conceptual attainment.

6.4.5. Analytical Statement 5:

Implications for considering learners' cultural beliefs/everyday experiences in learning concepts in science

The major challenge that I observed during this study was the nature of cultural beliefs/everyday experiences that emerged from the brainstorming session and from the community interviews. Cultural beliefs that emerged from this study could be linked to learners prior everyday experience in this research since there gap between them is narrow. Through analysis of that data, I learned that most of what learners and parents believed about the rainbow was mythological oriented. That is, both learners and community members' beliefs were not congruent with what a rainbow is from a scientific point of view. Abrahams and Millar (2008) caution that when learners' prior experiences are in conflict with what they are presented with at school, it would not be easy for them to translate what they already know to what they are presented with. Despite this observation, I strongly believe that such prior knowledge can be used to enhance critical thinking in science class (Loughran, Mulhall & Berry, 2008).

Sutherland (2005) infers that the idea of border crossing depends heavily on participants in negotiating learning from one cognitive domain to the other. Border crossing is an idea in which indigenous learners experience and acquire western knowledge (Sutherland, 2005; Aikenhead, & Jegede, 1999). For individuals to experience and acquire new knowledge without any cognitive conflict, Aikenhead and Jegede (1999) argue that individuals should be willing to cross the border. This idea was further echoed by Sutherland (2005) adding that factors such as motivation to cross are among other factors that enhance effective border crossing.

Thus, I fully oppose the idea raised by Ogunniyi and Ogawa (2008) that teachers sometimes force learners to abandon their prior everyday experiences in favour of what they are presented with in the classroom. My own view is that much depends on whether there is any alignment between learners' prior everyday experiences and the science in the classroom. However if there is no alignment, the teacher can investigate the learners prior knowledge and see how it hinders learners from learning school science. This can be used to clear possible misconceptions and engage learners in the discussion (Ramorogo and Ogunniyi, 2010).

In the case of my study, I have learned that everyday experiences can also be used as a tool to enhance learner engagement and arouse their interest to learning rather than using it as content knowledge *per se*. This needs, however, a skilled teacher to be able to analyse the type of knowledge learners bring to school and see whether to build on it or to use it as a tool for learning.

6.5 Concluding remarks

Engaging in this research study gave me an idea on how science can be made relevant to learners' lives even if it means using their non-scientific beliefs for meaning making. Planning science activities and the nature of those activities stood out as key areas that enabled learner engagement. I also learned that it is not necessary that prior knowledge should form part of the learning content but can still be used as a means of mobilising cultural values and make learning part of learners' everyday lives.

In the next chapter I summarise the findings of the study, discuss, the research limitation, make some recommendations and suggest areas for future research. I finally provide my critical reflections on my research journey and provide a conclusion to the study.

Chapter Seven

Summary of findings, recommendations and conclusion

7.1. Introduction

This chapter thus concludes my research study whose main goal was to investigate how my grade 10 learners could make sense of concepts on refraction of light through exploring their cultural beliefs/everyday experiences about the rainbow.

In the first part of this chapter, I provide a summary of the main findings drawn from my analytical statements presented in Chapter Six. I also discuss the major findings of my research study. Based on my findings, I offer recommendation and suggest areas for future research. I also assess the potential value of this study before giving a brief discussion on its limitations. Since this is a concluding chapter for my entire research, I engage in a critical reflection on my research journey and lessons learned during the course of my study. This is followed with some concluding remarks.

7.2 Summary of findings

The National Curriculum of Education proposes that teaching and learning should emerge from what learners already know. Similarly, the physical science syllabus for grades 8-10 encourages teachers to make use of local examples in explaining concepts in physical science. However, the basic competencies outlined in the syllabus under the topic of refraction of light lack provision for using learners' prior knowledge in teaching and learning.

From my experience when doing this research study, I realised that it is important to consider learners' cultural beliefs/everyday experiences when teaching science, thus agreeing with Rennie (2011). However, some of the learners' or community members' cultural beliefs/everyday experiences about the rainbow were found to be largely mythical. Nonetheless, Rennie (2011) supports that engaging learners in such exploration studies can also help both teachers and learners to close the gap between science and learners' everyday experiences. Since the syllabus does not outline how exactly everyday experiences should be used in the lessons, some teachers lack initiative in using it. As a result, they end up neglecting learners'

cultural beliefs/everyday experiences while teaching science. Yet, this could be useful to make science relevant to the Namibian context.

According to Roschelle (1995), neglecting learners' cultural beliefs/everyday experiences and knowledge has a negative effect on learning in general. To support this view, Aikenhead and Jegede (1999) outline that conceptual attainment is only possible if learners are able to align their experiences with what they are taught in the science lesson. If the two domains of knowledge do not come together, they are likely to affect learning.

To make this research study relevant, I related it to the transformation that took place in the Namibian education soon after independence in which teaching and learning is now underpinned by learner centred education (Nyambe, 2008; Pomuti, et al., 2003). Within learner centred approach, Nyambe (2008) contends that learners should be placed at the centre of the entire learning and teaching process. This can be done by providing opportunities that can enhance learner engagement at all levels of the lessons.

Therefore, it could be argued that this research study was a response to the National Curriculum of Basic Education (Namibian. MoE, 2009:4) which encourages teachers to use learners' everyday experiences as the point of departure during teaching and learning in general. To support this idea, Stears and Malcolm (2005) posit that science curriculum development should foreground the use of local examples to explain phenomena.

My concern, though, was the extent to which such cultural beliefs/everyday experiences enabled or constrained conceptual attainment in learning and teaching physical science. I therefore decided to investigate how the use of learners' cultural beliefs/everyday experiences about the rainbow can be used to enhance meaning making when teaching refraction of light. As a qualitative case study, this research only exposed the participants' beliefs about the rainbow and showed how exploring such beliefs enhanced learner engagement during lessons.

To support these findings, Otero and Nathan (2008) suggest that eliciting learners' everyday experience can enhance conceptual attainment because their experiences would serve as the basis on which new knowledge is developed.

It emerged during this research that eliciting learners' cultural beliefs can support conceptual attainment (Barab & Luehmann, 2003). Furthermore, this research revealed that not all cultural beliefs/everyday experiences agree with the subject matter in the classroom (Aikenhead & Jegede, 1999). However, giving learners an opportunity to discuss and debate what they believe can encourage learner participation that leads to the realisation of everyday experiences that could be classified as myth, scientific, or religious.

Using practical activities after exploring learners' cultural beliefs/everyday experiences afforded learners an opportunity for conceptual attainment. However, Rivard and Straw (2000) argue that when learners are engaged in activities that involves both talk and writing, they are likely to develop their understanding of science concepts. Thus, I argue that conceptual attainment can be achieved through talking, writing and practical activities of different kinds. A study conducted by Rivard and Straw (2000) indicate that learner talk is an important mechanism for clarifying, sharing and distributing knowledge among peers. Again, the use of the PEEOE approach (Maselwa & Ngozoa, 2003) during practical activities enhanced critical thinking because learners had an opportunity to think and confirm their thoughts throughout the research lessons.

From my observation and experience during this research I learned that the effectiveness of practical work activities in science class depends on how they are designed and facilitated. Rennie (2011) suggests that there is a need for teachers to have pedagogical knowledge in order to assist learners to benefit from their everyday experiences. Engaging learners in learning through enquiry-based approaches can stimulate their interest in learning. Learners feel confident in presenting content which they have collected through enquiry in the community rather than presenting something that they have read in a textbook.

