Effects of Dialogical Argumentation – Assessment for Learning Instructional Model on Grade 10 Learners' Conceptions and Performance on Static Electricity

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A full thesis submitted in fulfilment of the requirement for the degree DOCTOR OF PHILOSOPHY in Science Education

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DECLARATION

I declare that this thesis, **"Effects of Dialogical Argumentation – Assessment For Learning Instructional Model on Grade 10 learners' conceptions and performance on static electricity"** is my own work; that it has not been submitted before for any examinations or degree purposes in any other university, and that all sources I have used or quoted have been indicated and acknowledged by complete references.

NOLUTHANDO HLAZO

SIGNED: **DATE: 25 -01-2022**

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DEDICATION

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ABSTRACT

This study examined the effects of using Dialogical Argumentation and Assessment for Learning as an Instructional Method (DAAFLIM) in teaching static electricity focussing on lightning as an example of static electricity to Grade 10 learners. Three groups of learners from two township schools were used as a sample for the study. The Solomon three-group design was employed in collecting data. One class was used as the experimental group and the other two were the control groups: control 1 group and control 2 group.

The study drew on theoretical frameworks associated with prior knowledge of learners such as the constructivist viewpoint. The frameworks that were applied in the analysis of the data were Toulmin's Argumentation Pattern (TAP) and Ogunniyi's Contiguity Argumentation Theory (CAT). The experimental group and control group 2 were exposed to DAAFLIM as a teaching method and AFL as the assessment strategy. The control 1 group was taught in the traditional chalk- talk method and assessment was mostly summative. The experimental and control 1 groups received pre-tests and also wrote a post-test whereas the control 2 group only wrote the post test.

The techniques that were used to collect the data were questionnaires, science achievement test, open-ended interviews and group observations. The data was analysed using both qualitative and quantitative methods. The quantitative data set was analysed using the SPSS statistics programme version 26. For qualitative analysis, the grouping of learner answers was done according to TAP as well as the CAT descriptions.

The results of the study revealed that learners do bring their traditional conceptions of lightning to the science classroom. It was also discovered that learners do not actually leave their traditional

ideas at home as some authors had suggested. Also, some of the learners come with some scientific conceptions about lightning.

The study also showed that the attitudes of the learners towards the physical sciences class in the experimental group and control 2 group where the DAAFLIM practices were applied were significantly higher than the ones in the control 1 group where no DAAFLIM practices were applied. The findings of this study also showed that the academic achievements of the learners in the experimental group where the DAAFLIM was administered were significantly higher than the ones in the control group 1, which was taught using traditional teaching method of chalk and talk.

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KEY WORDS

NEW CURRICULUM

CONCEPTIONS

DIALOGICAL ARGUMENTATION INSTRUCTION

SOCIAL CONSTRUCTIVISM

INDIGENOUS KNOWLEDGE SYSTEMS

ASSESSMENT FOR LEARNING

SCIENTIFIC THINKING

SCIENTIFIC CONCEPTS

CONTIGUITY ARGUMENTATION THEORY

TOULMIN’S ARGUMENTATION PATTERN

ATTITUDE

PERFORMANCE

ELECTROSTATICS

LIGHTNING

TEACHER- CENTRED APPROACH

FORMATIVE ASSESSMENT

SCIENCE EDUCATION

CRITICAL THINKING

SOUTH AFRICA

ABREVIATIONS USED IN THIS STUDY

IKS - Indigenous Knowledge Systems

IK – Indigenous Knowledge

CAT – Contiguity Argumentation Theory

TAP – Toulmin's Argumentation Pattern

SIKSP – Science and Indigenous Knowledge Systems Project

WCED – Western Cape Department of Education

DBE – Department of Basic Education

NCS – National Curriculum Statement

CAPS - Curriculum and Assessment Policy Statement

AFL - Assessment For learning

CASS – Continuous Assessment

SBA – School Based Assessment

TIMSS – Trends in International Mathematics and Science Study

DAAFLIM - Argumentation-Assessment for Learning Instructional Model

OBE – Outcomes Based Education

ZPD – Zone of Proximal Development

DoE – Department of Education

HSRC – Human Science Research Council

OPERATIONAL DEFINITIONS

Dialogical argumentation: This refers to an instructional strategy used in the science classroom during which statements or viewpoints are made and challenged or defended through an organised protocol.

Assessment for learning- Process in which teachers and learners provide feedback during instruction to organize the learning and teaching process in order to increase learner achievement (McManus, 2008).

Language of instruction- The language in which teaching and learning materials are presented in the classroom (DOE, 1996).

Prior knowledge- Pre- existing information or prior understandings held by learners before instructions begin which can either support or interfere with future understandings (Hayward, 2014).

Assessment- Is a wide range of methods for evaluating learner performance and attainment including formal testing, examinations and classroom based assessment carried out by teachers (Gipps, 2004).

Conception- A mental idea or perception about the nature of a given subject matter.

Worldview – To Kearney (cited in Ogunniyi, et al., 1995) "A world is a culturally organized macro-thought: those dynamically interrelated assumptions of a people that determine much of their behaviour and decision making, as well as organizing much of their body of symbolic creations.

Constructivism – refers to a number of related ideas in learning theory that share the notion that learners must develop or construct understanding based on their prior experiences and personal experiences with objects and other learners (Ward & McComas, 2014).

Socio-cultural Critical Constructivism – Constructivism that takes cognizance of learners' socio-cultural environment and background.

Chalk-and-talk teaching method: It is the traditional teaching method that includes formal, expository and teacher-centred methods, during which learners had to read text or listen to a lecture.

Chapter 1

Introduction

1.1 Introduction

Science education is about helping learners develop essential valuable skills and attitudes, thinking in clear and logical ways, and solving practical problems. All these processes, skills, and attitudes are acquired through the medium of inquiry approach whereby learners are exposed to situations that stimulate their curiosity and interest to identify problems in their own environment and attempt to solve them (Erduran, Simon & Osborne, 2004).

A high level of poor performance in science leads to learners not meeting the entry requirements of most science faculties in universities. Despite decades of educational reform (Makgatho & Mji, 2006) in our schools, current statistics (WCED, 2010) indicate that not every learner is being adequately prepared for their future careers in science. This recurring poor performance of learners in science therefore, calls for a concerted effort on measures that will help improve the status quo. This study is hoping to propose a teaching-learning assessment model that will help learners improve their performance and results.

As the curriculum change the education system is challenged by transforming the desired teaching strategies into practical classroom practices (Herrenkohl & Guerra, 1998; Stoffels, 2005). Therefore, the Revised National Curriculum Statement (RNCS) emphasizes the development of critical thinking skills through learner-centered teaching methods that promote high learner participation (Department of Education, 2003), but still many teachers are unsure about what this requires of them (Sanders & Kasalu, 2004; Khoali & Sanders, 2006).

Most South African science teachers rely solely on traditional teacher-centred chalk-an-talk approach to communicate science. They are not familiar with the learner-centred approach recommended in the new curriculum. For the same reason and to make science more relevant to learners' sociocultural environment, many teachers have become aware of the need for professional development to be able to meet the mandate of the new curriculum for a learner-centred-based instruction such as: problem solving; group work; projects; practical work; dialogical argumentation instruction; assessment for learning; concept mapping; V-Diagramming; and so on. Although there are many inquiry-based and learner-centered instructional approaches, this study has adopted dialogical argumentation approaches and assessment for learning approaches as espoused by certain scholars (Erduran et al., 2004; Ogunniyi, 2007a, b; Simon & Johnson, 2008).

There is consensus in the literature that, by engaging learners in classroom argumentationdiscourse alongside formative assessment, they are able to develop and they are able to think critically and argue about issues related to science and consequently improve their understandingof scientific concepts as well as relate what they have learned to their daily endeavours (Erduran et al., 2004; Ogunniyi, 2007a).

When learners come into a science classroom, they have existing ideas about diverse natural phenomena. Learning involves construction of knowledge through experience. Science can therefore be taught more effectively if learners' prior knowledge is taken into consideration through assessment. According to Kilpatric, as cited by Rossow & Smith (1999), learners acquire knowledge when they can incorporate new experiences into existing mental structures. When these structures are re-organised they can be used by the learner to solve more problematic experiences.

According to Broadfoot (1996), assessment is disputably the most powerful policy tool in education and can be the most significant influence on the quality and shape of learners' educational experience and their learning. Popham (1999) also adds that assessment is an attempt by teachers to determine the status of learners' cognitive understandings and abilities as well as skills and attitudes as variables of educational interest. Broadfoot & Black (2004) reckon that it is impossible to visualize formal education that is not punctuated by assessments that are designed to check learners' learning. As a result, teachers engage in the assessment of learners' learning through formal and informal means by using different assessment approaches. Gipps & Stobard (2003) recognize assessment as a crucial element in the teaching and learning process and its role be that of ascertaining the strengths and weaknesses of learning.

As cited in Kelly (2007), Min & Xiuwen (2001), the use of formal tests goes back as far as 210 BC where they were used by the Chinese civil service examination system for selection purposes of candidates who could serve as government officers. According to Black (1998), these tests were used to ensure that test attainment was the way to select on merit than patronage, but the system was abolished in the 1900s due to educational reform. Testing filtered into Europe where it became a way of ensuring knowledge transfer from teachers to learners. Stray (2001) believed that it was also used to define what was expected from learners and to show their periodical progress.

Further developments in the use of tests led to them being used to rank learners from high to low based on their test scores. The United States of America also introduced the testing system in the 19th century. Developments in assessment issues in the Western countries filtered into the countries colonized by the western countries which led to countries like South Africa and Swaziland adopting the British education system (Madaus, 1993).

Assessment psychometric functions that are observed today, date as far back as the 18th century. Some developments have taken place along the way and the use of test results have also evolved from summative to formative ways. The introduction of formative assessment, as pointed out by Black (1996), was therefore intended to improve teaching and learning as well as curriculum development as the tests were designed to grade the learners for reporting purposes and for progression as well as to judge the degree to which subject outcomes are achieved by learners.

In South Africa, change in assessment was brought about by the Outcome Based Education (OBE) approach, which was introduced after the birth of the country's democracy in 1994. Then the Revised National Curriculum Statement (RNCS) (2002) aligned the school curriculum with the Assessment Policy published in Government Gazette No. 19640 of 1998. In that document, it is suggested that assessment in South African schools should provide indications of learner achievement in the most effective and efficient manner, and ensure that learners integrate and apply knowledge and skills. It is also highlighted that assessment should help learners to make judgements about their own performance, set goals for progress and incite further learning (Department of Education, 2003). According to Kanjee & Sayed (2008), even though assessment formed the basis of the National Qualifications Framework (NQF) and Outcomes-Based Education that underpinned the new education system, the assessment was the most neglected aspect of the new education system.

Mason (1999) argues that OBE intended to redress the legacy of apartheid by promoting the development of skills to prepare all learners for participating in the local democracy as well as in the increasingly competitive global economy. The National Curriculum Statement (NCS), as well as the new CAPS document, emphasize that assessment is an integral part of teaching and learning. As such, assessment is made to be part of every lesson and teachers are required to plan assessment activities to complement learning activities.

The curriculum change meant that assessment is not limited to sit-down examinations and tests as it has been done in the past, where it was only based on examinations in June and end of year examinations in December. The government policy on continuous assessment has been developed for that effect, and the main apprehension and prominence is on formative assessment. This study hopes to cement the demands for expanding how information on assessment can be used to support learning than just to give scores.

In the last two decades, educational research has been based on more consistent forms of assessment. According to Gipps (1994), this has led to a shift towards a broader assessment of learning with more teacher involvement in the assessment process and greater learner involvement during assessment. In order to ensure that the final assessment of the learner is not entirely based on the once off summative examination, the Department of Education in South Africa has also explored other alternate forms of assessment (Lubisi, 2002). As a result, Continuous Assessment (CASS) was introduced in the country's education system in 2001. The role of CASS was to remove the focus from end of year examinations to an assessment that is more continuous, school based and assesses skills beyond the domains of examinations (Broadfoot, 1984).

The Curriculum and Assessment Policy Statement (CAPS) document for Physical Sciences published by the Department of Basic Education (DBE, 2011) replaced the Revised National Curriculum Statement (RNCS) in January 2012. The CAPS document represents a policy statement for teaching, learning and assessment in South African schools. It is a single comprehensive Curriculum and Assessment Policy document that was developed for each subject to replace the Learning Program Guidelines and Subject Assessment Guidelines in Grades R-12. According to the new curriculum statement, assessment should be mapped against the content, concepts and skills and the aims specified for Physical Sciences. It is important to ensure that in the course of a school year:

- All of the subject content is covered
- The full range of skills is included and
- A variety of different forms of assessment are used (DBE, 2011)

Assessment is said to provide teachers with a systematic way of evaluating how well learners are progressing in a grade and in a particular subject. Learning is also driven by what teachers and learners do in the classroom. Over the years the link between assessments as carried out in the classroom with teaching and learning has become a crucial issue. Black & William (1998) reckon that present education policy seems to treat the classroom as a 'black box'. Inputs from the outside make demands and requirements that learners score highly in tests. The outputs that would hopefully follow are learners who are more knowledgeable, competent and scoring better results. In order to make sure that the output is positive depends on both the teacher and the learner not on the teacher alone as policies suggest.

Assessment for learning is a process in which teachers and learners provide feedback during instruction to organize the learning and teaching process in order to increase learners' achievement (McManus, 2008). In 250 studies from around the world that have been published between 1987 and 1998, it was found that a focus by teachers on assessment for learning as opposed to assessment of learning produced a substantial increase in learners' achievement (Black & Wiliam, 1998a). Wiliam (2004) has also discovered that teaching for deep understanding resulted in an increase in learner performance on externally-set tests and examinations.

What learners learn in class is not always necessarily what the teacher intended, therefore assessment can be regarded as the bridge between teaching and learning. According to Vygotsky (1978), only a small proportion of a child's cognitive development is self-constructed, the larger proportion comes from internalizing a successful performance seen in another person in their social environment or by working together with peers in the construction of more powerful strategies. In this view, the teacher provides appropriate and meaningful guidance and extension to the learners' experience by supporting the learners' attempts to make sense of their experiences and enables them to cross the zone of proximal development (ZPD). According to Wells (1999), zone of proximal development applies to any situation in which, while participating in an activity, individuals are in the process of understanding a topic. Assessment should help learners become more effective, self-directed and self-assessing (Angelo & Cross, 1993). This demonstrates that research on classroom assessment is central to the teaching and learning process.

The National Curriculum Statement regards assessment as an integral component of teaching and learning in Physical Sciences (Department of Education, 2003). For this reason, assessment should be part of every lesson and teachers should plan assessment activities to complement learning activities. Assessment cannot, therefore, be neutral with respect to what is taught and learned. It supports teaching and learning by providing both the teacher and the learner with insights into what the learner understands (Department of Education, 2003).

In Science Education, assessment is taken to concern the judging of the scientific capability, performance and achievement. In South Africa, assessment is one of the key areas of curriculum delivery. Curriculum 2005 advocates a radical change to what is considered “worthwhile” school knowledge, pedagogy and assessment.

Assessment is a critical issue in the teaching and learning of science and requires consideration by teachers. The assessment experience for many learners in the classroom, as noted by Niss (1993), is based on a behaviorist approach where discrete facts and skills are tested, where grading and ranking is the primary goals. Kilpatrick (1993) maintains that we need to understand how people come to use science in different social settings and how we can create science instructions that help them to use it better, more rewardingly, and more responsibly.

According to Kilpatrick (1993), this would require us to understand the crippling vision of mind as a hierarchy, school as a machine, and assessment as engineering. This further requires that multiple sources of assessment involve ways of presenting tasks to learners as well as different ways of probing assessment information so that valid inferences about learners’ progress can be made. Tasks can include a variety of formats: written, oral, and practical; can be closed or open-ended; real life or abstract; completed individually or as a group (Swan, 1993).

In the study, I investigated how learners who were exposed to assessment for learning performed in the teaching and learning process. The focus of the study was on teaching static electricity, to Grade 10 learners where dialogical argumentation was used as an intervention.