7.3 Highlights on my major findings

To conclude this thesis, I think it will be essential for me to display my major finding. From the document analysis, I learned that the National Curriculum of Basic Education Namibia. MoE (2009) suggests that teaching should emerge from what learners already know and what they can already do. Thus the national documents that I analysed assume that teachers should use learners' everyday experiences in making syllabus content relevant to their learners' context. My concern for these findings is doubt whether Namibian teachers are well trained to use learners' everyday experience in their science lessons.

In terms of learners' cultural beliefs/experiences, this research revealed that considering learners' cultural beliefs/everyday experiences serves several purposes. These include conceptual attainment, enhancing critical thinking and making learners aware of the values of their everyday experiences. For example, the lessons that required learners to learn through exploring their cultural beliefs/everyday experiences and those of the members of the community enhanced conceptual understanding which I measured using focus group interviews, learner engagement and also promoted critical thinking.

Although literature assertions that practical activities are among the factors that encourage learner engagement, this research revealed that for practical work to enhance conceptual attainment, the design of the practical activity determines whether learners benefit from it or not (Roschelle, 1995). Thus, the use of the PEEOE approach (Maselwa & Ngcoza, 2003) during the implementation of this research gave learners an opportunity to interact with the learning materials that leads to conceptual development.

Since the main focus of this study was to investigate how grade 10 learners make sense of the concept in refraction of light through exploring their cultural beliefs/everyday experience about the rainbow, it was also necessary to look at the implication for considering learners' cultural beliefs/everyday experience in teaching physical science. This study indicates that not all cultural beliefs/everyday experiences concur with western science. As a result, not all experiences of this kind will enhance conceptual attainment but can still be used to clear misconception that may exist among learners based on their beliefs (Rennie, 2011). Rennie further argues that where there is a mismatch between learners' experience and the content in the syllabus, it is always important for the subject teacher to see to it that such experiences are not ignored but are used as the starting point of the topics to arouse learners' interest.

7.4 Recommendations

Based on my findings of my research study, I therefore make the following recommendations and suggestions for future research:

- Engaging learners in activities that provide them with opportunities to explore their cultural beliefs/everyday experiences can enhance learner engagement and participation in science lessons;

- Engaging learners in learner talk and discussion can encourage them to ask and answer questions during the lessons;
- Meaning making and conceptual development among learners can be achieved by engaging learners in practical activities provided the focus is on the key scientific concepts to be developed. Engaging learners in researching information can reinforce their interest in research and in the learning activities;
- Teachers need to be trained to be able to elicit and integrate learners' cultural beliefs/everyday experiences in their science lessons. This can be done at the universities during initial teacher training programs.

7.5 Areas for future research

For any who want to carry out further research on learners' cultural beliefs/everyday experiences in science, I recommend that they research the teachers' perspectives as well.

In addition, since cultural beliefs are embedded within the specific group, it would be wise to conduct a similar research in a vernacular language to access the concentrated thought and beliefs of the participants.

7.6 Potential value of the study

In this study, I attempted to engage with learners' cultural beliefs/everyday experiences on the rainbow in the Namibian context. This should cast light on some of cultural beliefs or everyday explanations of a particular phenomenon dealt with in the science curriculum, namely, refraction. It should also potentially provide some insights into how one might engage pedagogically with these at the same time as teaching the modern scientific explanations and dealing with the interactions between these in a real classroom setting. This study may thus provide some signposts for other teachers in how to engage with cultural or everyday explanations of natural phenomena in the science classroom.

7.7 Research limitations

This research was small in scope since it is a half thesis in science education. Consequently, here are some limitations:

- Since it is a case study it would not be easy to generalize the findings of this study more specially as it relates to learners' cultural beliefs in the particular study area.;
- Due to the way the research lessons were planned and the busy schedule of teachers, it was not easy for me to get a critical friend who could observe and comment on the lessons immediately.
- Changing work environments during the course of my study might have affected the way this research was conducted;
- Interviewing learners who were not active during sessions could have provided me with views on why they were not participating actively which I could have used to analyze my teaching approach.

If I were to do this study again, I would try as far as possible to include about 10% of the population by including all the schools in the circuit and use questionnaire as one of my data gathering tools. This was not done because I came to realise the need for a large scale research when I was busy analysing my data. There was a need for funds to cover the travelling cost to and from the various school and also to pay a teacher to stand in for me in my while conducting research away from my duty station.. This would help me to generalise the findings about the cultural beliefs/everyday experiences on the rainbow to the entire tribe of Vakwangali. Finally, I could have gathered more quality data if I chose a minimum number of learners from the entire group to be my research participants because it would then have been easier to capture just the ten participants in video and voice recorder, thus making data analysis meaningful. This would also help me gain insight on learner talk and construction of meaning in science class.

7.8 Critical reflections on my research journey

Working on research study is an academic journey that requires the researcher to pause and look back. At this point I would like to share my experiences and what I learned throughout the research journey as a novice researcher.

7.8.1 Overview of the Masters in Science Education course

The rationale for the Masters in Science Education (Coursework and half thesis) course was centred on developing scholars into becoming critical reflective and reflexive practitioners who would contribute to the development of Namibia. Likewise, Vision 2030 of Namibia aims to achieve a prosperous and industrialised Namibia, developed by her human resource, enjoying peace, harmony and political stability Namibia. MoE (2009). By allowing Rhodes University to operate in Namibia is one way that Namibia is striving to reach Vision 2030 with its focus on developing and strengthening human resources.

7.8.2 My experience throughout the entire research journey

This study took place over a period of two years starting in the 2011 academic year when the focus was on exploring areas relevant to teaching and learning science in the Namibian context. Among other areas that we explored were philosophy of science, nature of science and indigenous knowledge, learning and teaching theories and practical work. As we explored those relevant areas I started to reflect on my own practice as a practicing teacher. The more I worked on my assignments and participated in the class discussions that took place during the contact sessions at Okahandja under the supervision of the lecturers I developed a strong feeling about my teaching approach and decided to base my research topic on my classroom practice. It could be argued that I wanted to improve my own practice. My research journey therefore started in 2011 and every day brought with it new experiences which I present under the following headings.

7.8.2.1 Writing up a research proposal

The writing up of a research proposal was done at the same time as we were exploring the different relevant areas in science education. However, the unique approach in 2011 was that individual students kept presenting their proposals to the entire MEd science class to invite critical comments and questions. Through this process, I learned the role and the need for a critical friend to enhance collaborative learning. In August 2011, a research design course was organised and run at Rhodes University, in South Africa, when different research experts handled different aspects of the research proposals such as the data collection techniques, theoretical framework *etcetera*.

Despite the presentations from experts during the research design course in South Africa, I found myself confused with different concepts I did not understand, no matter how good the people were who explained them, until I undertook my own research. Some of the terms that I grappled with were: *research paradigms, themes, categories* and *analytical statements*. Through the process of writing up a research proposal, I learned that a research proposal is a plan of what a researcher intends to do. Within the research proposal, it was significant to locate my proposed research within the existing theories and research (Babbie & Mouton, 2001).

In retrospect, I discovered that the more I worked on my research questions, the clearer it became for me to determine the data gathering tools for my research. To support this view, Leedy and Ormrod (2005; 2010) posit that the way a research project is designed determines the research methods that a researcher embarks upon. Based on that advice, the choice of a qualitative case study was suggested. Apart from the experience that I gained through writing the research proposal, I also developed a clear understanding on the significance of supporting each other in learning. If we had adopted a ‘man for himself and God for us all’ approach in this journey I certainly would have not survived!

7.8.2.2 Implementing the research proposal

To be a novice researcher demands patience and a willingness to take criticism. At first I thought conducting research means implementing the proposal as it was designed. However, when I started implementing my research proposal I came to understand that the practical situation in which a researcher finds him/herself determines what steps to take rather than following a research proposal religiously. That is, I learnt that a research proposal is a road map and guideline for a researcher. For example, I came to reduce the number of research participants to a number that was practically suitable for data gathering.

Implementing my research was a learning experience. One thing I liked the most was interacting with my research participants because I came to understand my learners better than could have been with other lessons. This was the time that I started understanding concepts that I had not grasped clearly during the writing up of my research proposal. The process of transcribing immediately after implementing the research component was helpful because I could still remember how the participants expressed their ideas during the research lessons.

At the end of the day I collected a huge amount of data of which some were not relevant for my study and I had trouble sorting out which data was relevant for my research. I revisited my data again and again trying to determine which data answered my research questions. This is the stage when I started to notice emerging themes. In the process of analysing my data, I also came to realise that analytical statements are those statements that a researcher uses to discuss the research findings. This was the stage when I started to see myself as someone in the process of learning.

7.8.2.3 Reporting my research study

This was the most crucial part of my journey as a novice researcher. Making my chapters talk to each other was quite a challenging experience. Coming from a non-English background was a challenge which affected the way I communicated my research report as a whole. Sometimes I found that in an endeavour to get my thoughts across, I ended up making long sentences that instead lost meaning. However, with the help and encouragement from my supervisor, this language barrier did not discourage me from writing up my thesis.

The process of writing up my research started immediately I came up with my research topic. I started to look for literature relevant for my study. Initially, I had very good literature but later I realised that I needed to focus on what was only relevant for my topic. So I had to be selective. The process of working with my supervisor ensured quality for my study because every time I completed a chapter, I emailed it to him for advice and critical comments. This allowed me to see how my research was growing from one level to the next. To support this experience, Leedy and Ormrod (2010) posit that novice researchers tend to lose sight of their findings and instead report on something which does not answer their research questions. As a result, in my chapters three and six, I ended up including tables that showed the type of data I had collected using specific data collection techniques or a table with analytical statements. These included possible research questions that lead to the emerging of such themes. This was done with the view to remaining focussed in my research study.

7.8.3 Lessons learned

From what I went through during the write up of this research, I learned that it is important to take good care when planning the research. If a study is well planned, its implementation is more likely to run

smoothly. When the research techniques are piloted, it gives the researcher a chance to make changes before implementing the intended research. Through data gathering process, I learned that some data that a researcher ends up gathering might not be relevant to his/her study. For example, the comments that I got from a critical friend and a video operator were good for my professional development but could not answer any of my research questions. Therefore, it was difficult for me to include it in to my research findings even though the comments made on my approach were useful for me as a teacher.

I also learned that doing research is a process that requires patience, and willingness to learn beyond its anticipated scope. Through this study I learned how to use a computer to a reasonable level even though not to the advanced level. I had very limited skills in computer use when I joined this course. Using emails as a mode of communication provided me with room for improving my computer skills. As of now, I can use basic features such as typing, editing, formatting, track changes and so forth. These are some of the skills I learned during this course. One advantage of typing my own research was that as I typed my work I internalised it and I gained a better understanding of what I was doing.

7.9 Conclusion

This chapter provides a synthesis of the entire research study. In the first part of this chapter, I gave a summary of the main findings drawn from my analytical statements presented in Chapter Six. This is followed by the highlights of my major findings. The recommendations and areas for future research are also made in this chapter. For realization of the value of my study in the Namibian context, I presented the potential value of this research in general. Since engaging in the research study provides the researcher with reflective and critical insight, I presented the limitations of my research in this chapter.

Finally, I wanted the reader to understand some factors that shaped my research study and I feel it is worth sharing my research journey. Therefore in this chapter I also I a detailed reflection of my journey including the lessons learned through the process of research.

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APPENDICES

LIST OF ITEMS INCLUDED UNDER APPENDICES.

Appendix A- Observation letter

Appendix B- Permission letter from the school

Appendix C- Consent letter

Appendix D- Sample of learners' written work [pencil in a glass of water activity]

Appendix E- Sample of learners' written work [triangular prism activity]

Appendix F- Sample of learners' written work [hosepipe activity]

Appendix G- Notes taken during focus group interviews.

Appendix H- Transcriptions from brainstorming sessions, presentations of learners' findings, and focus group interviews.

Appendix A

POBOX 1615

Rundu

Namibia

28 February 2012

The management

████████████████████ SCHOOL

Re: Request to conduct academic research at the above mentioned school

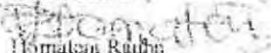
I Homateni Raula, a teacher at the above mentioned school would like to request the school management to grant me a permission to conduct my research study at the school as part of my professional development. **The aim of my research study** is to understand how learners make sense of concepts on refraction of light through exploring their cultural/everyday beliefs about the rainbow: A case study.

The research activities will not intervene with the normal school lessons but are designed to take place in the afternoons. Most of the research activities will be conducted within the school. Although there will be a day (Saturday) when learners will be expected to conduct interviews with the community members. During these activities, I will accompany learners to go into the community and conduct interviews. Consent letters will be send to the parents of the individual participants. The research activities will run from 5th March to 30th March 2012.

The results of the study will be used only for my research study.

Looking forward to hear from you as soon as possible.

Yours faithfully


Homateni Raula

Appendix B

REPUBLIC OF NAMIBIA

High School

Telephone : [REDACTED]
Ref :
Enquiries : [REDACTED]

P.O Box [REDACTED]
RUNDU
NAMIBIA

6 March 2012

Dear sir / madam

SUBJECT: RE: REQUEST TO DO OBSERVATION AT THE ABOVE MENTIONED SCHOOL.

We acknowledge receipt of your request to do school observation. You are welcome to carry out your school observation as from date of this letter up to the end of this school term. We guarantee our full support from the management and the entire staff during your observation.

Thanks for your trust in this school

Yours in education

[REDACTED]
PRINCIPAL

6 March 2012
DATE

13/03/2012

FOBOY 1615

ikand'u

Namibia

2 March 2012

Dear parents of—

Re: Consent letter

I Heratoni Rauba, a teacher at [REDACTED] school, would like to appeal for a permission from you to allow your son/daughter to participate in my research study. The aim of my research study is to understand how to make sense of concepts on refraction of light through exploring their cultural/everyday beliefs about the rainbow: A case study

The research activities will not interfere with the normal school lessons but are designed to take place in the afternoons. Most of the research activities will be conducted within the school although there will be a day (Saturday) when learners will be expected to conduct interviews to the community members. During these activities, I will accompany learners to go into the community and conduct interviews. The research activities will run from 5th to 30th March 2012.

The results of the research will be used for my research study only. You can reply by filling in the necessary information on the blank space below and send the same letter back to school.

I [REDACTED] the parent/guardian of [REDACTED] [REDACTED] allowed/did not allow my son/daughter to take part in the aforementioned research activity.