1.2 Motivation for the study

Various international studies have been conducted to evaluate learners’ performance in specific subjects in a global context and identifying the best-performing countries. The findings of the 2008 survey of the Programme for International Student Assessment (PISA) is used as a reference point. The survey focused primarily on the learners’ ability to comprehend and solve scientific problems, as well their progress in terms of performance in reading and mathematics. The survey revealed that learners from a more advantaged socio-economic background were more likely to show a general interest in science, as was the case in Ireland, France, Belgium and Switzerland. The factors identified to have contributed towards the good performance of learners in these countries were a low teacher-to-learner ratio, a quality assurance system and planning for assessment.

Reports on South African Grade 12 results over the past few years and findings from other surveys conducted on learner performance in South Africa, show a different depiction to the above. Christie (2008) reckons that despite many changes in the South African educational policy more than one decade after the implementation of Curriculum 2005, it is clear that the government both nationally and provincially is still struggling to provide quality education to all South Africans. This leads to one questioning the quality of education, teaching methods and assessment in our schools.

In other surveys: The Trends in International Mathematics and Science Study (TIMSS) report of 1999 and 2003 found South Africa's performance to be extremely poor, with learners achieving the lowest average scores in Mathematics and Science compared to all other participating countries, including those in Africa. In 1999 the average scale score for South African Grade 8 learners was 275, while in 2003 the learners scored 264 points out of a maximum of 800. The DoE (2009) found the scores to be well below the international average scale score. The findings of the TIMSS (2007) report are shown in the table below. The table below shows an illustration of the uninspiring performance of the South African learners in 2007 and also South Africa's weak overall performance when compared with other countries.

Table 1.1 *Educational rankings by least performance (TIMSS Report 2007)*

Least performing countries on TIMSS 2007	
1.	South Africa
2.	Philippines
3.	Chile
4.	Indonesia
5.	Iran

The statistical information obtained from the systemic evaluation report clearly indicates the need for improved quality of education with an emphasis on assessment. One of the greatest challenges facing the South African education system, along with assessment that provides the means to determine the performance of learners and the quality of the education received by learners is an improvement in the quality of learning output.

The Human Sciences Research Council's (HSRC) finding that the quality of education in South Africa is described as weak in comparison with other, even poorer countries was acknowledged as well by Newman (2008). As a result of the continuation of a decrease in science matriculation results, this study sought to investigate how argumentation and assessment for learning can be used to teach and assess selected science phenomena such as static electricity in order to improvethe status quo. The assessment determines whether learning has taken place, as well as the qualityof that learning and how learning and teaching can be improved. Therefore, it is believed that when assessment practices are of high quality, learning would improve.

It has also been highlighted by Harlen & James (1999) that formative and summative purposes of assessment have become confused in practice and that as a consequence, assessment fails to have a truly formative role in learning. Therefore, this implies that teachers are found to be treating all assessment as if it counts towards the summative aspect of the assessment. This is because teachers are unable to differentiate between the two types of assessment and that are focused on the completion of the syllabus rather than on ensuring that meaningful teaching and learning is taking place. Hence proper planning, guidance and knowledge about how to conduct an assessment in a formative way need to be addressed and that is one of the aspects that this study focused on.

The aim of the study was to suggest the use of dialogical argumentation-assessment for learning instructional model (DAAFLIM) so as to improve the quality of assessment practices in secondary schools. Assessment has an influence on the quality of education and quality education is one of the most valuable assets that a society and an individual could strive for.

1.3 Statement of the problem

Globally, education systems are currently undergoing transformational changes. In recent years, assessment has attracted increased attention from the international science education community. A review of the extant literature reveals that in the last two decades assessment has taken a prominent place in curriculum development, e.g., the Curriculum and Assessment Policy Statement (CAPS) Grades R-12 (DBE, 2011) has delineated the standards to be reached at every grade. Both the assessment literature and CAPS construe assessment as a catalyst for education as critical to the attainment of quality assurance.

The value that assessment can have in the process of learning as well as for grading work and recording achievement has been widely recognised. It provides a framework in which educational objectives may be set. According to the Association of Teachers and Lecturers in Britain (1996), assessment should be a powerful tool for learning, not merely a political solution to perceived problems over standards and accountability.

Learners do not begin to learn science as a blank board waiting to be filled. According to Bransford & Brown (1999), if the learners' prior knowledge is not taken into consideration, it is very difficult to reach a conceptual understanding. Therefore, there is a great need to plan and carry out the instruction based on the learners' existing knowledge. The purpose of assessment is to improve standards and not merely to measure them. As reported in the research article by Black &William (1998), this seems to be still a major weakness for many teachers in many schools around the world. The driving force behind this study was the possible resolution to the infusion of a dialogical argumentation teaching method with assessment for learning as an assessment strategy.

1.4 Research questions

The study endeavored to answer the following questions:

1. What conceptions of static electricity were held by Grade 10 learners before and after being exposed to dialogical argumentation-assessment for learning instructional model(DAAFLIM)?
2. What is the difference in performance and conceptions of static electricity held by the learners exposed to DAAAFLIM and those not so exposed?
3. To what extent are the differences in the learners' conceptions and performance of static electricity related to their gender, age and interest in science?

1.5 Significance of the study

The findings of this study envisioned to augment both current and further research data on how to improve assessment practices from a quality assurance perspective, in view of improving learning in South African schools. This was made essential by the weak performance of learners in South African schools in comparison with learners from other countries around the world.

A need for advanced exploration into the potential of context-based science teaching and learning for promoting understanding of scientific concepts and other higher order learning abilities and skills is still very much in demand. Continuous Assessment (CASS) was introduced in 2001 as part of an assessment system for the award of the senior certificate (Umalusi, 2004). This was done to remove focus from exam to a more continuous and school based that assesses skills (Broadfoot, 1984).

This study hoped to provide additional information from the learners' perspectives on the use of alternative assessment models. It is also anticipated that the dialogical argumentation assessment for learning instructional model used will help learners develop skills that will also assist them to solve problems in their daily lives and in other school subjects and not just in physical sciences. This study will also add to the body of knowledge on the quality of assessment in schools. I believe there is a need to improve the reliability and validity of assessment methods used in South African schools.

1.6 Limitations and Delimitations

Limitations were recognized during the data gathering and analysis. The specific limitations for the study need to be shared and stated so that the findings of the study can be read in the context of the limitations.

Learners at both schools in the study were English second language and the language of instruction was English and science was also taught in English, therefore the learners had problems expressing themselves during the argumentation lessons. According to Poliah (2009), if learners are limited in their understanding and use of English as the language of communication, teaching and learning, then language would become a barrier to the success of the intervention which depended heavily on discursive discourses. The learners were then allowed to use IsiXhosa and code switch whenever the need arose, to answer the questionnaires, as it was a language they felt comfortable in and their responses were translated into English.

The use of argumentation-based teaching and formative assessment tasks were a new experience for the learners. Therefore, a longer period of data collection was needed so as to promote familiarity of the teaching–learning method for the teachers and learners to form elaborated perceptions. It was noted by Hord (1987) that change is not an event but a process that often needs a long time to take effect. Hord further warns that possible and permissible change may be effected only to a limited extent because of demands placed on individuals dealing with change and the pressure to produce results from innovations.

1.7 Delimitation

Only learners were interviewed on the perceptions of using the DAAFLIM model of instruction and not the teachers who are the ones to implement the teaching and assessment model. The study was also limited to selected topics in static electricity and was taught to a limited group of Grade 10 physical sciences learners in the schools.

1.8 Thesis outline

This thesis is organized into five chapters. The first three chapters are the introduction, the review of related and relevant literature and the research design and methodology. The fourth and fifth chapters are dedicated to the data presentation, focus on the discussion of the results as well as the conclusions and outlining some considerations for future research and recommendations from the investigation. Below are the synopses for each chapter.

1.8.1 Chapter 1: Introduction

This chapter gives the rationale for this study and describes the role and importance of assessment in education and the need for alternative methods of assessment that can provide more information about learners' capabilities than traditional assessment methods. The chapter also presents the education reforms in terms of assessment procedures used in schools in the country. The research questions of the study are also examined and lastly, the significance of this study in science education as well as the limitations was provided.

1.8.2 Chapter 2: Review of related literature

Chapter 2 discusses the literature that was found to be relevant to this study. It reports on the history of assessment for learning and the differences between formal and informal forms of assessment. The chapter also looks at the problems associated with traditional forms of assessment, shows and justifies the call for alternative methods of assessment such as assessmentfor learning in a re-conceptualization of assessment of learners' learning.

Argumentation as an instructional tool for resolving conceptual conflict, benefits of using argumentation and the role of a teacher in an argumentation, lesson are also alluded to. The chapter ends with a discussion of the studies done on lightning and argumentation as well as beliefs and myths associated with lightning.

1.8.3 Chapter 3: Research design and methodology

This chapter focuses on the research design and methodology for this study. Steps taken to construct and validate the research instruments used in the study are clearly described and illustrated. It also describes the sampling procedures used to select the participants, the different instruments that were developed and used in the study, the administration of the data collection process and the data analysis. The chapter ends with a report on the ethical considerations that were undertaken.

1.8.4 Chapter 4: Results

This chapter presents and analyses the collected data qualitatively and quantitatively. The analysis of the data uses the analytical frameworks (TAP and CAT) that were found to be useful for this study.

1.8.5 Chapter 5: Discussion of results

This chapter encompasses a presentation and discussion of the results reported on in Chapter 4. This final chapter provides a summary of the main findings and answers to the research questions. It also gives a brief discussion of the findings, the conclusions drawn from the results, the recommendations based on the findings and suggestions for further research.

Chapter 2

Literature Review

2. 1 Introduction

This chapter presents the literature relevant to the study. Firstly, the restructuring of curriculum since 1998 will be discussed, followed by the beliefs about lightning in general and myths about lightning in South Africa, in particular.

Secondly, dialogical argumentation, its benefits, challenges associated with it and studies done on lightning and argumentation will be discussed. Thirdly, assessment for learning is discussed. This will be followed by the history of assessment for learning and research done on assessment for learning.

Then, the conceptual framework of dialogical argumentation and assessment for learning instruction model is discussed. This will then be followed by the discussion of the theoretical background and the theoretical framework underpinning this study.

2.2 Restructuring of curriculum in South Africa

One of the greatest challenges facing educators worldwide today is how to produce learners who are critical thinkers. Critical thinking can be fostered in the classroom by applying learner-centred instruction and assessment. Outcomes-Based Education (OBE) was implemented in South Africa in 1998 in the form of Curriculum 2005 (DoE, 2002). This approach was introduced in order to replace the traditional instruction approach with learner-centred and self-discovery learning. The development of critical thinking skills was adopted as one of the Critical Outcomes by the South African Qualifications Authority in 1997 (Pienaar, 2001).

Curriculum 2005 was revised in 2001 and introduced in schools the following year, as the Revised National Curriculum Statement (DoE, 2005). This revised curriculum statement also accentuated a learner-centred and activity-based education. Even though the changes were made in an effort to simplify and rationalise Curriculum 2005, teachers were still struggling to effectively implement the Revised National Curriculum Statement (RNCS).

In November 2009, the Minister of Basic Education announced the dearth of OBE. What came in its place in 2012 was what was believed to be an improved curriculum called the Curriculum and Assessment Policy Statement popularly known as CAPS. Some scholars such as Jones (2011) as well as Govender & Naidoo (2011) perceived this new curriculum as a classical curriculum which heightened the procurement of basic pedagogic skills in literacy and numeracy. The Department of Basic Education (2011) on the other hand believes that CAPS encourages an active and critical approach to learning, rather than the traditional rote learning by re-emphasizing learner-centred instruction in all subjects.

Rousseau (1928), who worked on and propagated self- activity and discovery learning, pointed out that learners learn more when they discover things themselves than just being told by the teacher. Ozmon & Craver (1995) discovered that ideas of learner-centred instruction through strategic questioning were researched about over 2000 years ago. Therefore, that means that learner-centred instruction does not originate from the modern era. Teachers though are still using the traditional way of teaching where teachers are in charge of the learning process and learners play a receptive role in their learning. Deblois (2002) reckons that learner-centred instruction means upending the traditional teacher-centred understanding of the learning process and puts learners at the centre of the learning process.

2.3 Beliefs about Lightning

The holding of scientific as well as traditional views of concepts is called collateral learning (Jegede, 1995) or harmonious dualism (Ogunniyi, 1988a). Jegede (1995) found that African learners learning western science and mathematics display certain traits that are not congruent with other learners learning the same. Lewin (1990) also wondered why children studying sciences in developing countries do not master more than a small proportion of the goals set for them.

The number of learners who pursue professions that require more science and mathematics is by far small in the developing countries when compared to those learners who are from the developed countries. Below is a table compiled by Kennedy (1993) which shows the number of scientists and engineers per million of population in different countries and or continents.

Table 2.1 *Number of engineers per million of population in different countries*

Country	**Number per million**
Japan	3.548
USA	2.685
Europe	1.632
Latin America	209
Asia	99
Africa	53

The above Table 2.1 clearly shows how African learners are the lowest number and at the bottom of the table in terms of producing scientists and engineers. People's behaviors are commonly in variance with what they believe. Scientific behavior on the other hand is based on stimulus-response and social influences. Most Black people go to witch doctors to be treated of ailments that scientific medical practices can handle. As people tend to solve problems in terms of meanings available in their sociocultural environment. These meanings are firmly implanted in their cognitive structures, manifest habitually and may be inhibitions to new learning (Ogunniyi, 1988b).

Jegede (1995) agrees that if the sociocultural environment of the learners is ignored, it becomes difficult for new learning to occur. Wilson (1981) then suggested that for science education to be effective it must take much more explicit account of the cultural context of society which provides its setting. Another challenge recognized by Waldrip & Taylor (1999) was the inability to harmonise science views with traditional views. In their study they found that secondary school learners who appeared to embrace the legitimized rationality of school science did not only lack traditional knowledge but also ridiculed the notion of traditional world views.

Jegede's (1995) paradigm therefore highlights the relevance of constructivism, where the learner constructs his or her own knowledge from new experiences using existing conceptual frameworks and the worldview the learner brings to the science classroom. He further suggests that the concepts to be learned must begin from where the learner is and what they already know. Yakobu (1994) and Cobern (1994) also noted that the differences in cultural perspectives must not be constructed to suggest that westernized scientific rationality is inherently good or that people must discard their indigenous beliefs in order to embrace it. Some beliefs about lightning are tabled below in Table 2.2.

Table 2.2 *Beliefs or misconceptions about lightning*

Belief	**Reason**	**Scientific explanation**
1. During thunderstorms iron nails should be nailed to tall trees and stuck to the ground with the metal touching the ground.	It is believed to protect people from dangerous effects of lightning.	Nails are metal therefore acting as lightningconductors.
2. Putting on red clothes during a thunderstom could cause one to be struck by lightning.	Lightning flash is a bit reddish in colour, therefore it is attracted by anything red.	There is no scientific explanation of this that has been proven.
3. Lightning is a big multi coloured bird.	Birds dive swiftly to catch chickens, therefore lightning occurs very swiftly striking down to destroy things hence it is compared to the bird.	No scientific explanation.
4. Mirrors should be covered during a thunderstorm or else lightning would strike the house.	Mirrors are shiny, therefore would attract lightning.	Has not been scientifically proven.

It is important to gather and take into account learners' prior knowledge and beliefs or cultural views that are brought to a classrom. While some of the views are scientific or may have some scientific explanations, some might not be scientific and might not have any scientific explanations.

2.4 Myths about lightning in South Africa

Lightning kills a lot of people in the country every year. Awareness of lightning safety needs to be a priority as research has shown that people get killed because they do not follow the proper safety precautions during lightning storms especially in the rural communities.

Rural houses are built in such a way that they have thatched roofs and that makes them more prone to be destroyed by fire, if hit by lightning. Cooper & Ab Kadir (2010) found that lightning injures more people than it kills, destroys properties and also kills livestock.