Yours faithfully

Heratoni Rauba

Activity: two

GROUP 2

Refraction in everyday life

In this activity, you are going to investigate what happens to the pencil when it is placed in the glass of water. Before you start with your investigation, use your free hand and predict by drawing the shape of the pencil when placed in water. What do you think could be the reason for your prediction?



- It will look big
- Water will increase
- It looks as if it bends

[1]

Explanation: ~~because the object will occupy the space in the water~~ because it depends on the liquid inside the container [1]

Aim: To investigate the bending of light as it pass from air to liquid.

Materials needed: A glass of clean water, and a pencil.

What to do: Place a pencil in the glass of water and leave it to lean on the wall of the glass and observe.



Draw the pencil in the glass of water based on your observation on the space above and explain the possible reason for your answer— because of our eyes

[1]

Appendix E

Activity 3

Activity three (Group Investigation)

Aim: Investigating where colours come from.

Materials needed.

A triangular prism (glass)

A white cardboard/wall

A source of white ray (sun light)

What to do

Note: This activity should be done outside the class room in order to get the rays from the sun.

1. Hold the triangular prism so that you direct some light from the sun rays from the sun to pass through it.
2. Observe the rainbow colours in the floor or wall.
3. Focus the rainbow colours on the white wall and identify the individual colours.

Questions

1. From your observation, which colour bend the most? Give a reason for your answer. Blue
because it is the one which is on the
bottom of the triangular prism
2. Which colour bends the least? Give a reason for your answer. Red because
it is the one which is on the top of
the triangular prism
3. Why do you think a rainbow is commonly observed during the rainy season? because
the rays from the sun pass through the
cloud droplets and only rain can cause during
the rain season.
4. Below is the diagram of the spectrum showing the seven colours of the spectrum? Identify the colours on the diagram (mnemonic ROYGBIV will be useful in this case).



red, orange, yellow
green, blue, indigo,
violet

Making a rainbow using mist method (hose)

The aim of this activity is to make rainbows using garden hose and water on a bright sunny day

Materials:

Hose pipe

Water

Part one

Before you do this activity,

Prediction: What do you think will happen when you make a ^h mist with water in the direction of the bright sun? Give a reason for your answer.

I think it will display as some clouds or a rainbow because the water is broken up into small particles and the sun is high in the sky.

Activity

1. Get a hosepipe. Check that its bright sunny day for this method to work.
2. Put you finger over the water hose, thus creating mist.
3. Turn the water hose towards the sun.
4. Continue to try and look hard into the mist to see the rainbow.
5. Write down your observation and make drawings for your observation. (you can use colour pencils to show your rainbows.)

A rainbow appeared because the water was forced to pass through a hose pipe the sun's rays passed through the water forming a rainbow.

Appendix G

Sample of rough note
taken during focus group interviews

Focus group interview question

1. How do you feel that the lesson on refraction started by considering your cultural beliefs/everyday experiences on the rainbow? Feel that learned a lot. Proud to participate, self worthiness. I felt good because it was done to honor someone of importance to me.

(asked other kids to write)

what did you like or not about conducting interviews with the community members on their cultural beliefs/everyday experiences on the rainbow? Liked the interview with elders, interesting, new people

2. How do you feel about using practical activities in learning refraction? Feel successful, learned refraction

4. To what extent did practical work helped you to understand the concept refraction? Very much, understand how the rainbow is formed

5. To what extent did practical work constrain your understanding of the concept refraction? Did not constrain

6. After all the discussions and the practical work related to the rainbow, how can you describe a rainbow? Refraction of sun rays.

DA

19/04/2012

H-

H_TRANSCRIPTION FROM BRAINSTORMING SESSION.

Group 4

L1: When the water is running, you cannot cross if the rainbow appears on the sky when the water is running because they believe that God is..mmh the.. is having a meeting with those people our mmh ... *Ngapi nye ?...* God is having a..a meeting with to the... our ancestors.

L2: We also believe that the one we see on the sky is not a living organism and the real one is in the river.

Teacher: But what connection is there between the one on the sky and the one that you are talking about? Why do people get terrified and scared when they see the rainbow colours?

Learner: The one from the sky, we believe that those are just colours when heavy rain will take place and after the rain it appears.

Teacher: learner X is you recording all that? Write everything on your mind map. Write in short, just lines and key words and use that later to explain when you present.

Learner: We can say it in Rukwangali? There are a lot of beliefs.

Group 2

Teacher: You know with your mind map you just need to write the bullets and explain in detail when you do your presentations. If there is a word that you want to use and you do not know it in English, you can still use your own language. What other believes do you have?

Learner: We believe that a rainbow can vomit fish and like a python when it gets old it enters the river and grows horns

Teacher: Like cattle?

Learner: No like a springbok

Teacher: Have you seen it before?

Learner: Yes at Tondoro.

Teacher: What link does it have with the colours that we see?

Learner: The rainbow starts from the sky it is coming from a place and enters in the water. If someone did something wrong like, romance and you go to the river.

Teacher: Do you mean when someone had sex with a girl or a boy? What will it do to you? Will it kill you or what?

Learner: Yes and when you are in the canoe, the canoe will not move and you must cut yourself and drop the blood in the river so that it can leave you.

Teacher: Write all those on your poster.

Group3

Teacher: Wow this people wrote a lot. What did you write?

Learner: We decided to write this, what the Shambyu, Vakwangali and the Gciriku believe about the rainbow.

Teacher: Okay. Who is a Shambyu, Gciriku and Kwangali? Even learner Y? Okay start.

Learner: They say that when you like eeh .. Get to the end of the rainbow you will get gold.

Learners: They believe that a rain bow is a black mamba like the vakwangali believes that if a king die or a queen when they die they have to be buried near the river in order to turn into the rainbow.

Learner: Some people.... some other religion they believe that when a king dies they have to be buried near the river. Many people believe that rainbows will catch you and make it your worker some people believe that if you are from ... can I mention?

Teacher: Ya.

Learner: Maybe you had sex, you committed adultery like if you are not married and make sex with someone's husband the rainbow will kill you.

Teacher: How will it kill you?

Learner: If you are in the canoe, it will stop the canoe and...

Group1

Teacher: I missed a lot from this group and it seems you guys wrote a lot. What did you come up with?

Learner: A lot in short the Kwangali they believe that a rainbow are those kings that die and return to look after their families. They also believe that that if a rainbow chases you, you must smash the *uguva(kiaat)* tree I don't know how to mention it in English because it can suck blood. When it comes to people when the rainbow is chasing you, you must smack in the *uguva(kiaat)* tree and run away while it is sucking blood.

Teacher: What about this thin of putting on a red shirt?

According to the shirt, when the rainbow is chasing you while you have a red shirt, you must run while taking off the shirt. The rainbow will chase you thinking it is blood. So you must throw it away so that it attacks the shirt.

Teacher: Wow! Learner X you are not participating

Learner No Ms. I'm participating Ms. the rainbow dislike twins.

Teacher: You mean it hates twins like me? What will it do if it finds me? What else?

Learner: It will swallow you and also when kings are buried near the river, they turn into a rainbow. And if you are near the mangeti tree, you must chop it for the rainbow to suck.

Teacher: What else does it mean that when it is a person, it will swallow and when it is a tree it will suck?

Learners: Yes

Teacher; Now do you have an idea of what a rainbow look like? Does it look like a person, hyena, a lion or what.. What does it look like?

Learner: It looks like water?

Learner: You mean it is colourless?