There has been a decline in the number of lightning deaths in other countries like the United States of America. This has been attributed to the effectiveness of their lightning awareness campaigns (Cooper, 2010; Holle, 2008; Lengyel, 2010). Therefore, with appropriate awareness about lightning, South Africa could also experience a decline in lightning injuries or deaths. The South African government has not done anything about the problem, even though it has been brought to their attention as far back as the 80's (Blumenthal, 2012; Dlamini, 2009;).

The beliefs or myths or misconceptions that people of South Africa have about lightning might be another reason why it is difficult to introduce lightning awareness education as people have their own traditional beliefs about lightning. The most common lightning myths in South Africa are that lightning is caused by witches, putting a tyre on a roof protects one from lightning and shiny things attract lightning.

1. **Lightning is caused by witches**

This is the most common myth about lightning. People believe that witches can send lightning to kill their enemies and only a sangoma (traditional healer) can save you or take away the spell or protect you from getting struck by lightning sent by witches by making you strong and can cause lightning to change direction and no longer come to your house.

2. **Putting a tyre on the roof**

There is a strong belief amongst South Africans that if you place an old car tyre on the roof of your house, you will be protected from lightning. When I asked my grandmother how a tyre protects the house from lightning, she said that the tyres protect you from lightning when you are inside a car during a lightning storm therefore that is the same reason tyres are placed on top of the roof. It is also believed that burning a piece of tyre in the house during a lightning storm will chase the lightning away.

Pabale (2006) also found in his study that it is a common belief for parents to tell their children that a tyre put on the roof protects against lightning. According to Physics, tyres have no protection abilities. It is actually the metallic body of the car that offers protection against lightning.

3. **Covering mirrors**

Another popular misconception about lightning is that we must cover all mirrors in the house during a lightning storm as it is believed that mirrors attract lightning . They believe that any shiny objects such as pots and other items, attract lightning and therefore, should be covered when there is lightning.

2.5 Dialogical Argumentation and its Benefits

In a dialogic classroom, teachers and learners act as conquerors where they collaboratively, as noted by Burbules (1993), engage in generating and evaluating new interpretations of situations in order to gain a fuller appreciation of the world as well as themselves. Black & William (1998) are of the opinion that quality teaching involves providing quality feedback to learners to assist them with arguing from evidence to explanation. Argumentation is believed to feature prominently in real- life practices and can help learners to learn core content.

Teachers can engage learners in a collaborative deliberation of complex questions and support the development of learners' thinking by making their classrooms more dialogic. Educational researchers, such as Alexander (2008) and Cazden (2001), have for many years criticised recitation as a prevalent instructional approach to conduct lessons as the teacher is regarded as the ' only one who knows'. These researchers also reckon that through recitation, teachers ask known information questions and therefore control the key aspects of communication. This is then believed to impede learner engagement and learning at higher levels of cognitive complexity. Hence, this research suggests that communication in the classroom needs to be more dialogic.

Argumentation plays an important role in the teaching and learning process. According to Chinn & Clark (2013) engagement in argumentation can result in educational benefits that include: motivation, content learning, argumentation skills and knowledge building practices. These education benefits are discussed in the subsections below.

2.5.1 Enhanced motivation

Although there is some more research that is needed to be done on the topic, Chinn (2001) found in his study when comparing learners who engaged in argumentation with those being taught using traditional lessons that learners who engaged in argumentation talked more and showed greater eagerness to talk. Motivation is increased through argumentation because learners have more autonomy over what they say in an argumentation- based discussion than in traditional- led recitation where teachers tightly limit learners to answer their numerous questions. Argumentation also provides an opportunity to learners to interact more with their peers and allows them to share their different ideas.

2.5.2 Content learning

Researchers such as Andriessen (2006) and Schwarz (2009), have distinguished between learning to argue and arguing to learn. When learners engage in argumentation it is for the purpose of mastering content about which they are arguing. For example, when learners engage in argumentation about how to explain results of experiments with electric circuits, they may learn something general about how to construct arguments, counter arguments and rebuttals and they may also learn core ideas about electric circuits, such as Ohm's law. Therefore the focus is on content learning, learning the core concepts.

McLaren & Scheuer (2010) also did studies that also demonstrated that collaborative argumentation can promote content learning. McArthur et al. (2010) also provided evidence from a sixth grade project who did a topic of American immigration that learners with or without learning disabilities gained in knowledge immigration from an instructional intervention that featured argumentation as part of the intervention.

Asterhan & Schwarz (2007) also found that undergraduates who engaged in argumentation about evolution theory showed more gains in understanding the evolution theory principle than undergraduates who simply collaborated without encouragement in argumentation. Sampson & Clark (2009) investigated high school learners' learning about melting through argumentation. Learners who engaged in argumentation demonstrated greater mastery of ideas about heat and temperature than learners who wrote arguments individually but did not engage in collaborative argumentation. Collaborative argumentation therefore appears to have benefits over and above individual argumentation.

2.5.3 Improved argumentation skills

Various researchers, for instance Kuo & Anderson (2007), Kuhn (2008) and Kim & Li (2008), have documented that instructional methods that engage learners in argumentation help them learn to argue and evaluate arguments better. Zohar & Nemet (2002) similarly demonstrated that engagement in collaborative argumentation in genetics promotes the ability to write written arguments on both similar and different topics.

In a series of studies, Kuhn and her colleagues developed methods for providing instruction in general argumentation. Components such as counter arguments and rebuttals paired with extensive opportunities to engage in argumentation. The results of the studies showed that learners who learn to argue and practice argumentation become better at arguing including on new topics being taught.

2.5.4 Knowledge Building Practices

Argumentation plays a role in knowledge building practices. Vygotskian (1981) explanation for knowledge building practices is that when people learn to think, the functions of their thinking first appear in a social plane and are only later internalized by the individual. This means that on the social plane of collaborative argumentation, learners learn that their positions may be challenged with counter arguments and that they need to revise their position in response to the counter argument or develop rebuttals for the counter arguments.

When using argumentation, learners are driven by cognitive conflicts which arise between their views and those of others. This makes the learner think about their own process known as metacognition (Shakespeare, 2003). Piaget in Lawson (2003) describes this cognitive conflict as the shock that arises when an individual encounters ideas of others that are different from their own and the learner might get a desire to validate those ideas and that is how a person develops intellectually.

2.6 Role of the teacher in argumentation

The idea of argumentation may lead to the impression for some that learners are left at will to engage in meaningless dialogue. According to Shakespeare (2003), the teacher plays a vital role in ensuring that resolutions and coherent conclusions are reached. It is also of vital importance that learners never leave the classroom with false ideas as the aim of argumentation is to present learners with as many ideas as possible to sustain an argument.

It is the duty of the teacher to also alert learners that a claim should not just be accepted simply because it is a view of someone else. Ideas should always be coupled with suitable scientific evidence. Teachers are cautioned by Shakespeare (2003) that although learners may encounter many different and conflicting ideas they should not be led to believe that in science there are many answers to a particular question but should be educated to seek the most credible answers and ultimately realise that there is one answer that is the most acceptable. In light to this, teachers have to ensure that a satisfactory resolution is reached.

2.7 Challenges associated with argumentation

Research that has been done in science learning regards argumentation as a fundamental aspect of the discipline. Argumentation is said to expose and address inconsistencies between ideas and evidence (Kuhn, 1993; Dushl, 2007). Berland & Reiser (2009) synthesized that when individuals engage in argumentation, they make sense of phenomena, articulate understandings and persuade others of their ideas. This requires them to then construct and support claims using evidence and reasoning and challenge other's ideas or claim, evidence or reasoning.

The work of Kuhn et al. (2000) demonstrated that higher levels of argumentation abilities were rarely seen in school children and that was viewed as a result of deficiency in reasoning abilities of the children. In their study, Kelly et al. (1998) asked high school learners to engage in argumentation and their results revealed that the learners warranted their claims when they experienced a lack of shared understanding with their peers.

McNeil & Pimentel (2010) found that when they compared three classes who received the argumentation process, the learners when asked open ended questions their arguments were more thorough and they engaged with other learners substantively as compared to the other groups not so exposed to argumentation.

Kuhn (2010) investigated the cognitive challenges when learners participate in argumentation and found that learners were able to rebut counter- arguments but were not so spontaneous. Therefore, it was suggested by Reiser (2006) that teachers should create a learning environment where learners' understanding of the purpose of the discussion aligns with scientific argumentation.

2.8 Science as an argument

Duschl (2008) and Berland & Reiser (2009) are some of researchers who are widely endorsing and advocating the conception of science as an argument to be a frame for science education. Eduran (2015) and Bricker & Bell (2009) regard argumentation as an epistemic practice of science education as it should not only be about mastering the science concepts but also learning how to engage in scientific discourse.

Shifting the dominant focus of teaching from what we know to a focus that emphasizes how we know what we know and why we believe what we know requires a different classroom culture and discourse environment. An assessment design challenge is to provide teachers and learners with tools to help them build budding forms of argumentation to develop more revolutionary and rational specific knowledge claims.

Science education seeks to move away from the implementation of discrete single lessons that seek outcomes related predominantly to learners' concept learning regarding facts and principles. Sawyer (2006) is one of the many researchers that emphasizes the importance of supporting the development of complex reasoning amongst learners.

Argumentation has three recognized forms: analytical, dialectical and rhetorical (van Eemeren, 1996). Analytical arguments are said to be grounded in the theory of logic. In an analytical approach, an argument proceeds inductively from a set of premises to a conclusion. Dialectical arguments occur during discussion and involve reasoning with premises that are not evidently true as they are part of the informal logic domain. Both dialectical and analytical represent high quality scientific argumentation. Rhetorical arguments are oratorical in nature and they are represented by the discursive techniques employed to persuade an audience. All these three forms of arguments are used in science as theories that are refined and justified.

2.9 Argumentation as an Instructional Tool for Resolving ConceptualConflicts

Argumentation requires learners to engage with data or evidence, to make claims based on these and to weigh the extent to which others' claims can be substantiated (Erduran, Simon & Osborne, 2004). Through dialogical argumentation the teacher is able to attend to the learners' points of views as well as to the school science view. Toulmin (1958), cited by Simon, Osborne & Erduran (2003), describes a good argument as one that supports a particular point of view in a logically consistent manner. However, not all arguments are amenable to logical reasoning since learners hold multiple worldview conceptions of natural phenomena.

Teaching science involves introducing learners to the ways of talking and thinking of the science community. In light of the above, it is believed that argumentation helps teachers to move from a situation where learners understand little or nothing about science concepts to one where they are able to talk and think about the concepts themselves. A cross-cultural instructional approach integrates school science with knowledge customary in the socio-cultural environment of the learners. It combines scientific and traditional worldviews about natural phenomena in a holistic manner. According to Aikenhead & Jegede (1999), learners negotiate and resolve cognitive conflicts caused by infusion of school science and traditional views through cognitive border crossing.

If learners are not given the chance to talk to one another and debate their ideas, it makes it difficult for them to learn science concepts. Therefore, argumentation is essential to understanding the nature of science. Newton, Driver & Osborne (1999) and Driver, Newton & Osborne (2000) have strongly expressed that argumentation is a critically important epistemic task and discoursed process in science.

The central role of argumentation in doing science is to engage learners in strategies that enhance decision-making about controversial issues in science, and to do so they need to understand how evidence is used to construct explanations. They also need to understand the criteria that are used in science to evaluate evidence. These views are also supported by psychologists and philosophers of science such as Kuhn (1993) and Siegel (1995), as well as science education researchers such as Kelly et al. (1998) and Lemke (1990) who studied the discourse patterns of reasoning in science contexts.

Argumentation is also seen as a reasoning strategy and it also falls under the general reasoning domains of informal logic and critical thinking. There is increasing evidence in science education that argumentation is a powerful strategy for teaching and learning (Kuhn, 2005). Argumentation requires learners to engage with data and evidence, to make claims based on these and to weigh the extent to which other's claims can be substantiated (Erduran et al., 2004).

Through dialogical argumentation, the teacher is able to attend to the learners' points of views as well as to the school science view. In Simon et al. (2003), Toulmin (1958) describes a good argument as one that supports a particular point of view in a logically consistent manner.

Argumentation is a process of linking evidence to a claim. Kuhn (1992) noted that it requires learners to externalise their thinking therefore, as pointed out by Erduran et al. (2006), when they understand the relationship between claims and warrants, their ability to think critically inscientific concepts is sharpened.

Learners should be able to engage in decision-making about controversial issues in science, and to do so they need to understand how evidence is used to construct explanations. They also need to understand the criteria that are used in science to evaluate evidence. Therefore, there is a need for them to be educated about the scientific world-view – seeing science as a distinctive and valuable way of knowing. This shift in emphasis requires that teaching of science focus more on the nature of science and on the evidence and arguments for scientific ideas, and help learners develop skills of engaging in prolific argumentation.

Teaching of argumentation through the use of appropriate activities and teaching strategies can provide a means of promoting a wider range of goals, including social skills, reasoning skills and the skills that are required to construct arguments using evidence (Osborne, Erduran & Simon, 2004b; Simon, Erduran & Osborne, 2006). To change the emphasis in teaching science to incorporate argumentation, as pointed out by Mortimer & Scott (2003) and Alexander (2005), educators must adopt a more dialogic approach that involves learners in discussion.

Argumentation is central to the study as the intervention as it is hoped that it helps learners to use their indigenous knowledge to understand the scientific explanation about certain concepts.Studies have shown that learners from socio-cultural backgrounds experience school science differently than those otherwise exposed. Dialogical argumentation as a teaching and learning method, therefore, is proposed to facilitate the border crossing.

2.10 Studies done on lightning and argumentation

Moyo (2012) did a study where he wanted to determine the relative impact of an argumentation based instructional intervention programme on Grade 10 learners' conceptions of lightning and thunder. The argumentation based intervention programme was designed and used to help learners to develop argumentative skills to negotiate and harmonise divergent and conflicting explanations of the nature of lightning and thunder that are propounded by science and Indigenous Knowledge.

The case study used 16 Grade 10 IsiXhosa learners from the Eastern Cape. Questionnaires, interviews and activities were used to gather information on causes, dangers and prevention of lightning. Observation schedules and a science achievement test as well as field notes were also used as sources for data collection.

Findings of the study were that argumentation based instructional intervention programmes helped learners to develop argumentative skills and use them to navigate and synchronise different and contradictory explanations of the nature of lightning. The study also showed that argumentation based instructional intervention programme can broaden, strengthen and deepen the learners' understanding of lightning. The learners were able to challenge each other's arguments and also collaborated with each other to build stronger arguments. Also emanating from the study was that there is a need to support the implementation of the policy of integrating school science with Indigenous Knowledge, using argumentation.

Nanghonga (2012) did an investigation on how Grade 8 learners make sense of static electricity through exploring their cultural beliefs and experiences about lightning. This study was conducted in the rural areas in Northern Namibia. The researcher wanted to find out whether learners' understanding of static electricity was enabled or constrained by integration of their cultural beliefs and experiences about lightning.

Data was gathered through document analysis, brainstorming, discussions, semi-structured interviews, observations as well as assessment tests. During the analysis of data, it was revealed that in the Namibian science curriculum there is no learning objective that requires learners to bring in their cultural beliefs and experiences about lightning.

The study also revealed that learners possess a lot of prior everyday scientific and non-scientific knowledge and experiences acquired from their communities about lightning. When learners were engaged in practical activities in static electricity, it helped them to understand the scientific concepts.

Nkopane (2006) focused on identifying and finding the impact of Grade 8 learners' alternative conceptions of lightning. There were 33 learners who took part in this qualitative study. Some of the learners in the study believed that lightning was a result of witchcraft, and it demonstrated the anger of the ancestors. This led to the researcher suggesting that the learners' conception was a hindrance to the learning of science because learners' cultural identity is often different from the culture of conventional science.

As they experience a cultural clash when they attempt to learn science, therefore the learners chose to believe that the African conception prohibits them from learning the Western conception. The researcher therefore indicated the need for a teaching model, aimed at helping educators deal with misconceptions instead of wanting to change a belief system.

A study on the effect of cross- cultural instructional approach on learners' conceptions of lightning and attitude towards science was done by Liphoto (2010). In the study he explored the Basotho's (people from Lesotho) conceptions of lightning and thunder. The learners in the study were introduced to the scientific interpretation of lightning in the Lesotho science curriculum using a cross-cultural instructional approach which is based on Jegede's (1995) cross-cultural pedagogical paradigm. The approach used a combination of knowledge about lightning prevailing in the learners' socio-cultural environment with school science.

Findings of the study revealed that:

- Learners had both scientific and traditional views about lightning even before being exposed to cross-cultural instructional material.
- Some learners believed in the humanistic behavior of lightning
- There were learners whose conceptions of lightning and thunder oscillated between scientific and traditional worldviews.
- The groups that were exposed to the cross-cultural instructional approach were found to be more elaborate in their explanations of the scientific phenomenon than those groups that were not so exposed.
- The learners attributed their perceptual shift and positive disposition towards science in terms of the empirical nature of science while also arguing that cultural practices were based on their cultural beliefs.
- The study recommended that all stakeholders should deliberate on the rational and mode of integration between the two views.

Another study investigated the effect of an Argumentation Instructional model on pre-service teachers' ability to implement a science-IK curriculum in selected South African schools. Siseho (2015) examined what instructional practices pre-service teachers engage in when they introduce scientific explanation and whether those practices influence learners' ability to construct scientific explanations during a natural sciences lesson.

The study questioned how teachers interpreted and implemented IK in the science classroom. Three pre-service teachers were followed into their classrooms to investigate how they use argumentation instruction as a mode of instruction and what approaches, relevant to the inclusion of IK, were developed; and it was found that the three teachers used different approaches which incorporated IK into the science classroom.

One teacher used the assimilation approach which introduces IK into science by seeking how best IK fits into science. The second teacher used a segregation approach which holds IK side by side with scientific knowledge. The third teacher applied an integration approach which makes connections between IK and science. It was concluded in the study that the type of approach used by the teachers was due to the individual teachers' cultural background and world views.

2.11 Assessment for learning

The word 'assess' comes from the Latin verb '*assidere*' meaning 'to sit with'. In assessment, one is supposed to sit with the learner, which implies that it is something that we do with and for the learner and not to the learner (Green, 1998).

Assessment for learning is defined by McManus (2008) as a process in which teachers and learners provide feedback during instruction to organize the learning and teaching process, in order to increase learner achievement. According to Miller & Lavin (2007), assessment for learning can be viewed as a valid and vital part of the blending of teaching and assessment. Formative assessments inform teachers about whether the students have learned and they have an indicator qualification for how the teachers should plan their next lessons (Wuest & Fisette, 2012).

Assessment in education is about gathering, interpreting and using information about the processes and outcomes of learning. Assessment takes different forms and can be used in a variety of ways, such as to test and certify achievement in-order to determine the appropriate route for learners to take through the differentiated curriculum or to identify specific areas of difficulty or strength for a given student. Assessment is an integral part of learning and is one of the most powerful educational tools for promoting effective learning. Research by Black & William (1998) reveals that successful learning occurs when learners have ownership of their learning and when they understand their goals and are motivated to achieve success. Good assessment takes into account learning styles, strengths and needs of the learner.

Assessment for learning is more commonly known as formative and diagnostic assessment. Formative simply means that the assessment is carried out frequently and is planned at the same time as teaching. Assessment for learning is the use of a task or an activity, for the purpose of determining student progress during a unit or block of instruction. Teachers are now afforded the chance to adjust classroom instruction, based upon the needs of the students. Similarly, students are provided valuable feedback on their own learning (Angelo & Cross, 1993). Assessment for learning is said to be appropriate in all situations, as it helps in identifying the next step to build on success and strengths as well as to correct weaknesses.

An essential component of formative assessment is learner's self-assessment (Sadler, 1989). Therefore, for assessment for learning to be productive, learners should be trained in self-assessment so that they can understand the main purposes of their learning and grasp what they need to achieve. In a class where assessment for learning is practiced, learners are encouraged to be more active in their learning and associated assessment.

2.11.1 History of Assessment for Learning

Assessment for learning was originally conceived as formative assessment and placed in contrast to summative assessment. Scriven (1967) proposed the terms formative and summative to explain the two distinct roles that evaluation could play in evaluating the curriculum. Bloom (1971) suggested applying the same distinction to evaluate how learners learn referred to as assessment. Bloom (2001) suggested that summative assessment should focus mostly on summing up or summarizing achievement of learners in their classes as well as in the whole school. According to Shavelson (2006), formative assessment centers on the active feedback loops that assist learning. Black & William (2004) began to refer to summative assessment as assessment of learning and formative assessment as assessment for learning.

Since Scriven's (1967) identification and Bloom's (2001) extension of summative and formative assessment types, the interest in summative assessment has bettered that bequeathed upon formative assessment. Sadler (1989) boosted the interest in assessment for learning, which appeared to be corroborated with Fusch & Fusch's (1986) analysis and Black & William's (1998) comprehensive review of about 250 articles, which reported considerably the positive gains in learner learning. Black and William's (1998) work established the gains of full deviations with the low achieving learners making the largest proliferation. In 2007, international researchers in assessment for learning identified five attributes of the assessment for learning process to be that:

1. Learning progression should clearly articulate the sub goals of the ultimate learning goal.
2. Learning goals and success criteria should be clearly identified and stated to learners.
3. Learners should be provided with evidence- based feedback that is linked to the intended instructional outcomes and criteria for success.
4. Self and peer assessment are important for providing learners with an opportunity to think metacognitively about their learning.
5. A classroom culture in which teachers and learners are partners in learning should be established.

A mounting tide of enthusiasm for assessment for learning is apparent in education research and practice since Black and William have continued to highlight positive impacts on learner learning at various grade levels and in different content areas.

The garden analogy, as described by Crooks (2001), is that, if we think of our children as plants; summative assessment of the plants is the process of simply measuring them and that does not affect the growth of the plant and formative assessment is the equivalence of feeding and watering the plants appropriate to their needs, therefore directly affecting their growth.

2.11.2 Research done on assessment for learning in other countries

According to Altman (2010), twenty-five states in the United States of America use assessment for learning at schools as official policy. This is regarded as an indispensable strategy for reaching the targets set in numerous countries and for acquiring qualifications in education. Klinger *et al.* (2012) did studies in Finland, Germany, Sweden and Spain where they found that the importance of assessment for learning is highly emphasized in these countries as well as the need of constant assessment of each learner using diverse assessment methods such as verbal feedback.

Many other countries have developed guidance books in order to assist teachers in implementing a more methodical practice of assessment for learning. An assessment for learning program was introduced in pre-school and primary school levels in England in 2000. Similarly, in Scotland, teachers are encouraged to use assessment for learning in the processes of teaching and learning. New Zealand as well has grounded its National Assessment Strategy that was implemented in 1999 on assessment for learning. In many cities in Canada, assessment for learning is viewed as the most critical assessment strategy.

Koh *et al*. (2010) in Singapore established that assessment for learning also contributes to the professional development of teachers as well as to learner learning by transmitting professional development practices to their lesson planning and how they teach. They also found that as part of assessment for learning, teachers use a variety of assessment activities and approaches in the classroom to gain comprehensive insight into how much learners learn and in addition to providing feedback to the learners, teachers analyze the information, comment on it, and use it to review and organize teaching. Berry (2008) describes learners as being active information providers as they not only participate in learning and teaching activities, but also use assessment information to identify goals and make decisions about their own development.

In order for learners to be active participants in the teaching- learning process, the teacher needs to share the goals of the lesson with them at the beginning of the lesson (Heritage, 2008).

According to Lombard & Schneider (2013), this gives the learners responsibility for their own learning, giving each one a chance to create their own knowledge of the subject, to work together with their peers and the teacher. Ritchhart (2011) also says this helps to expand the learners' framework and to move toward more complex knowledge and understanding. Moss & Brookhart (2009) noted that one of the benefits of sharing learning goals and outcomes with learners is that they are given tasks in alignment with the goals of the lesson.

Obtaining information about learners' learning and understanding is crucial in assessment for learning and can be attained through asking questions. McMillan (2014) trusts that this objective can be achieved if the questions are active and effective at determining the learner's depth of knowledge. Teachers spend one- third of their teaching time asking learners questions, according to Borich (2014), about fifty or more questions are asked both in elementary and secondary school classrooms during lesson time. This deep focus on a single strategy shows both its suitability and perceived effectiveness.

Hattie & Timperley (2007) reckon that feedback is at the center of assessment for learning. The influence of assessment for learning arises from the strength of the feedback provided to learners about their learning and to teachers about their teaching (Palma & Hefferen, 2015). According to Shute (2008), formative feedback is information communicated to learners that inspires them to shape their opinions in order to improve their learning. Luckett & Sutherland (2000) also emphasize that feedback provided through assessment for learning has noteworthy benefits when motivating learners, it helps learners improve their learning and reinforce their work.

Teachers should not be treated as the only source of feedback. Andrad (2015) trusts that self and peer assessments when taught carefully can guide learners on how to provide their own constructive and learning-oriented feedback. This process helps learners to criticize their own work according to clearly stated expectations which are provided as aims or objectives of lessons.

Harrison & Harlen (2006) also point out that self-assessment is one of the critical components of assessment for learning because it helps learners participate directly in the learning activities. Kollar & Fischer (2010) ascertain that peer feedback is another way for learners to comment on other learners' work and believe that it is also influential in creating a more participatory learning culture within the learning environment.

Hattie (2009) evaluated 800 meta-analysis studies on educational factors based on their impact size. The assessment included 52,637 studies and 146, 142 effect sizes which investigated the effects of educational factors on learners' academic achievement. The research results revealed that assessment for learning was the third most influential factor among 138 factors for learners' achievement whereas feedback, which is one of the most significant elements of assessment for learning, came in at eighth place.

Dunn & Mulvenon (2009) and Kingston & Nash (2011) conducted two more meta-analyses studies in 2009 and 2011 regarding assessment for learning. These studies were critically evaluated by Bennett (2011); Shepard & Yin (2012); Filsecker & Kerres (2012); McMillan & Varier (2013) and they found several methodological problems in the research, and it was clear that more studies should be conducted to examine the effects of assessment for learning on academic achievement. This study is hoping to achieve such. Florez & Sammons (2013) also suggested in their critique that the impact of assessment for learning on achievement, attitudes, classroom behavior and participation of learners should be measured.

In another study by Heitink, Van der Kleij, Veldkamp, Schildkamp & Kippers (2016)**,** a systematic valuation was made to evaluate assessment for learning. At first, 25 studies were selectedaccording to inclusion and qualification criteria in the study. From these studies, it was found thatthree studies had high quality and that the number of qualified studies related to assessment for learning was limited. The studies selected, mostly used only qualitative research design and this study is therefore expected to contribute significantly to filling a gap in the literature using both qualitative and quantitative research methods.

In Turkey, studies on assessment for learning have been conducted since 2009. In experimental studies with secondary school students, Buldur (2014) examined the effects of the assessment process for formation performed with performance-based techniques on learners and teachers. It was concluded that the experimental procedure process increased the learners' perceptions of learning-oriented assessment environments and decreased their performance-oriented assessment environment perceptions.

The perceptions of the learners in the experimental group toward the experimental process on the assessment tasks were effective in terms of complying with planned learning, transparency, and considering learners' differences. Qualitative findings showed that a large proportion of the learners in the experimental group had positive views on the assessment approach in the experimental process and that they would like to be similarly assessed in future science lessons. When the results of the teacher in the study group were examined, it was determined that the teacher realized the effectiveness of assessment for learning after experiencing the process that gave prominence to the diagnostic assessment before the experimental process.

Another study was done by Bulunuz, Bulunuz & Perker (2014), where they examined the effects of assessment for learning on how eighth-graders learnt physical science concepts. One hundred and ninety-seven learners participated in the study. According to the results of the research, assessment for learning significantly increased the learners' level of understanding of the basic physical science concepts.

Bulunuz & Bulunuz (2016) conducted another study that examined learners' conceptual understanding of inertia. They found out that learners know that objects that either stop or have constant velocity have inertia. The same learners were discovered to have little understanding of the fact that objects that either accelerate or slow down, have inertia as well. As a result of assessment for learning based instruction, the learners were able to understand that if a vehicle decelerates or changes its direction has inertia. The results of the analysis of the study shows that assessment for learning would improve the ability of the learners to organize their own learning.

Bala (2013) wrote a master's thesis intending to determine the contribution of assessment for learning practices in addition to the chalk and talk approach that is commonly used in teaching the topic "structure and properties of matter" in a seventh-grade science class and a technology class. The study was conducted for six weeks with 44 learners in a secondary school. In both groups, the same activities were prepared and the chalk and talk method was used. The researcher developed some quizzes for assessment for learning and used them only on the experimental group. The results of the research revealed that assessment for learning that was added to the chalk and talk approach had a positive contribution.

According to these studies, assessment for learning is said to have a positive effect on learner behavior with regards to learning outcomes. Assessment for learning is tiered at the top of the list in studies that compare teaching strategies, and techniques in terms of the degree of influence on learners' academic achievement. Related meta-analysis studies have also shown that assessment for learning has a high impact scope in terms of learner success.

In other studies done on assessment for learning, McCroskey & Richmond (1992) remarked that the effect of assessment for learning interventions in the classroom is that learners keep learning and remain confident so that they continue to learn at productive levels with life-long benefits.

Johnson & Johnson (1996) noted that embedded within the assessment for learning classroom is discipline and cooperative learning behavior. Cooperative learning acts as a catalyst for higher achievement and more positive relationship among the learners. Sparks (1999) pointed out that the two important things that teachers must note are firstly, that they must clearly articulate the achievement target that they want learners to hit and secondly, if there is knowledge to be mastered they need to openly communicate with the learners. Findings by Xue & Bickel (2003) and Rodriguez (2005) confirmed that the most significant discovery on the use of formative assessment is the increased improvement for low achieving learners.

There have been some studies that are critics of assessment for learning in recent years. These studies, such as Bennett (2011); Brigg (2012); Filsecker & Kerre (2012) and McMillan (2013), have indicated that selected studies for meta-analysis are problematic in terms of the principles of methodological and constructive assessment, and that qualitative and empirical work on assessment for learning is needed. From this point of view, it is anticipated that this study, which examines the effect of dialogical argumentation and assessment for learning practices on Grade 10 learners' academic achievement, attitudes towards static electricity lessons in physical sciences classes might contribute to the related literature.

2.12 Dialogical Argumentation Assessment for Learning Instructional Model (DAAFLIM)

Research studies that have been done on the Dialogical Argumentation Instructional Method (DAIM) have shown that the method does not extrinsically include assessment strategies. Taking from the shortcomings of DAIM led to the formation of the Dialogical Argumentation Assessment for Learning model (DAAFLIM). This model was developed by doctoral students at the SIKSP group at the University of the Western Cape in South Africa, who have done their Masters Research studies using the DAIM.

DAAFLIM places emphasis on and addresses the disconnection between the ways of assessing during the different stages of a DAIM lesson. This is done by using Assessment for Learning (AFL) strategies as stimulated by the work of Black & William (2009). DAAFLIM provides the critical formative feedback to make sure that the objective of the learning activity is met during each DAIM process.

2.12.1 The stages of the DAAFLIM

The DAAFLIM comprises of six stages of cyclic swirls arranged in increasing sizes of a shell. All the swirls start at the nodal point. The symbolic representation of the cyclic swirls in the model provides space for a return to any stage of the discussions and arguments if required. In the DAAFLIM, the AFL-strategies are incorporated into the DAIM process as shown in the figure below.