Learners: Yes it looks like just water, it is shiny than it give colours

Teacher: How many colours do you see on the rainbow?

Learners: Seven

Teacher: Do you see seven?

Teacher: What time of the year does it appears? Is it every time or...?

Learner: During the rain.

Teacher: Do you have ideas on to why it appears during the rain?
Does it appear in all the direction of the sky?

Learner: In the west.

Teacher: Why do you think it appears in the west?

Learner: We believe that it goes to the river to drink water.

Teacher: Okay put up all those on your paper.

Learner: *yinke Nye ayi horokere asi pamwe ekongoro kulidingilika kezuva* ? (Freely translated) Why does it happen sometimes that the rainbow surrounds the sun?

Teacher: What does that mean?

Learner: That is why I'm asking this guy.

Learner: I never saw that but, if that is the case than the colours around the sun is caused by the rays of the sun on the clouds. Some people believe that if you are a boy and cross the colours of the rainbow. You are likely to change into a boy and vice-vesa.

Teacher: We should have enough points on our papers. What I want us to do now we have to write our final mind maps on the posters but strictly on one side. Write short and... and use the pointed on your mind map to explain while you are presenting. You have said a lot but some of you wrote less. You have five minutes to write on the poster.

Learner: Can we write on the other side?

Teacher: No! The other side we are going to use it during the next lesson. Write on one side only and you must come up your own design, very nice. Some people say that said when the rainbow appears on the water surface, they said it is vomiting fish or its drinking water.

Learners: Some people believe that the rainbow can swallow you and when it vomits you and you will be come very rich.

Teacher: Have you ever heard of someone who was vomited by a rainbow? Tell me that story

Learners: Yes! We heard there were two girls who were swallowed by the rainbow and they stayed in its stomach for rainbow because one of them had sex with someone's husband.

Teacher: So they did not die? What did they have? But this one told me that when you are swallowed by the rainbow you will be rich while inside.

Learner: Yes they were vomited naked.

Is there any story that you feel like sharing with the rest of the class?

Learner: Yes I heard story from my grandmother. My grandmother told me that that a rainbow is very huge snake that can live on land and in water. It has all the colours and when it comes to the ground and chases you.... you must run until you get to a big tree with a hollow and change the direction.

Teacher: People write fast please we are running out of time. Calling the (video operator) this girl her want to share something with the whole class..No Msokay we believe that when a rainbow is chasing you must cut of your finger so that it leaves you.

Teacher: You mean you must cut off your finger?

Teacher: You Ms you must just make a small cut so that blood comes out.

Teacher: Was the rainbow ever killed?

Learner: Yes Ms I heard it was killed by the san people in Kavango. When they killed it, they cut the meet and cooked it, later when they checked the meet if it was cooked, it turned into water. Those people decided to drink water, they all died from drinking that water and only one person who live to tell the story>

Teacher: Did you hear that? Have you all heard of that story?

Whole class: Yes

Teacher: Except me. Everybody knows that story? Okay now its time to present to the entire class. During presentation, you are allowed to put up your hand and asks questions where you need clarification. If .. if .. While your friend is presenting and you find that something is not clear you must put your hand up that we will give you a chance to ask.

Presentation

Group 3

Presenter: We believe that a rainbow is a python snake that enters the river when it gets old. If a rainbow is chasing you while you have a baby on your back, carrying a baby you must beat the baby and the rainbow will leave you.

Teacher: What...What will you do to the baby? You kill the baby?

Learner: Ooh you make the baby cry and the rainbow will leave you.

Teacher: Ooh! You mean the rainbow hates the baby cry? Okay.

Learner: We also believe that when a king dies he is turned into the rainbow; we also believe that when you go in the stomach of the rainbow you will find shops and nice things.

Teacher: Listen, eeh... learner Y's group class you are making noise listen. You heard that when rainbow swallow you, you will find shop right, spar and hungry lion..... wow.

Learner: We believe that there is diamond on its' face. And it can also vomit you into a beautiful country. If it gets you in the forest you must chop the mangeti tree.

Teacher: Why should you do that?

Learners: We believe that the rainbow can suck the liquid from the mangeti so that it can leave you. And if you river if you are in the canoe,

Teacher:....and go home naked?

Learner: Yes.....and we also believe that a rainbow vomits fish. If you are wearing a red shirt, you must take it off and throw it in the river.

Learner question: You said that a rainbow vomits fish, will you find the fish in the rainbow when you kill the.

Learner: We don't know.

Teacher: Okay group 2 start.

Group 2

Learner: The rainbow only appear when it rains and we believe that the kings who are buried along the river are the ones that turn kings turn into the. The rainbow reminds us the promise on God that he will not kill people with the flood.

Teacher: Where did hear that?

Learners: When the bible in the book of Genesis. Old python. And we also believe that when you commit adultery, and go to the river, the rainbow will kill you yes... We also believe that if you find the scale of a rainbow you will become rich.

Teacher: Wow! Does that mean that if you just pick the scale of the rainbow you will become rich?

Learner: No, you need to bury it near your room and you will become rich,

Teacher: Just by burying it in your house?

Learner: Mmh...it is believed that it has horns like a kudu and does not like twins:

Teacher: hat else? ...mmh are you done? Learner Y your question.

Mukuve: Madam, they said that if you commit adultery, and go to the river the rainbow will kill you. What you

Learner answer: That is not adultery when you are married it is not adultery.

Teacher: Yes that is not adultery.

Learner asking: You said that when you go to the river while you have committed adultery, how will the rainbow know this?

Learner answer: It will know automatics.

Teacher: Mike your question.

Mike: You said that the rainbow vomits fish, from your own opinion, where does this fish come from?

Learner answer: From what it eats, it its fish and blood.

Teacher: But you said it sucks blood?it make sense because you vomit what you eat isn't? Okay next presenter please.

Group 2

Learner: The Shambyu belief that a rainbow is a big snake that can only eat people except animal. When it comes to the human being, except pregnant woman the Kwangali believe that if you find a rainbow at the river, you will become rich. The Kwangali believe that when a stream has a rainbow, it will contain a lot of fish, they also believe that the rainbow is a serpent, a serpent is a big snake and if it live in the steam, it is very dangerous. When you have a red shirt on a rainbow will attack you so you must remove it and run away. They also believe that the kings.. The kings when they die they turn into rainbow that is why they are buried along the river. The vakwangali believe that when you get a rainbow at the river you will be rich. The *Shambyu's* believe that if a rainbow catches a pregnant woman, the elders must go to the river and talk to the ancestors so that it can vomit the pregnant woman alive.

They also believe that when the rainbow comes on the ground, if you are a woman and cross these colours, you will turn into a woman. Believe that when a rainbow is chasing you, you must chop a tree called *uguve* so that the rainbows will such the liquid from that tree while you run away. It is also believed that the rainbow fight with lighting when you hear thunder. As a result, some of the scales fall off from the rainbow. When you get those scales, you just take it and put it on your pillow. When you wake up the following day you find yourself very rich in a new house.

That is the end of our presentation.

Teacher: Questions for the group.

Question1. How will you know that this scale is for the rainbow?

Learner answer: The *Kwangali's* believe that the rainbow' hi having scale is very big and when you get it you just put it on your pillow and when you wake up tomorrow... ai you are in a real nice house.

Question: Nikko you said that you heard that the rainbow was cooked. Did they find the fish in the pot.?

Answer: They did not get either fish or meat but water. When they drunk the water they died meaning that the rainbow is poisonous.

Group 4

The sky rainbow is believed that it is not a living thing. The real one live in the water and it is a big snake that have almost the size of anaconda that snake in Brazil. The *Owambo* people believe that when you rich the end of the rainbow, you will find gold. We also belief that it hates red colour and when it chases you.... you must cut a certain tree so that it can suck the liquid from that tree. And it says if the rainbow appears on the sky ..like..like what the other groups have said, it vomits fish but only one kind of fish. It hates Christians and it surrounds the house of Christians but themselves they will not see it. The vakwangali people also believe that when you see the rainbow, you are lucky.

Teacher: Questions..... please. Only two question.

Questions: When it comes to the beliefs of fish, you said that the rainbow eats fish and only vomit one type of fish. In your opinion why is only one type of fish vomited while it eats different type of fish.

Answer: Look in my opinion, the fishes will be many but only one type that can be vomited.

Teacher: Okay, next is a group with a boy presenter. Okay start

Group 6

Learner: We believe that a when a python swallows an animal with horns it will develop horn and go in the river to become a rainbow.. we also believe that a rainbow vomits fish. And we also believe that if you eat a dead rainbow you will die. We also believe that kings are buried along the river in order to turn into the rainbow. The rainbow hates twins, when the twins are swimming in the river, they will be taken by the rainbow but we do not know where they are taken. The most important one is that when a king dies

they are not buried in the commentary because they will damage the commentary; therefore they are buried along the river. A rainbow hates twins and the rainbow prevents rain. it is a sign of god

Teacher: Wait..wait before you continue. Do we have places along the Kavango River where chiefs are buried?

Whole class chores: Yes.

Teacher :Okay. Last, group thank you.

Learner: We are the group ones and it is about cultural beliefs about the rainbow. Let me start with the Kwangali. They believe that the rainbow is a big snake that lives in the water. They believe that it sucks blood from living organisms. I do not know weather it sucks blood from people only or from the other animals .T hey also believe that a when you see the rainbow, you must not say it is a rainbow but you must say that chief rainbow because it like to be respected.

Teacher: You mean we must not say the rainbow but chief rainbow... wow.

Learner: Yes it like to be respected. The rainbow vomits fish. Some Christian believes that is a sign the God gave to Noah that he will not kill people with flood. The Shambyu believe that the rainbow is the chiefs that past away long time ago, if you go to the river it will kill you. This statement is not clear but in my understanding,

Teacher: Yes I like that

Learner: I think if you belong to the chiefs' family and goes to the river you will be caught by the rainbow

Question: How will the rainbow know that this is the family of the king?

Answer: Okay its like like in my case for example my grandmother was a king and its like my mother's mother told us that... we...we are not allowed to go to the river the rainbow will catch us'.

Question: How will the rainbow know that you are the family? What is you are not a family of that rainbow

Answer: If you are from the royal family, the rainbow that came from your family will come and catch you because we belong to the same family. We share the same blood so it will know.

Teacher: Wow, I like the way this girls are answering wow.

Teacher: The last question. Who was not given the chance to ask? Okay leaner Y.

Learner: Learner X just said that the rainbow must be called king rainbow. What if the rainbow if a female?

Learner X: It does not matter. King or chief as long as you respect it is fine.

Teacher: Wow, that's very good. Okay people, we are all children talking about the rainbow. We need to find out from the elders in the community. So we are going to conduct interview whereby we ask people about their cultural beliefs about the rainbow. You must record what you find out, in writing you must use mind maps to write in short and make sure you write the important things. Can we come up with the uniform questions that we will use when we go for interviews?

Learner: What is a rainbow? Learner X! yes what form up a rainbow? Repeat again. Is a rainbow a living or a non living? Okay write that down, we want the question that will prompt them, the question that will make them to tell us what they believe. Look suppose we go and ask Mr. Y what is a rainbow and he tells us from the science perspective? We must come up with a question that will lead a person to tell us what they belief culturally.

Learner: Ms I have a nice question I ..In your opinion, your cultural beliefs, what is a rain?

Teacher: Wow! How does that sound?

Learners; We said that already

Teacher: But there is a different between a statement and the question. We need such questions. Write it down. Whatever question they will tell you. I mean whatever answer they will give you.... you must ask them follow up question. You must ask questions until you will be told what you are looking for. Please you must show respect to parents during the interview.

Activity one [Exploring our everyday beliefs about the rainbow]

In groups of four to five, discuss and brainstorm your cultural beliefs and values about the rainbow. Write down the results of your discussion in a form of a mind map and present your findings to the rest of the class. Below are mind maps generated by learners during the brainstorming sessions.



Transcription 2 presentation of findings from the community

X's group;

They we went there, they told us that there are two types of rainbows. There is the one that lives in water and the one that we see on the sky .the on that lives in water use to vomit fish the one that us e to provide fish in the river .The one in the river is very big and dangerous. It can destroy all houses and buildings. It got horns and ...and it stops rain, the one in the sky can stop rain from and if it finds you, you must cut yourself and let the blood fall in the water. It won't leave you to there but it will throw the canoe. If you did not do that it will suck the blood .Some people told us that it can take you but they do not know where it will take you. It appears in the day and in the evening. During the day, the one in the water does

not appear. And they told us that this snake that lives in the water is a python .It is the one that turns into the rainbow and if you are passing by like in the morning or in the evening, the water will be like boiling and is very dangerous. That is all they told us.

Any question? Any question on what they just presented? Those are some of the beliefs that they obtained from the community, questions? You cannot let them go like that. Nikko. Any question? You can't let them go, question that side.

Learner 1 question: How many rainbows are there?

Answers: They are two.

Learner 2: What will you use two cut yourself?

Answers: I really don't know but any sharp object.

Learner question: When it comes to the community beliefs, did they tell you which type of fish does it vomit? a specific?

Answers: They just said it use to vomit fish, that's all.

Question: Did they specify how long or big the rainbow is?

Answer: they just said it is big.

Question: did they specify what the blood use to formulate in the rainbow?

Answer: I don't know but they just said that even if it catches someone, you must not get closer to it because it is dangerous. The moment you come closer it will catch you.

Question: Which of the two rainbows is visible?

Answer: The one that is not visible is the one that is in the water you cannot just see it like that, the one on the sky is visible because it has colours. The one in the water you can only see if something has happened it is like if the pregnant woman cross the river but you...you can just see it like that you will see like water is boiling,

Question: When it comes to changing from python, do you think at the point of aah... mmh... the size of a rainbow, do you think that a python really change into a rainbow?

Answer: In my own opinion I think but in but in my beliefs I don't believe it other people they believe it but for me not yet

Question: Mmh...I 'm also realized that if it appears in the place, it which destroy houses how will this happen. Your house is built near the river, may be the accident happen near your house it will destroy ever thing in your house.

Teacher: Okay thanks can we give them hands, next group please!

Group three

Learner: About the rain bow from the community.

Teacher: How did you get the information from the community?

Learner: We did a research

Teacher: When?

Learner: On Wednesday.

Teacher: How many people have you interviewed?

Learner: Three.

Teacher: Okay.

Learner: It swallows people if it finds you in the river and puts you under the *etondo* [hole] it digs hole. It keeps people under the water and those people pounds.

Teacher: They us to pound?

Learner: Yes, It has horns and it's like a snake you don't find it anywhere but during the rain.