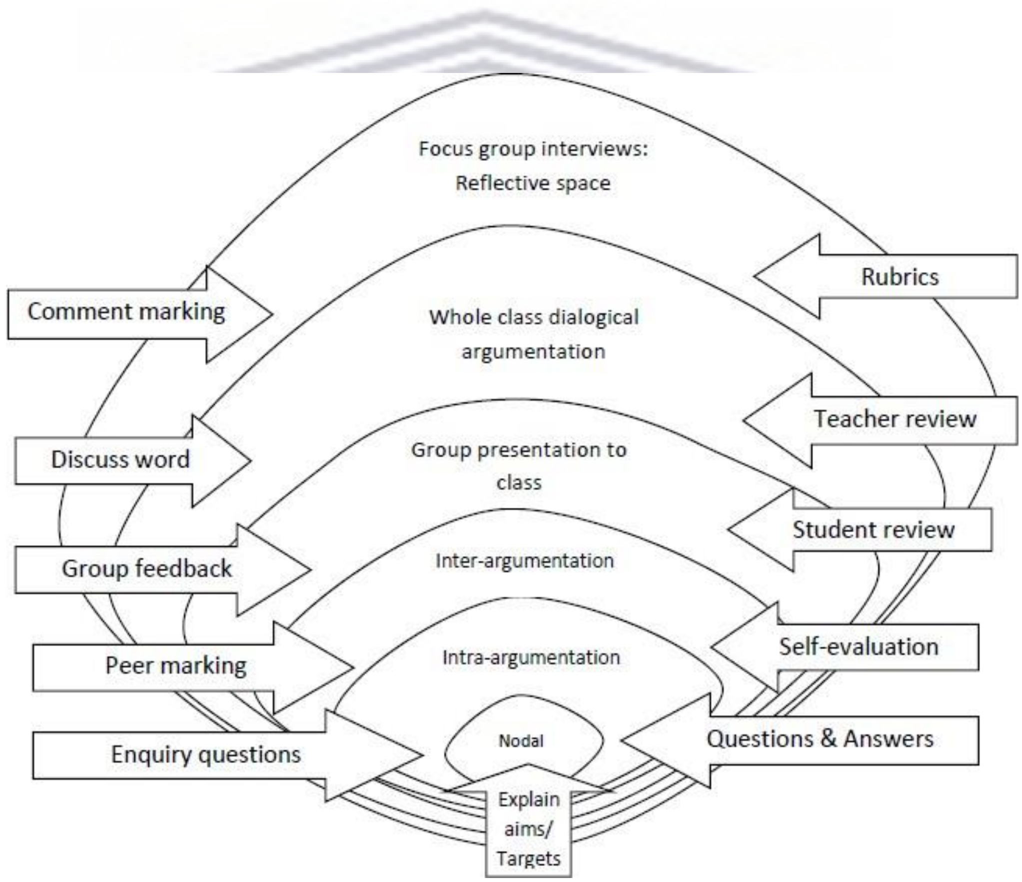


Figure 2.1 *The DAAFLIM Model*

The six different stages of DAAFLIM are discussed below. During each stage the teacher employs an AFL strategy so as to track the performance assessment at that particular point of the DAIM. The nodal point is where the topic of the activity is presented.

Stage 1: DAIM- Nodal point: Introduction of the topic of discussion or activity.

AFL strategy – Learners use the KWL chart to state what they Know, what they Want to Know and what they have Learned. The teacher makes the aims of the lesson clear to the learners.

Stage 2: DAIM- Individual task (intra-argumentation) – Allows for individual thinking space.

Each learner is provided with stimulus material, then the learner is prompted to engage with the material through a set of questions. These questions promote internal argumentation (intra-argumentation). An accessible writing frame is provided to thelearner to record claims, backings, warrants and rebuttals.

AFL strategy – Self-evaluation and enquiry questions

Stage 3: Small group discussion (inter-argumentation) – Allows for individual sharing space with other members of the group (inter-argumentation). Each learner is invited to present his or her ideas, thus encouraging each group member's voice to be heard. After the group debate, an internal consensus (cognitive harmonization) is achieved for presentation to the class.

AFL strategy – Peer marking and group feedback

Stage 4: Small group presentation – Allows for general discussion space. The group leader presents the arguments, counter-claims, rebuttals, evidence and warrants.

AFL strategy – Learner review and words discuss

Stage 5: Whole class mediation – Allows also for general discussion space. This process is managed by the facilitator (teacher), who assists in identifying trends and patterns by advancing a cognitive harmonization.

AFL strategy – Teacher review

Stage 6: Focus group evaluation – Allows for a reflective space. An interview process, managed by the facilitator, is held with a random selection of learners, in order to reflect on the process of argumentation and the understanding of the issue (Vaughn, Schumm, & Snagub, 1996).

AFL strategy- Comment marking. Dialogue between the teacher and individual learner to reflect on the lesson gives the learner an opportunity to express their ideas (Black & William, 2009).

At the end of the activity, the teacher summarises the different groups' findings, highlights the misconceptions and erroneous concepts, and reinforces the intended learning objectives. Formative feedback is important to make sure that the objective of the learning activity is met at the end of the lesson (Slavin, 1983).

2.12.2 Studies done on DAAFLIM

In a study done by George (2018) on DAAFLIM, it sought to determine if there is a significant difference between purposefully selected N2- Engineering students in a TVET college exposed to DAAFLIM and those not so exposed. The study was based on selected science topics. The study used TAP, CAT and the Social Constructivist Theory as lenses to examine how the construction of knowledge takes place during the teaching process using AFL activities. The study used a quasi-experimental design where one group (experimental) was exposed to DAAFLIM and the other group (control) not. The results from the t-test for the independent samples showed that there was a difference between the mean scores. Therefore, that means that there was an improvement on the results of the experimental group and that can be attributed to the use of DAAFLIM as an intervention.

The present study sought to determine the effect of DAAFLIM on the conceptions and performance of Physical Sciences on randomly selected learners enrolled in Grade 10. The selected science topic for the study was static electricity and lightning, as static electricity was the focus of the study. The study was interested in finding out whether learners had Indigenous Knowledge or scientific views about lightning. This study used the Solomon 3 research design with one experimental group and two control groups. The second control group did not write a pre-test but only a post-test. The second control group was deemed vital as it was used to eliminate the Hawthorne effect (Fraenkel & Wallen, 1996).

This study took place in two disadvantaged township secondary schools. Therefore, the DAAFLIM was implemented on children younger than those in a TVET college and in a different environment. The study also used DAAFLIM to emphasize on the IK view about lightning, which made the arguments in class more interesting as the learners were sharing their different views on the topic. The study attempted to identify the effects of DAAFLIM on resolving conflicting views and ideas.

The two studies are similar in the sense that they use DAAFLIM as a model of learning and attempt to ascertain the effect of DAAFLIM on the conceptions and performance of learners in science. Nevertheless, the present study is different from George (2018) in the sense that it focusses on the learning processes and seeks to understand the role that DAAFLIM plays in resolving two conflicting views (IKS and science) in the mind of learners. It also addresses the educational benefit of DAAFLIM in the process of learning.

2.13 Conceptual Framework for DAAFLIM

This study drew on theoretical frameworks associated with prior knowledge of learners such as the constructivist viewpoint. According to Pabale (2005), the constructivist perspective is of the view that learning outcomes are the result of the interaction between the learner and the information the learner encounters and how the learner processes it based on perceived notions and existing personal knowledge. Prior knowledge includes the traditional knowledge that learners have and bring to the classroom. According to this perspective, school science learning can make more sense if it is related to the knowledge that the child brings to the classroom from his or her culture. This then calls for integration of the two thought systems, namely the science view and the IKS view (Driver et al., 1994).

Driver et al. (1994) describes learning as a process of conceptual change and the role of the teacher as that of providing learners with experiences that induce cognitive conflict and encourage learners to develop new knowledge schemes that are better supported by group discussions which the learners can use to stimulate learning. This perspective seems to suggest that connecting the science content being taught in class to the learners' experiences and prior knowledge maximizes the learners' involvement and understanding of the topic being taught. Gipps (1994) reckons that teacher instruction, learning and assessment are all linked classroom processes as shown in the Figure 2.2 below. Aschbacher (1993) also discovered that there is a collaborative connection between teaching, learning and the perceptions held by learners and teachers as well as assessment.

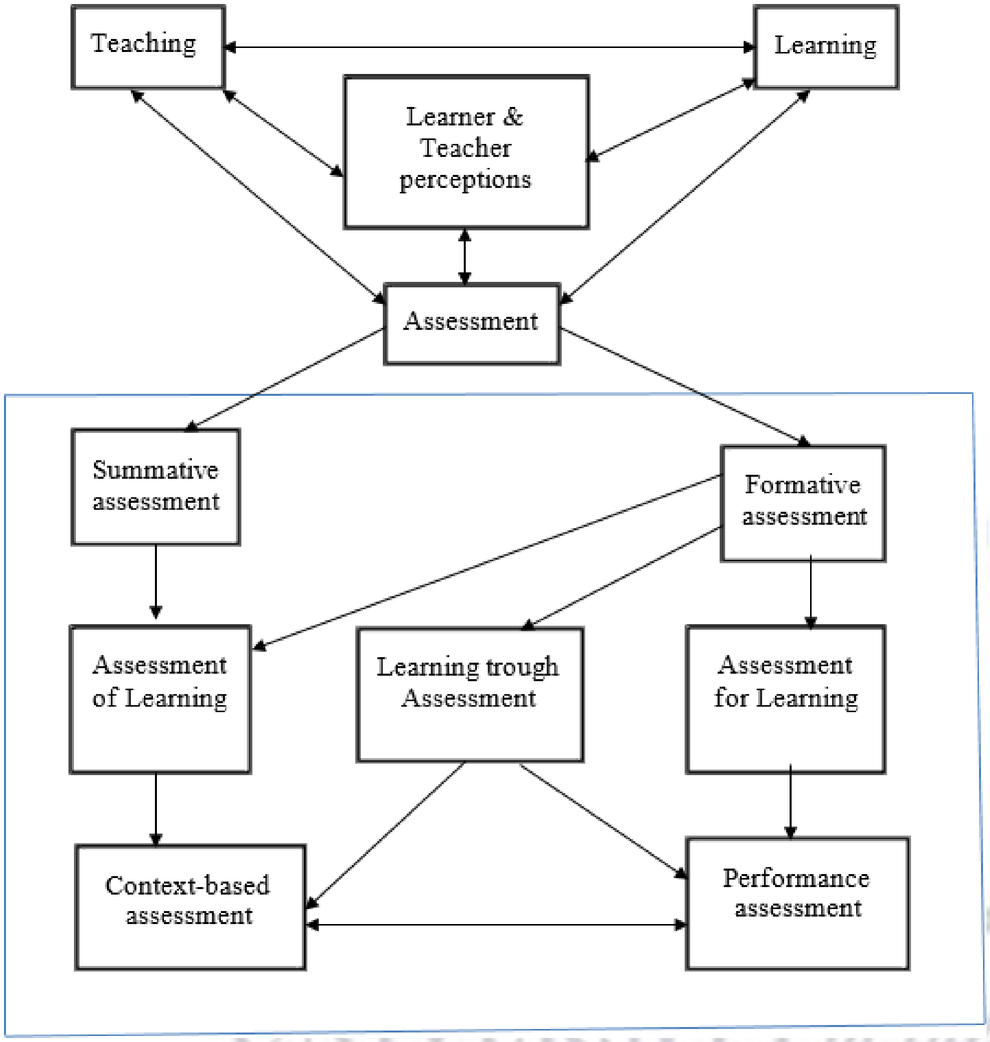


Figure 2.2 *The different components of educational assessment (Adapted from Kelly, 2007)*

The diagram above demonstrates the two forms of assessment which are formative assessment and summative assessment and their uses. These are in relation to learners' erudition and the assessment model used for the context of this study. Formative assessment is seen as encompassing assessment of learning, learning through assessment and assessment for learning (Gipps, 1994). The diagram also shows that there is an overlap in assessment of learning in the purposes of summative and formative assessment which was developed into the conceptual framework of this study. This framework was adapted from a conceptual framework which was initially proposed by Shepard (2000) for new views of assessment that are derived from an emergent re-conceptualization of assessment that is based on cognitive and constructivist learning theories as well as a transformed vision of a curriculum.

This involved matching the principles of classroom assessment to performance assessment and context-based assessment models. The framework directed the design of this study and its components are elaborated on below. It was adapted from Shepard (2000) and Kelly (2007) and comprises of a relationship between a constructivist curriculum approach, learning and classroom assessment (AFL).

2.13.1 The interrelation between context- based crriculum and assessment for learning

The framework also shows the interrelation between a context-based curriculum, constructivist learning theory and assessment for learning:

A context-based curriculum that highlights relevance of science, authentic problem-solving and interest in Science. Learners construct meanings rather than simply memorise somebody else's meanings to regurgitate them as answers during assessment. Problem solving skills are developed. Learners' interest in science and the nature of science improves. Context-based teaching facilitates connections between the different components of scientific knowledge by learners and fosters a new understanding of this knowledge within a social context. It also, as noted by Shepard (2000), complements learning through the use of social issues or social contexts that are familiar to learners or apply in real world situations and enables students to construct relevant and meaningful knowledge. Through context-based teaching learners are encouraged to link school science to contextual variables like culture and life experiences through the use of events that are relevant to learners, and in which scientific concepts are embedded (George, 1999). Social contexts are a good starting point for concept development and make it easy for learners to transcend the boundaries between science as experienced in school and science as experienced in the real world context (Shepard, 2000).

In the case of this study, there is a need to understand lightning from both the cultural and the scientific perspectives. The sharing of ideas during the lessons helps learners to either change their conceptions of phenomena or add onto what they already have. During collaborative learning, the teacher becomes a culture broker (Aikenhead, 2000) and helps learners to navigate between their culture and the scientific worldview. In this study the focus was on the effect of creating cognitive conflict where two different cognitive structures related to lightning exist. One cognitive structure of lightning derives from traditional beliefs while the other develops from school science.

Constructivist learning theories accentuate the importance of social contexts and prior knowledge, self-monitoring of thought processes and learning, in the construction of knowledge for deep understanding. New views on assessment are based on constructivist theories of learning that emphasizes learning as a continuous and active constructive and collaborative process. Learning is best achieved in a social setting where two or more individuals engage in a discourse about a topic.

Social interaction promotes learning and improved cognitive structures by exposing learners to different and contradicting ideas. Different ideas motivate learners to reflect on and re-examine their ideas and maybe restructure and modify them. The need to communicate ideas to others in a group compels learners to articulate their ideas more clearly and realize new links that lead to a better differentiation and organization of their cognitive structures (Good & Brophy, 1995).

This view of learning implies that assessment for learning can be achieved by making it part of the learning process, as well as a collaboration between teachers and learners. Osborne & Freyberg (1985) admit that prior to formal teaching, children develop meanings of their world around them. According to these researchers, learners learn through their senses as they interact with the environment and construct ideas or concepts of what they experience.

The meanings they construct are tested for their usefulness and then stored in memory units. The new construct about an already existing concept is compared against the already stored meaning and is accepted or rejected on the basis of its applicability. According to Posner et. al (1982), this form of learning is based on conceptual change theory which suggests that in order to learn new concepts related to a given topic, learners must first become dissatisfied with pre-existing ideas. Further still, this form of learning is an elaboration of the conjectural nature of knowledge as understood within the constructivist corpus. According to this view, knowledge is a human construction and humans are constantly undergoing new experiences and as a consequence, reconstruct knowledge.

Assessment for learning (AFL): performance and context-based assessment that is integrated with instruction to support learning and demand higher order thinking from learners (Gipps, 1994). In assessment for learning there is no real distinction between assessment and instruction. Assessment is a regular part of the teaching and learning processes and information from the assessment is used to shape these processes.

According to Shepard (2000) and Gipps (1994), assessment for learning places less emphasis on scores of the number of facts and procedures that students can reproduce, but places more emphasis on descriptions of learners' abilities. It takes place all the time enabling learners to self-assess their progress continuously and the teacher to adjust their teaching in response to learners' needs (Neesom, 2000).

The figure below, i.e. Figure 2.3, is the conceptual framework for the Dialogical Argumentation and Assessment for Learning Instruction Model (DAAFLIM). It shows how the context based science curriculum, constructivist learning theory and assessment for learning are interelated with the Dialogical argumentation instruction method.

As illustrated in the figure, the context based science curriculum enhances problem solving skills by linking science to cultural experiences. The constructive theory of learning emphasizes on the use of prior learning in constructing a new learning and theryby improve cognitive structure. Assessment for learning is context based assessment and focusses on learning process and self assessment.

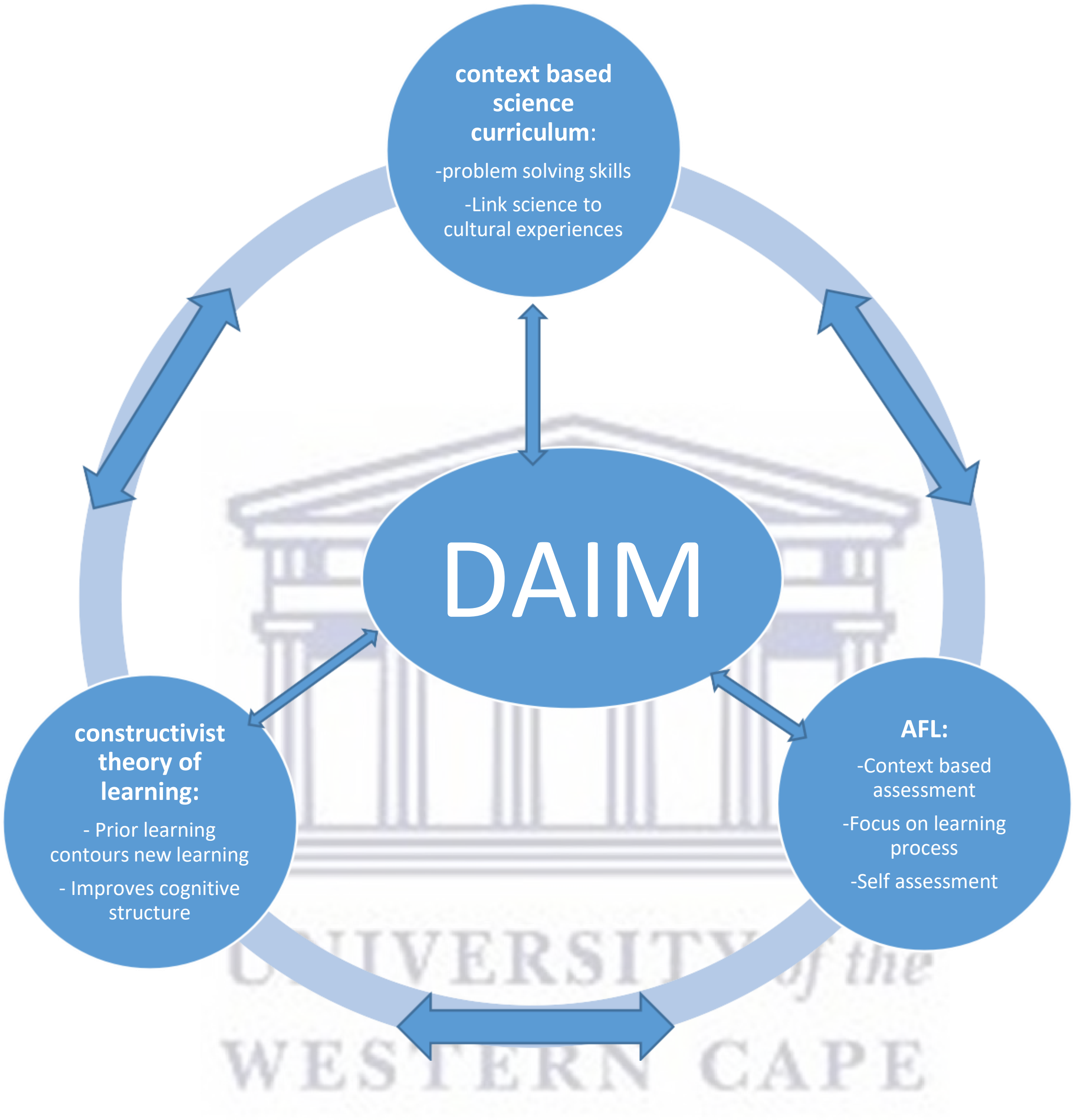


Figure 2.3 *Conceptual Framework for DAAFLIM*

The learners bring their own views on lightning and in class are taught the scientific perspectives of lightning through dialogical argumentation, according to Aikenhead (2002) and Ogunniyi (2005), this is with the intention of assimilating the learner into the scientific worldview. Once the learner is exposed to the scientific view, they are then left to choose between school science and their own cultural beliefs, customs and practices about lightning. During the lessons, the teacher using context based curriculum, collaborative learning and a cross-cultural pedagogical approach, teaches both conceptions from scientific and cultural perspectives. The aim of this exercise is to guide the learner to navigate between everyday conceptions of lightning and those presented through school science. Assessment for learning being used as an encouragement for learners to engage in interactive assessment tasks (Gipps, 1994) because what transpires out of collaborative learning as per Sawyer (2004) and cross- cultural pedagogy cannot be predicted in advance. The study attempted to find out the effect of these interactions through DAAFLIM on the learners' conceptions of lightning.

2.14 Theoretical Background of assessment for learning

Assessment for learning, as pointed out by Black (1993), allows teachers to use knowledge of learner understandings to inform their ongoing instruction. Duschl & Gitomer (1997) claim that assessment for learning can be seen as falling on a continuum from formal to informal. They define informal assessments as ongoing strategies that help teachers acquire information from learners that can immediately be used in instruction.

2.14.1 Differences between formal and informal forms of assessment for learning

The differences between formal and informal forms of assessment for learning is illustrated in Table 2.3 and Table 2.4. The table below illustrates how a teacher could gather evidence about learners' learning formally and how the teacher could interpret this gathered evidence and make use of this information and incorporate these with his/her teaching strategy to help learners achieve learning goals.

__Table 2.3__ Formal: designed to provide evidence about learners' learning

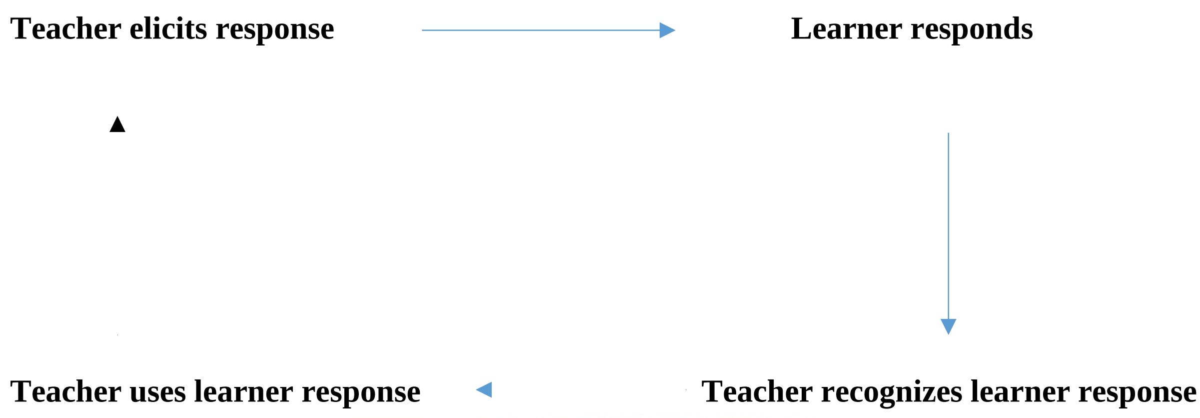
Gathering	**Interpreting**	**Acting**
Teacher collects information from learners at a planned time.	Teacher takes time to analyse information collected from learners	Teacher plans an action to help learners achieve learning goals.
Example: Give quizzes or embedded assignments	Example: reading the work of the learners and provide written comments to all the learners	Example: change lesson plans to address the state of learner learning

Table 2.4 below illustrates how evidence of learning is generated during the daily activities and how a teacher informally obtains evidence by eliciting, how the teacher recognizes learners' responses and compares them to accepted scientific ideas and makes use of the information during the course of the ongoing classroom.

__Table 2.4__ Informal: Evidence of learning generated during daily activities

Eliciting	**Recognizing**	**Using**
Teacher brings out or develops information in the form of verbal responses from the learners	Teacher recognizes learners' responses and compares them to accepted scientific ideas	Teacher makes use of the information from the learners during the course of the ongoing classroom narrative
Example: Asking learners to formulate explanations or to provide evidence	Example: Repeat or re voice learners' responses	Example: Asking learners to elaborate on their responses, explain learning goals and promote argumentation

In order for learners to fully experience scientific inquiry, teachers should pay less attention to rote procedures in the science classroom and concentrate on generation of knowledge. It is also essential that teachers be able to take the ideas of the learners and use them to inform instruction and guide learners according to their existing understandings. The model below suggests that content knowledge alone is not enough to conduct informal practices of assessment for learning.



Content knowledge alone is not enough to conduct informal practices of assessment for learning. Teacher initiation, learner response, teacher feedback of classroom discussion is important for eliciting information to improve learner-learning. Therefore, teachers must integrate assessment into their daily instruction in order to enact inquiry-based reforms as well as welcome and integrate learners' own experiences as part of the learning environment and development of knowledge.

2.14.2 Principles of assessment for learning

According to Black & William (2008), assessment for learning has ten principles. The five research-based principles which reflect the essential features of assessment for learning to guide classroom practice in science education, are discussed below.

- **Assessment for learning should be part of effective planning of teaching and learning.** A teacher's planning should provide opportunities for both learner and teacher to obtain and use information about progress towards learning goals. It also has to be flexible to respond to initial and emerging ideas and skills. Planning should include strategies to ensure that learners understand the goals they are pursuing and the criteria that will be applied in assessing their work. How learners will receive feedback, how they will take part in assessing their learning and how they will be helped to make further progress should also be planned.

- **Assessment for learning should focus on how learners learn.** The process of learning has to be in the minds of both learner and teacher when assessment is planned and when the evidence is interpreted. Learners should become as aware of the 'how' of their learning as they are of the 'what'.
- **Assessment for learning should be recognized as central to classroom practice.** Much of what teachers and learners do in classrooms can be described as assessment. That is, tasks and questions prompt learners to demonstrate their knowledge, understanding and skills. What learners say and do is then observed and interpreted, and judgments are made about how learning can be improved. These assessment processes are an essential part of everyday classroom practice and involve both teachers and learners in reflection, dialogue and decision making
- **Learners should receive constructive guidance about how to improve.** Learners need information and guidance in order to plan the next steps in their learning. Teachers should: pinpoint the learner's strengths and advice on how to develop them; be clear and constructive about any weaknesses and how they might be addressed; provide opportunities for learners to improve upon their work.
- **Assessment should foster motivation.** Assessment that encourages learning fosters motivation by emphasizing progress and achievement rather than failure. Comparison with others who have been more successful is unlikely to motivate learners. It can also lead to their withdrawing from the learning process in areas where they have been made to feel they are 'no good'. Motivation can be preserved and enhanced by assessment methods which protect the learner's autonomy, provide some choice and constructive feedback, and create opportunity for self-direction.

Assessment for learning is the process of seeking and interpreting evidence for use by learners and their teachers to decide where the learners are in their learning, where they need to go and how best to get there (Black & Wiliam, 2008). While assessment of learning has well established procedures, assessment for learning requires some theoretical ideas to be put into practice if the potential benefits are to be gained.

2.15 Theoretical Framework

In order to locate a research study in a particular paradigm, theoretical frameworks underpinning learner-centred instruction need to be considered. This study is grounded in a constructivist research paradigm as learner-centred instruction is framed within this learning theory. The theoretical frameworks for this study draw inspiration from a variety of theoretical paradigms about learning science.

2.15.1 Vygotsky's Socio-cultural Theory

A Constructivist approach to teaching and learning emerged from the work of psychologists, such as Bruner, Piaget and Vygotsky. The theory of socio-constructivism is an eclectic theory whereby elements from other curriculum theories are combined. Traditionally learning has been a process that involves learners simply repeating newly presented information, whereas Brooks & Brooks (1993) regard constructivist teaching as helping learners internalise and transmute new information taught to them.

According to Vygotsky's sociocultural theory of human learning, learning is described as a social process which is the origin of human intelligence in society. The most important implication of constructivism on teaching and learning lies in the shift from teacher-centred instruction to learner-centred instruction. Learners must engage in hands-on activities and independent research in order to construct their own meaning. Constructivism is based on the belief that learners should be helped to construct knowledge that is meaningful and useful in their own lives.

What learners learn in class is not always necessarily what the teacher intended, therefore assessment can be regarded as the bridge between teaching and learning. According to Vygotsky (1978), only a small proportion of a child's cognitive development is self- created, the larger proportion comes from internalizing a successful performance seen in another person in their social environment or by working together with peers in the construction of more powerful strategies.

In this view, the teacher provides appropriate and meaningful guidance and extension to the learners' experience by supporting the learners' attempts to make sense of their experiences and enables them to cross the zone of proximal development (ZPD). According to Wells (1999), the zoneof proximal development applies to any situation in which, while participating in an activity, individuals are in the process of understanding a topic. Assessment should help learners become more effective, self-directed and self- assessing (Angelo & Cross, 1993). This demonstrates that research on classroom assessment is central to the teaching and learning process.

Taylor (2002) explains that the skills that learners learn are more important than the content. The teacher, who strives to meet the need for active participation of the learner, engages the learner in reflective and critical thinking exercises about the content. Borich (2007) agrees with this explanation and adds that learner-centred instruction fosters true learning for understanding and that the teacher should act as facilitator who encourages learners to discover principles for themselves and to construct knowledge by working to solve realistic problems.

According to Matthews (1998), the constructivist view of learning has been the most noticeable psychological influence on curriculum thinking in science. Most of the recent reforms like CAPS are based on constructivism. Constructivism is viewed as a way of thinking about learning, it is also regarded as a theory about knowledge and learning (Haney & McArthur, 1996). In constructivism, knowledge is the result of the social, cultural, and historical background. Therefore, this implies that knowledge is constructed individually by learners based on their socio-cultural background and this includes their prior conceptions or beliefs about the natural world.

The conceptual change teaching and learning is all about: how learners change their vision of the world from a traditional worldview to incorporate the scientific worldview as well. Constructivism is based on the premise that knowledge is not something that can be transferred from one person to another, but instead must be built by the individual. In a constructivist classroom, learners are active participants in the meaning making process.

This study then aligns itself with a perception of learning that considers learning as a socialization process that engrosses learners with people around them (Aikenhead, 2000). The learners in this study, even after being exposed to school science are expected to still keep their social beliefs as the main aim of school science is to provide learners with an alternative worldview to theirs but not to isolate them from their socio-cultural environment.

Argumentation is chosen as one of the frameworks for the study; the rationale being that it is an effective means for self-expression and for resolving conflicting ideas (Erduran, Simon & Osborne, 2004; Ogunniyi, 2007a, b). Two argumentation frameworks that have received increased interest among researchers are the Toulmin's Argumentation Pattern-TAP (Erduran et al., 2004) and Ogunniyi' Contiguity Argumentation Theory-CAT (Ogunniyi, 1997; Ogunniyi, 2007a, b). However, while TAP is suitable for analysing logical arguments it is not suitable for analysing non-logical or culturally nuanced arguments (Diwu & Ogunniyi, 2012; Ogunniyi, 2007a).

For argumentation, this study is underpinned by a dialogical argumentation framework as espoused by Toulmin's Argumentation Pattern (TAP) and Ogunniyi's (1997) Contiguity Argumentation Theory (CAT). These two theoretical frameworks were chosen because of their amenability to classroom discourses dealing with substantive arguments as well as non-logical deductive/inductive metaphysical discourses embraced by Indigenous Knowledge Systems where there is a possibility that learners might be holding conflicting worldviews (Ogunniyi, 1997) and Ogunniyi, 2007a).