It stops rain, it sucks blood. When it swallows you...

Teacher: Did you asked them to tell you where they get these beliefs.

Answer: they said from their grand, grandparents.

Q : Did you asked them to tell you if they had any experience where rainbow caught... caught someone

A : They said that if it finds you in the bush you must cut uguva if you have something sharp so that the liquid can come one for it to suck while you run away . If you get the scales you will become rich.

A: The sky in the sky is the one for god but the one in the river is like magic, it is for black people ... like

Q: learner X: The point that you said that the rainbow fights with God.

A : It will take you.

Q : You said that it sucks blood and takes you are taken somewhere and you will be pounding . It means it will not kill you it will just take you somewhere.

A : Yes it will take you...you will be pounding and hear celebrating li li li li li miss I don't know people will be pounding and they gave an example of Oshikoto lake that's why you see if you throw something it will back at you.

Teacher: You mean it will come back at you?

A: No miss it will just fall in the lake and they said there is a rainbow.

Teacher: They...they said anything about how you will know that at this place, there is a rainbow

Yes they said in the river the water will be boiling but in the bush it will just be red.

GROUP2

On Wednesday, we went aah ... in the community to find out what they beliefs about a rainbow. We like had some points we had ah... ahh asked questions about the rainbow. So when we reached there, we interviewed three people. They believe that the rain bow fights lightning, they said that there are two types of rainbows, one lives in the water and the other lives in the sky the one that lives in the water has scales , and they believe that the one that lives in the sky prevent bad rain falls from falling they also believe that the one in the river has scales when there is lightning they believe that the one in the river can also light, so which means that if lightning strikes more than three times, what will happen is that ahh... they told us that there is a conflict between the two types of rainbows.

The community people they told us that there are the one in the water wants to prove that it is strong if you get this scales, will be full of fish but it's just one type. Sometimes if you catch one type of fish, you must take care, if that type of fish it will release a second type, meaning you must be care full it will be angry because it's like you are finishing the fish. And also they told us that it sucks the blood and the reason why it sucks is because it is adding to its red colour. If it appears in the place, the witch doctor has to apply something on their face, and talk to their ancestors.

They also believe that the old python enters the river and settles there for months or years. They said before changing into a rainbow first it must grow horns like for kudu like that it is in the process of changing in to a rain bow. If it appears and you will be close to it, you will fill very hot because that colour is red. Truly speaking they told us there is no one that saw the rain bow from the sky. The other one in the...the river many people have seen it. We even came across a person who went across the rainbow. They told us that there was a day when he did his friend went. There is a day and they were two and wanted to look after the cattle. They relaxed and the rainbow started. They saw the one on the sky appearing with in a while the rain bow which was on the trees closer to where he was standing .so they just realized that the cattle's started running and realized that the thing that was far from them had just came closer, so they started running they told us that one was faster than the other one. So it came closer until it got in contact with one that was slow. So the one who was caught to the other one that "just go". The told the other one to run and tell parents at home.

After a while he managed to escape and ran. The one which is in water makes a big hole it rotates water based on the power of the rainwater which means if you do not know anything about the rainbow and you clips in the canoe and you are trying to cross the river, if you reach that point your canoe will stop moving but rotating at the same place. The community members told us if that happens, to you in order for you to survive you must cut yourself and drop blood in the river. That moment you must be a real man. You must hold because it will throw your canoe either back to Angola or Namibia. Throw a metal in the water for it to release you. They also said...said that when the rainbow is chasing you...you must run until to get some milky tree and cut them when the rainbow come there and suck. When a whole, lake or stream has rain bow it will always have water. No matter how small it is it fill a big bucket. They said that if you fetch and hear a sound like *bwi ...bwi* like that it's angry that you are finishing the water it's producing for itself *bwi... bwi* the water becomes more and more until it kills you. It can catch you because the whole place will be full of water. According to what they told us that the one in water remains in the form of snake and it is the source of light. If you keep the scales in your room it can also give light at night.

Focus group interviews

Learner 1

Focus group interviews

Introduction by teacher

What we are going to do now is called focus group interviews. The main reason why I'm going to interview you is to get your feeling view in the whole lesson. Remember this lesson is not the only today's lesson but we started this lesson may be to remind you with brainstorming we sat in different groups and then we caucused on what a rainbow is, what our cultural beliefs is are and we came up with many... many beliefs. They said when you cross where the colours are you will turn into a boy. Than the second lesson, we went down into the community to find out what their beliefs are about a rainbow. We came back and reported. And then today we investigated using a triangular prism, water with a glass and a pencil. So now the main idea is whatever we are going to talk here is going to be confidential. Remember as I told you that the main idea of this lesson is for my studies, so for me to pass it depend on how good you answer this questions right. So each one is going to be given a chance to speak and I will write (say) everything. You must tell me everything that you are feeling and don't say it because your friend has said it. Don't even feel that I must not mention this because it was mentioned by someone. I have a list of six questions and I expect you to answer them all. It you feel maybe you want to use a different language, you are welcome.

Interview with learner 1

Teacher: How do you feel that the lesson on refraction started by considering your cultural beliefs on the rainbow?

L1: I feel or I thought that maybe I'm going to learn something.

Teacher: Now you said that I felt, is it at the beginning.

L1: Even now I feel that I learned new things and I believe in myself.

T: What did you like or not about conducting interviews with the community members? Okay let us start with what you liked the most?

L1: Ms. I like it when we asked the elders, they told us a lot of information it was so interesting.

T: What else?

L1: I met new people.

T: How do you feel about using practical activities to learn refraction?Remember we did not even talk about refraction but we talked about rainbow... rainbow.. rainbow but then today we looked at the rainbow as something that is formed by the bending of light, and we even had a chance to touch those materials in learning refraction. How do you feel that we have used practical activities to learn refraction?

L1: I feel so successful. I was happy to do this research because I did it for someone, I love.

T: Who is that....why?

L1: Because at first, I did not know?

T: Is there anything new that you have learned?

L1: Yes Ms....refraction

T: You mean you never came across the concept refraction before?

L1: Yes Ms.

T: Are you sure?

T: To what extent did practical work helped you to understand the concept suppose I just came in the class and start that today we are going to talk about refraction. Light bends as it enter from one medium to another. When it moves from air to water (liquid) compared to using practical....how...how? Did you? How did this practical activity helped to understand the concept.

L1: Ms it helped me to understand

T: How?

L1: By making me understand how a rainbow is formed.

T: To what extend did practical work constraint (confused you) your understanding of the concept refraction.

L1: I was confused when you said that it is formed with a triangular prism.

T: So that confused you?

L1: Yes Ms I thought a triangular prism form a living.....a real one.

T: Let me reframe the question. To what extend did this practical work made confused you, did it came with some confusion?

Learner 2

Teacher: Good after noon.

L2: Afternoon miss

T: How do you feel that lesson on fractions was started by considering your cultural beliefs and everyday experience on the rain bow.

L2: I really felt very good, I was happy about it; I thought I was very hungry and thirsty of knowing. Its like, I was very interesting it set a smile on my face when I heard that we are going to do it

T: Okay

L2: Mostly when it came to my cultural beliefs, I wanted to believe the cultural beliefs and the science of the rainbow

T: Our second question is what did you like or not about conducting interviews with the community members?

L2: Aah... I really liked it because I wanted to know what my community knows about the rainbow and when conducted the interview, a lot of ideas were given onto us. I wanted to know their experience and beliefs such as what they believe such as rainbow sucks blood etc.