2.15.2 Toulmin's Argumentation Pattern (TAP)

Toulmin (1958) developed a model of argument that has been drawn upon by educators and science educators in particular, to identify the components and complexities of learners' arguments. He describes the structure of an argument as comprising an interconnected set of claims, which are conclusions whose merits are still to be established, data or grounds which supports the claim, warrants that provide a link between data and the claim, backing to strengthen the warrants and rebuttals which point to the circumstances under which the claim would not hold true.

When learners engage in argumentation and support each other in high quality argument, the relations between the personal and the social dimensions promote reflexivity, requisition and the development of knowledge, beliefs and values. To clutch the connection between evidence and claim is to understand the relationship between claims and warrants and to sharpen children's ability to think critically in a scientific context, preventing them from becoming blinded by unwarranted commitments (Quinn, 1997).

An argumentation-based instruction creates a positive learning environment that enables learners to participate actively in class and that can lead to the attainment of cognitive optimum. Research has also explored the use of argumentation and Toulmin's Argumentation Pattern as a methodological tool for the analysis of classroom based verbal data in science classrooms (Scholtz *et al*., 2004).

Toulmin's framework of argumentation, noted by Kitcher (1988), was used as it is a crucial instrument involved in the growth of scientific knowledge. It is also a crucial component of scientific discourse (Pera, 1994). Argumentation plays a central role in the building of explanations, models, and theories (Siegel, 1995) as scientists use arguments to relate the evidence they select to the claims they reach through use of warrants and backings (Toulmin, 1958).

Toulmin's Argumentation Pattern (TAP) illustrates the structure of an argument in terms of an interconnected set of all these terms namely: claim, data, warrants, backings, grounds andrebuttals. These terms are discussed below.

Claim: a claim, as described by Ogunniyi (2007), is an assertion that is put forward publicly for general acceptance. Berland & McNeill (2010) perceive a claim as an answer to a question.

Data: support the claim: data could be obtained from a variety of sources which include experience, observations, reading, and hearing from others (Berland & McNeill, 2010).

Warrants: provide a link between the data and the claim. Warrants are statements that show the relationship between the claim and the evidence. These are the justifications for moving from specific grounds or evidence to specific claims (Bricker & Bell, 2008).

Backings: strengthen the warrants; which point to the circumstances under which the claim would not hold true. Leitao (2000) views a backing as a specific information that may support the warrant.

Grounds: are the specific facts relied on to support a given claim. Backings are "generalizations making explicit the body of experience relied on to establish the trustworthiness of the ways of arguing applied in any particular case."

Rebuttals: are "the extraordinary or exceptional circumstances that might undermine the force of the supporting arguments. Kuhn (2010) refers to rebuttals as counterarguments to arguments. Berland & McNeill (2010) view a rebuttal as a claim that says an alternative claim, known as a counterclaim, is correct and it does this by providing additional evidence and reasoning to justify that point of view. According to Osborne *et al.* (2004), rebuttals are important in that they teach the learner to discuss and evaluate competing arguments and alternatives by identifying their strengths and weaknesses. Arguments that contain rebuttals are more complex than those without as they involve and require more complex thinking.

An example given by Moyo (2012) is that if the claim is: 'The person was struck by lightning, because he was the tallest man in the crowd', a rebuttal could be 'there is no much difference between the height of people' while a counterclaim could be 'the man has an enemy who sent the lightning.'

Philosopher Stephen Toulmin recognized the need for a simple model of argumentation that helps learners to develop and organize ideas. The model is an aide-de-camp to modern rhetoric as it focuses on the audience and is flexible.

Toulmin based his method of argumentation on a model in which a person will make a claim, then gives grounds to support the claim and backs the ground with a warrant. These primary elements are present in every argument. Three additional elements are; a backing, rebuttal and a qualifier. According to TAP, the strength of an argument is based on the presence or absence of specific combinations of these structural components (Sampson & Clark, 2008).

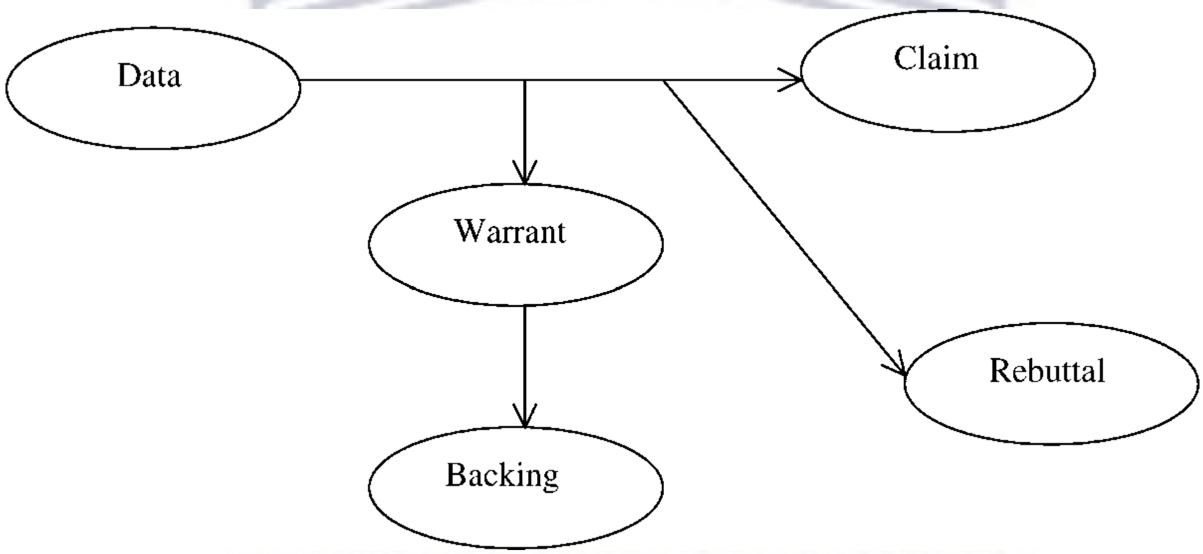


Figure 2.4 *Toulmin's Argument Pattern (Toulmin, 1958), cited from Erduran and Osborne (2004)*

The three primary elements in TAP are essential to any argument. The claim is the basic purpose of an argument, the grounds are the foundation of the argument and are the evidence or facts that support the claim and the warrant links the grounds to the claim and gives the grounds support. The backing establishes reliability and relevance of the warrant, the rebuttal acknowledges exceptions that invalidate the claim and the qualifier.

Learning in science, as pointed out by Siegel (1995), is considered to involve construction and the use of tools which are very much instrumental in the generation of knowledge about the natural world. Pera (1994) reckons that scientists use arguments to relate evidence they select to claims that they reach through the use of warrants and backings.

Kelly & Chen (1999) regard argumentation as a critical tool for science learning as it enables within learners the appropriation of community practices and discourse. Giere (1991) emphasizes that science is not simply the accumulation of facts about how the world is, it involves the construction of theories that provide explanations for how the world may be.

This study used TAP as a methodological tool for analyzing oral argumentation. Research on pedagogic practices show that Toulmin- based materials are advantageous in helping teachers conceptualise argument and model it for learners.

Toulmin's Argumentation pattern (TAP) offers the basis for a theoretical perspective on argument and also illustrates an interconnection between argument components that facilitate a conceptualization of the meaning of an argument. TAP is used to identify learners' use of rebuttals (statements that counter grounds for claims in an argument). Rebuttals are significant indicators of the quality of argumentation as rebuttals force learners to evaluate the validity and strength of arguments.

Toulmin's Argument Pattern (TAP) was used to identify the construction of arguments demonstrated by the learners throughout each lesson. The learners' arguments were categorized according to the TAP levels as illustrated in the table below.

Table 2.5 *Analytical Framework used for TAP*

Level 0 Non-oppositional
Level 1 Argument involved a simple claim versus counterclaim with no grounds or rebuttals.
Level 2 Argument involved claims or counterclaims with grounds but no rebuttals.

Level 3 Argument involved claims or counterclaims with grounds but only a single rebuttal challenging the claim.
Level 4 Argument involved multiple rebuttals challenging the claim but no rebuttal challenging the grounds (data, warrants and backing) supporting the claim.
Level 5 Argument involved multiple rebuttals and at least one rebuttal challenging the grounds
Level 6 Argument involved multiple rebuttals challenging the claim and/or grounds.

According to the TAP analytical framework as shown in Figure 2.4, a claim is a viewpoint a learner would like to express and aims to persuade others to agree with. A warrant establishes a cognitive interaction between the claim and the grounds. Therefore, a warrant demands an implication to the underlying meaning that it sheds light on the claim. The warrant's responsibility as a link is achieved by the qualifier, which states the degree of probability that the claim is true or indicates how sure the argument is. The rebuttals are counter-arguments or statements depicting situations where the argument fails to prove itself. A backing further justifies the warrant with evidence arguing for the reasoning of the warrant.

These types of scientific argumentation can be classified into six levels according to their complexity and how elaborate the evidence or grounds are, and how compatible they are with examples given as justification and the appearance of any rebuttals to counter-arguments. Learners' scientific argumentation patterns can be classified using the levels in Table 2.5.

It should be noted that the numbers in the levels of scientific argumentation are not of hierarchical levels. Rather, the numerical order indicates the degree of complexity; Level 1 is the most elementary, while level 6 is most advanced. On the other hand, in some cases, the complexity is less prominent between level 3 and level 4 as level 3 may represent better established justifications with more extensive grounds than level 4, whereas level 4 may contain a very basic justification, but includes rebuttal. Some researchers using TAP, including Bell and Linn (2000), have found that learners tend to rely on data to support their claims but seldom include warrants and backings in their arguments. In another study using TAP as an analytical framework, Jimenez-Aleixandre, Rodriguez, & Duschl (2000) found that learners constructing arguments about genetics focused on making detailed claims but did not support them with data or warrants.

2.15.3 Contiguity Argumentation Theory (CAT)

Toulmin's Argumentation Pattern has also been applied as a methodological tool for the analysis of a wide range of science curricula but it is more applicable to deductive- inductive classroom discourse than what is required when Indigenous Knowledge Systems is being integrated into school science (Ogunniyi, 2007a). The Contiguity Argumentation Theory (CAT) was used in addition to the TAP in the study as it deals with logical and scientifically valid arguments as well as non- logical metaphysical discourses embraced by Indigenous Knowledge Systems.

According to Ogunniyi & Hewson (2008), CAT asserts that the two different co-existing systems of thought, such as science and IKS, tend to readily link with each other in the mind of the learner to create a most favorable cognitive state. When a conflict arises in the mind of the learner, as a result of being exposed to science at school and IKS at home, an internal argument or conversation arises within the learner. According to Ogunniyi (2011), an internal dialogue or argument supervenes within the learner's working memory to resolve the conflict between the competing thought systems. CAT also holds that claims and counter-claims on any subject matter within fields like science and IKS can only be justified if there is no system that is dominant to the other. That way, learners will be able to negotiate the meanings across the two distinct systems of thought so as to integrate them. CAT was used in this study as a framework to analyze and explain how learners resolve conflicts arising between the scientific and indigenous views of the selected phenomena.

This study also attempted to test the applicability of Ogunniyi's (1997) Contiguity Argumentation Theory (CAT) to the township context with the aim to see if learners demonstrated any of the five categories of CAT below. According to Ogunniyi (2005), how a learner moves from one cognitive state to another depends on the result of a given response, interest and desire (Fakudze, 2004). It is also presumed that during an instruction in class, the two contiguous thought systems science and IKS clang and as a result, an intra-dialogue within an individual supervenes as the learner attempts to resolve the conflict.

Contiguity Argument Theory (CAT) recognizes five categories that describe the way conceptions can move within a learner's mind when dealing with conflicting worldviews: science and IKS. These five categories also explain the movement of conceptions amongst learners involved in dialogues warranting the conscription of scientific and IKS-based conceptions. Concepts move in the mind of a learner in five different ways in response to the arousal context as follows:

1. **Dominant-** a powerful idea effectively explains or predicts facts, or resonates with an acceptable social norm and a sense of identity;
2. **Suppressed**- an idea becomes suppressed in the face a more convincing evidence, or established social norms;
3. **Assimilated**- a less powerful idea might be assimilated into a more powerful one in terms of the of the persuasiveness or adaptability of the dominant idea;
4. **Emergent**- there may be circumstances where no prior knowledge about a phenomenon exists and new knowledge has to be acquired as is the case with many science concepts; and
5. **Equipollent-** when a learner's worldview is influenced by two competing and/or co-existing worldviews e.g. science and IK with comparably equal intellectual force without necessarily resulting in cognitive dissonance (Ogunniyi, 2007a).

Ogunniyi (2005) also contends that the five cognitive states above exist in a dynamic flux and can change from one form to another. Hence, the context in which a given discourse takes place dictates what cognitive states an individual displays. The study also attempted to determine whether these states of cognition are exhibited during the argumentation lesson.

The Contiguity Argumentation Theory is a philosophical description of constructivism, whilst Toulimin's Argumentation Pattern is a pedagogical tool. Therefore the Contiguity Argumentation Theory provides justification for intergrating science with indigenous knowledge systems whilst Toulmin's Argumentation Pattern provides instructional educational structure.

The theories discussed above are relevant to this study in that they highlight the value of cultural and social components of making sense of the natural world. These theories also suggest that teachers need to exploit and take into account the ideas that learners bring to science classrooms from home.

2.16 Summary

Regardless of restructuring of curriculum in South Africa several times, the education system faces a challenge in producing learners who are critical thinkers. To some extent this is attributed to the teaching methodology used by teachers as they tend to use more of teacher-centred instruction. Learners learn more when they discover things by themselves than just being told by the teacher.

Learners bring cultural views to the science classroom. Some of these views have scientific explanations while others have not. There are some misconceptions or myths about lightning that learners bring to the classroom. Argumentation engages learners in a collaborative deliberation of complex questions and supports the development of thinking. It plays an important role in the teaching and learning process. Argumentation also has some educational benefits. These educational benefits are motivation, content learning, argumentation skills and knowledgebuilding practices.

Argumentation is an effective means for self-expression and for resolving conflicting ideas. However, argumentation has its own challenges. One of the challenges is that learners experience a lack of shared understanding with their peers. Therefore, teachers need to create a learning environment that enables learners to understand that their discussion aligns with scientific argumentation.

Assessment for learning is a process in which teachers and learners provide feedback during instruction to organise the learning and teaching process in order to increase learner achievement. It helps to identify the next step to build on the success or strengths and to correct weaknesses.The five attributes of assessment for learning include: articulating learning progress; stating learning goals; providing feedback; promoting self and peer assessment; and establishing a classroom culture in which teachers and learners are partners.

Brown & Knight (2012) reckon that assessment is at the heart of the learner experience and Sambell (2016) believes that it could be a powerful tool in ensuring learner engagement and success. According to Furtak (2012), assessment for learning is a teaching approach that supports learners' conceptual understanding of science concepts. Assessment for learning has some principles. These include: (i) It should be part of effective planning of teaching and learning; (ii) It should focus on how learners learn; (iii) It should be recognised as central classroom practices; (iv) Learners should receive constructive guidance about how to improve; and (v) Assessment should foster motivation.

The conceptual framework of DAAFLIM showed how dialogical argumentation instruction method serves central in relating the context-based science curriculum, the constructivist theory of learning and assessment for learning. In their research Martínez-Gudapakkam *et al*. (2012) discovered that assessment for learning in science lessons contributed to learners' conceptual understanding and that these techniques helped learners to develop a positive attitude towards science lessons. The expectation is that this study will contribute to further research in terms of assessment for learning in science education. The DAAFLIM approach may also be particularly important for children who do not have extra support for learning at home (Bransford (1999).

The context-based science curriculum focuses on problem solving skills. It links science to cultural experiences. Constructivist theory of learning highlights the importance of prior experience in constructing new learning. It intends to improve cognitive structures. The most important implication of the constructivist theory of learning lies in the shift from teacher-centred to learner-centred instruction. Learners engage in constructing their own meaning whilst the teacher monitors and guides them towards scientific argumentation. Assessment for learning therefore is context-based assessment. It focuses on the learning process and promotes self assessment.