T: How do you feel using practical work to learn the concept refraction?

L2: Using practical work really made me understand. Without any practical work, I might have confused me. Since I touched the proper materials. If we could just talk about it without any aah... Practical work carried out, it might have confused. Since we carried out the experiment, it really made me.

T: Triangular prism

L2: Yah. All the colours were exposed

T: To what extent did practical work help you to understand the concept of refraction?

L2: Aah ... it helped me understand.. it really made me understand.....aah because when we used the materials we can observe different colours of the rainbow so which means for both of us who saw it, it was really impressive because I was still in the belief of the cultural that says if you pass on the colours of the rainbow you will change to a woman. When I came to the instance of understanding, the colours were placed on my fellow learner to see if something will happen but nothing really happened but it gave me an aah... impression that nothing really happens you will remain the same it is just the reflection of colours

T : Than we should have checked Paul, he should have changed to a girl.

L2: Because light bend in water and prism

We even tried to ask if he was filling something as the traditional said but nothing is just colours.

T: Okay! The fifth question: To what extend did practical work constrain or did not make you to understand the concept of fraction.

L2: Honestly speaking I understand everything. It did not confuse me, it did not take my mind anywhere further but it made me understand everything that I did not know

T: Okay. After all the discussions and practical work about fraction how can we describe the rainbow?

L2: I can say the rainbow is the refraction of light in the presence of water vapors in the atmosphere in order to formulate colours that we say it's a rain bow .

T: Is there anything maybe you want to say

L2: Let me say may we not live with the cultural and what we heard in the past because we experience the truth

T: But yes I like that but in learning what you know already from home for example learners who are from houses where they are exposed to reading, they read very well. Like the paper where Y is reading, if you go to my village and ask people about lemon juice, they will not know because they don't know even know how it test. So you cannot use it as point of departure. Instead if I use *nompeke* they will all say..... Ooh! Then they will realize that acids should be something tasting like ... and already think of home, if you know something from home, your learning will be fine. When existing knowledge is challenged new know ledge will be established that if we learn.

T: Excellent X May you go through and see if what you have is what I have written.

Learner 3

Teacher: How do you feel that the lesson on refraction started by considering your cultural beliefs and everyday experience on the rainbow?

L3: I feel good and happy and I was adding more knowledge to my brain and I knew many things about the rainbow.

T: What else?

L3: That all.

T: Question 2. What did you like or not about conducting interviews in the community? Remember, there was a group that kept us waiting. Did you like that?

L3: I like it when we interviewed people, I like the stories that they told us. The part that I did not like was when we waited for other people. But the rest I liked it.

T: How do you feel about using the practical work to learn refraction?

L3: Amh.. I learned that there is a natural and the traditional rainbow because I did not know much about the rainbow.

T: How did you feel about using the rainbow, I mean practical activity.

L3: I feel good because I understood.

T: What is that you have understood?

L3: Everything about the rainbow in my case, next year I will not have a problem.

T: To what extend did practical work made you understand and the concept refraction?

L3: I knew how a rainbow is formed and I knew how a rainbow was formed and I knew that a rainbow is a refraction of light.

T: Be careful not reflection but refraction, reflection is the bouncing back but refraction is the bending.

T: To what extend did practical work not make you to understand the concept of refraction? Was there any confusion?

L3: There was no any confusion.

T: How did you feel about the ideas of predicting before carrying out an experiment?

L3: At least, I felt good because I exchanged the information with my fellow learners and the teacher.

T: After all the discussion, how can you describe a rainbow?

L3: It is a refraction of light; it is not really something that sucks blood, and that kills people. About the Christianity thing, it is a promise of god.

T: We call that a covenant. **T:** Good after noon X.

Learner 4

T: How do you feel that the lesson on refraction was started by exploring your cultural beliefs and everyday experience on the rainbow?

L4:quite...

T: Let me change the question. You know we started with this topic I did not talk about refraction; I said can we discuss our cultural beliefs about the rainbow. More special that part how did it make you feels?

L4: Felt good (answer not clear).

T: Okay. You had many stories. What did you like or not about conducting interviews in the community?

L4: I wanted to know more about what the rainbow is?

T: How about the issue of learning outside like jumping in a truck and walk?

L4: No.

T: You mean you did not feel that what will I learn from this old people?

L2: We can really learn a lot from those elders, because before we even step here they were already here, which mean they know a lot.

T: Do you also belief that they are more experience than us?

L2: yes

T: But we are more educated.

L2: We might be educated but they a lot than us.

T: Okay.

T: How do you feel about using practical work to learn fractions?

L4: I learn that the one that that will appear in the sky. If it happens to me I will not be scared

T: In other words is because you know what the rain bow is.

L4: Yes

T: After all the discussion, how do describe a rain bow ?

L4: Is the bending of light in the atmosphere in the combination of water droplets to form colours in the sky.

T: Thanks a lot go through and rectify if there is anything that you have said and not written.

LEARNER 5

T: How do you feel that the lesson on fraction started by considering your cultural beliefs on the rainbow?

L5: I felt good because it was even my first time to experience it.

T: Was it your time to learn something by exploring your cultural beliefs?

L: Yes.

T: What did you like or not about conducting interviews with the community on their cultural beliefs about the rain bow?

L5: Everything I like it because they told us a lot and they told us a lot of stories what they experience in life.

T: How do you feel about using practical activities in learning refraction on light?

L5: I felt good because I got ideas from the other.

T: Apart from getting ideas from the others, what else did you like?

L5: I like it because I learn when I touch things, that how I learn.

T: So you learn better when you touch things?

L5: Yes.

T: To what extent did practical work help your understanding of the concept re fraction?

L5: It helped me because we used many things and used the ... ah ...

T: From these activities are you really convinced that light really bent?

L5: Yes.

T: Why?

L: Because I have seen it with my two naked eyes.

T: After all this discussion, what is a rainbow?

L: A rainbow is the bending of the light due to water.

LEARNER [6]

T: How do you feel that the lesson on refraction started by considering your cultural beliefs?

L6: I feel good and comfortable

T: Why?

L6: Because learned a lot about the rain bow.

T: What did you like or not about conducting interviews in the community?

L6: I like the stories

T: So you like stories? What about how we went and split up into people's houses? Did you like that?

L6: Yes

T: How do you feel about using practical work to learn refraction?

L6: It made me understand

T: To what extend did practical work made you to understand the concept re fraction?

L6: It helped me to understand

T: Be careful not reflect but refraction.

L6 cont: due water in the sky

LEARNER (7)

T: How do you feel that the lesson on refraction started by considering started by considering your cultural beliefs?

L7: Quite...

T: What did you like or not when we conducted interviews in the communities?

L7: I liked what they told us.

T: So you feel like writing a book on what they told us?

L7: Chorus: yes ... a lot.

T: To what extend did practical work made you to understand the concept refraction?.

L7: By using rectangular prism and by experiences it.

T: You mean, you experience the formulation of rainbow colors?

L7: Yes.

T: To what extend did practical work constrain (made you not to understand) the concept refraction?

L7: I only understand and practice.

T: After all the discussion what is a rainbow?

L7: The formulation of colours in the atmosphere in the presence of the water vapor and light

T: You can verify and I think everybody have singed this information. I would like to thank you for your support and teamwork throughout the course of my research lesson.