The two argumentation frameworks that have received increased interest among researchers are Toulmin's Argumentation Pattern (TAP) and Contiguity Argumentation Theory (CAT). Toulmin's Argumentation Pattern is suitable for analysing logical arguments. But it is not suitable for analysing non-logical or culturally nuaunced arguments. TAP was used as a methodological tool for analysing oral argumentation. It offers the basis for a theoretical perspective and was used to identify learner's use of rebuttals.

The Contiguity Argumentation Theory was used to analyse and explain how learners resolve conflicts arising between the scientific and the indigenous views of the selected phenemena. It recognises five categories that describe the way conceptions can move within a learner's mind when dealing with conflicting worldview. These five categories explain the movement of conceptions amongst learners involved in dialogues warranting the conscription of scientific and Indigenous Knowledge system base concepts move in the mind of learners in a five different ways in response to the arousal context as dominant, suppressed, assimilated, emergent and equipollent.

Toulmin's Argumentation Pattern is a pedagogical tool whilst Contiguity Argument Theory is a philosophical description of constructivism. Whereas Toulmin's Argumentation Pattern provides education structures, Contiguity Argumentation Theory provides justification for integrating science with indigenous knowledge systems. This research made use of aspects of each of the above theoretical frameworks.

The next chapter presents the methodological design of this study and takes into consideration the views advanced in the literature. It also explains how the data necessary for addressing the research questions were collected.

Chapter 3

Research Methodology

3.1 Introduction

The research methodology used in a study, as pointed out by Leedy (1993), depends on the nature of data to be collected and the nature of the research problem. This study sought to establish the effects of using dialogical argumentation and assessment for learning instructional models (DAAFLIM) in order to determine the perceptions, experiences and performance of Grade 10 science learners with regards to lightning.

In order to achieve the above, this chapter pursued to discuss the participants for the study by describing the sample and their demographic locations. The research methods employed in developing the research instruments, their evaluation and final development of the instruments is also looked into. This was done with the aim of finding answers to the research questions.

1. **What conceptions of static electricity were held by Grade 10 learners before and after being exposed to dialogical argumentation and assessment for learning assessment instructional model (DAAFLIM)?**
2. **What is the difference in performance and conceptions of static electricity held by the learners exposed to DAAAFLIM and those not so exposed?**
3. **To what extent are the differences in the learners' conceptions and performance of static electricity related to their gender, age and interest in science?**

The research design that was followed is discussed, as well as the ethical considerations that werefollowed. The details of the DAAFLIM as an instructional intervention that was designed for this study and for the learners is given in this chapter. The chapter attempts to show and justify the suitability of the methodology used for the study. This study is underpinned by the social constructivist theory. Harris (2009) argues that constructivist theories focus on lived experience and the perceptions, feelings and understanding of the people in these experiences and social constructivists are interested in the construction of knowledge through the social group.

3.2 Research approaches in education

Educational research is distinguished by processes related to teaching and learning and its purpose being the improvement of teaching and learning methods and practices for the betterment of society (Mutch, 2005). The two main research approaches that an educational researcher chooses and what research design to use are quantitative and qualitative approaches. This study employed a mixed methods approach, where each question is analysed quantitatively to give a descriptive picture. This is followed with an in-depth qualitative analysis to interrogate the underlying substantive factors corresponding to the quantitative descriptive summaries.

A quantitative research approach, as noted by Robson (2002), involves fixed, deductive designs where procedures to be followed are specified before the main part of the study. Quantitative research design studies describe phenomena using numerical data that is analyzed through statistical procedures where samples of participants are used to produce statistically meaningful data. Gay & Airasian (2003) reckon that quantitative research designs involve stating and testing of hypotheses and maintaining contextual factors that might interfere with the data.

Schumacher & McMillan (1993) explain qualitative research as a research method that is flexible and inductive in design and uses verbal narratives to describe data from which explanations about a phenomenon under study emerge. Experiences and beliefs of the participants are interpreted in terms of the meanings participants bring in the setting and are described using their words and the test for validity is through triangulation rather than statistical means.

Qualitative research believes in the existence of multiple realities and truths based on one's understanding of what constitutes reality. This study rests on the premise that there are many ways of knowing and that natural phenomena have many possible plausible explanations. In other words, there is neither one truth about nor one explanation of a natural phenomenon.

Whilst the quantitative approach could be more effective in determining the role that DAAFLM plays in the performance of the learners in static electricity (lightning), the qualitative approach could be more effective in determining the role that DAAFLM plays in constructing scientific views by making use of traditional views. In light of this, it was believed that this research paradigm would enable the researcher to gain a deeper and sharpened appreciation and understanding of the learners' perceptions, values, and beliefs on science, indigenous knowledge and lightning.

3.3 Research paradigm

A paradigm, as pointed out by Krathwohl (1993), is a framework of beliefs, values and methods within which research takes place. Lather (2006) classifies educational research under three paradigms: positivist, interpretive and critical. Patton (1990) defines them as three distinct worldviews which provide three different perspectives for how a researcher sees and makes sense of social reality and knowledge. The paradigms are a basic set of beliefs that researchers hold to make claims about reality and knowledge (Kuhn, 1970).

Chapman (2000) centered the three beliefs on ontological, epistemological and methodological assumptions. The table below provides a breakdown that differentiates the three philosophical assumptions that researchers can make about researched knowledge behind the three paradigms.

Table 3.1 *The three philosophical assumptions*

Assumptions	Positivist	Interpretive	Critical
Ontology	Knowledge is Objective/found/ Universal.	Knowledge is Subjective/constructed/ Multiple.	Knowledge is Subjective/ Influenced by power and politics.
Epistemology	Knowledge is verified and uncovered.	Knowledge is communicated, generated and interpreted.	Knowledge is collaboratively decided.
Methodology	Researcher observes and controls investigations. 'Quantitative data'	Researcher interacts to develop in-depth and multiple understandings. 'Qualitative data'	Researcher facilitates and encourages change. Mixed method approach.

Adapted from Lanther (2006)

Of the three paradigms, this research is placed within the interpretive paradigm. According to interpretive research, social reality and knowledge is constructed, interpreted and experienced by people only when they interact with one another (Creswell, 2003). The interpretive research, as noted by Cohen (2007), aims to understand how people make sense of their world. This is because of the interpretivist belief that each person is different and they experience the world in different ways unlike the positivist's belief of objectivity, where they believe that reality is universal.

There are four major interpretive paradigms as outlined by Denzin & Lincon (2003). These paradigms structure qualitative research as positivist and post positivist, constructivist-interpretive, critical or Marxist emancipator and feminist-post cultural. According to them, the constructivist-interpretive paradigm adopts relativist ontology which means that there are multiple realities, a subjectivist epistemology and a naturalistic set of methodological procedures. According to Andrade (2009), the focus of interpretive research is to interpret the explanations people make about their actions and interactions in a socio-cultural environment, which is dynamic and is influenced by history, politics, economy, language, geographical settings, science and technology. The construction of knowledge in interpretive research is characterized by the active interaction between the researcher and the participants.

Interpretive research regarding teaching, learning and assessment in education is regarded as a complex intellectual endeavor, especially with respect to learners in the socio-cultural context of a classroom (Borko, 2007). The main endeavor of the interpretive paradigm in qualitative research is to understand the subjective world of human experience. Therefore, due to the nature and purpose of this study, the research is placed within the constructivist- interpretive framework in order to understand the views or perceptions of Grade 10 learners about static electricity (lightning) and how using dialogical argumentation and assessment for learning (DAAFLIM) has an effect on their understandings of the natural phenomena.

3.4 Research Design

A design is a detailed description of the procedures that the researcher uses to investigate the research topic. It includes justification for the exploration of posed research questions and the detailed presentation of the research steps to be followed when collecting, choosing and analysing data (Gay & Airasian, 2003).

According to McMillan & Schumacher (2001), a research design refers to a plan for selecting subjects and data collection procedures to answer the research question. It shows which individuals will be studied, when and under which circumstances (Babbie, 2001). The main purpose of the study was to have a comprehensive look at how to effectively integrate DAAFLIM with school science regarding static electricity focusing on lightning as an example. The quantitative research design that was used in the study is the Solomon three group design model.

The Solomon three-group design, Figure 3.1, was used to collect data. Three groups were used in the study. Two groups received pre-tests and one group did not, and the results showed if the pretest has an effect or if the treatment does.

Pre-test		Post-test	
O_1	X	O_2	(Experimental group, E)
O_3		O_4	(First control group, C1)
	X	O_5	(Second control group, C2)

Figure 3.1 *Solomon 3 group design*

Figure 3.1 above shows that O_1 was the pre-test and O_2 the post-test of the experimental group (E). X depicted the use of DAAFLIM as an intervention among the experimental group (E) and the second control group (C2). O_3 (the pre-test) and O_4 (the post-test) of the first control group (C1) which was not subjected to the intervention model. The second control group (C2) was treated with an intervention but not subjected to the pre-test, they took only the post-test (O_5).

McMillan (1992) and Fraenkel & Wallen (1996) describe the Solomon-3-Group design as an experimental design, in which a planned intervention is introduced into a normal class situation and its effect is systematically studied. In this study, three comparable groups were identified. The first group, the experimental group (E) and the control group 1 (C1) were pre- and post-tested. However, the second control group, (C2) was post-tested only. The control 2 group controlled for the pre-test effect. This was done so as to reduce internal threats to the validity of the study as well as to reduce Hawthorne effect (Fraenkel & Wallen, 1996).

The Hawthorne effect, as described by Cook (2008), is the inclination of people who are the subjects of an experimental study to change or improve the behavior being evaluated only because it is being studied and not because of changes in the experiment parameters or stimulus. Fraenkel

& Wallen (1996) also describe it as when research participants act in a way that is consistent with their perceptions of the researcher's expectations during a study, which then biases the outcomes of that research study.

The independent variable of this research was the different instructional strategies, the DAAFLIM and Traditional Instruction that were used and evaluated. The dependent variable was the performance of the learners within the different pedagogical settings and their achievement at the end of the study. In order to ensure that the results of this research were reliable and fair, the degree of difficulty of the content of the activities was kept the same in all groups.

The instruments that were used were questionnaires, open ended interviews and group observations. From the data collected learners' responses from the questionnaire about the use of dialogical argumentation and assessment for learning were analysed. The pre- test and post- test responses were compared to see if there was an improvement in the learners' performance or not.

3.5 Research setting

The research was conducted in two predominantly Black township high schools under the Metro East Region of the Western Cape Education Department (WCED) in Cape Town. The schools were situated in the outskirts of the Northern suburbs of Cape Town in a gang infested area. Most of the children in the community were involved in gangsterism and fought with each other even in the school premises. The area in which the study was conducted can be classified as a semi- urban and was solely occupied by Black people of the Xhosa ethnic group staying mostly in shacks made of corrugated iron. Most of these informal housing structures had no electricity or proper running water.

The majority of the learners were originally from the rural area of Eastern Cape, which is where their parents grew up and where most of them spend their school vacations. Parents of the learners in both schools were mostly unemployed, others were farm laborers, factory workers and a few professionals staying in the township. Both high schools include Grades 8 to 9 which is called the General Education and Training (GET) band and the Grades 10 to 12 also known as the Further Education and Training (FET) band. There were four feeders' primary schools surroundings the schools. These feeder primary schools also served the two other high schools in the township with learners who had passed grade seven and were ready to start grade eight.

Due to ethical considerations the schools are fictitiously called Masakhane Secondary School and Blokkie Secondary School. Both schools used English as a medium of instruction during lessons.

3.5.1 The experimental group and Control 2 group (C2)

Masakhane Secondary School was a neighboring school to Blokkie Secondary and was where the experimental study took place. Both the experimental group and the control group C2 which received the treatment were learners from this school. The school had an enrolment of 1800 learners of different races. Masakhane Secondary was the only school in the township that offered English as a home language because of the different races of learners that were enrolled at the school. Majority of the learners in the school were Xhosa, about 70 learners were Coloureds and Afrikaans speaking, about 100 learners came from Zimbabwe and 50 learners were Sothospeaking. There were 50 teachers and 20 supporting staff including the secretaries, cleaners, security and kitchen staff employed to cook for the learners through a department funded feeding scheme initiative.

The organisational structure of the school had a principal, two deputy principals and ten heads of departments. The deputy principals were in charge of the heads of departments who coordinate curriculum and administrative affairs in their departments. The teacher to learner ratio at the school was 1:50. The school prides itself for having received an award for being one of the top three Black township school enrolling the highest number of learners from a township schools at the University of the Western Cape.

The DAAFLIM mentor for the experimental group was the researcher, a 38-year-old female teacher with 13 years teaching experience in Physical Sciences Grade 10 to 12 and Natural Sciences Grade 8 to 9. The researcher was also a member of the Science and Indigenous Systems Project (SIKSP) based at the University of the Western Cape, where she had undergone training on implementing a science curriculum using DAAFLIM for six years. She holds a Masters' degree in Science education and is Xhosa speaking but teaches in English, which is the language of instruction at the school.

The Control group 2 which was in Masakhane Secondary is the group that did not write the pre-test and took only the post-test but received the same treatment as the experimental group. This group was taught by a 40-year-old female teacher from Zimbabwe. She speaks English and Shona, which is Zimbabwe's native language. She had 10 years teaching experience in Life Sciences Grade 12, Natural Sciences Grade 8 to 9 and Physical Sciences Grades 10 to 11. She has an Honours degree in Science Education and is currently enrolled for a Master's degree. This teacher had been trained in using DAAFLIM in her lessons through seminars and workshops convened by the SIKSP group at the University of the Western Cape. The SIKSP group held biweekly seminars and workshops to train Mathematics and Science education honours, masters and PhD students on DAIM and DAAFLIM. The thrust of DAAFLIM is to create a discursive classroom environment where teachers and learners argue, discuss, dialogue and learn together with the ultimate aim of reaching consensus on various issues at stake. The training was used to help the teachers to be able to use DAAFLIM in their classes so as to enhance learners' conceptual understanding, awareness about certain subject matters, participation in class and to show increased interest in the topic being discussed.

3.5.2 The control group C1

The control group C1 was from Blokkie Secondary School which was situated about 10km from Masakhane Secondary. The school had an enrolment of 1400 learners and 39 teachers. The teacher to learner ratio was 1:35. There was one principal and one deputy principal in charge of six heads of departments.

The control group 1 was taught by a 33-year-old male teacher from Ghana. The teacher had been teaching Physical Sciences to Grades 10 to 12 for the past 7 years at the same school. He held an Honors degree in Science Education. This group did not receive any treatment and was taught with the traditional method of chalk and talk. The teacher was not trained or exposed to the DAAFLIM teaching method.

3.6 Target Population and Sample

Population is the group of interest to which the results are ideally generalised and where information is collected and conclusions drawn (Gay & Airasian, 2003). The population for the study was Grade 10 physical sciences learners of Secondary Schools situated in a township in Kraaifontein in the Metro East district in the Western Cape. The two schools involved in the study were from the same community and the learners' backgrounds were similar. Their performance was almost the same and their teachers had the same level of teaching qualifications and similar experience in teaching Physical Science.

Grade 10 was the selected grade for this study. This grade was purposely chosen as the chosen topic – static electricity is taught in Grade 10 and is the basis of the topic electricity. This is one of the topics that Grade 12 learners perform very poorly in their final examinations. The study envisaged that the process would help the learners understand the topic better. The learners would be able to apply the knowledge of static electricity in Grade 11 and 12 final examinations, thereby improving their performance in the subject. Moreover, Grade 10 was also chosen as it is easy to conduct the study on Grade 10 learners as they are usually not under the demand of the externally written matric examinations.

Due to time and financial constraints, a convenient sample of 125 learners was selected from the two schools. Mouton (1996) defines a sample as elements selected with the intention of finding out something about the population from which they are drawn. A convenient sample consists of subjects included in the study because they happen to be in the right place at the right time (Polit & Hungler, 1993). The two schools were located closer to where the researcher works. The schools had similar backgrounds.

Eighty-two learners were from Masakhane Secondary, which hosted both the experimental and control 2 groups. The experimental group had 40 learners in class, 25 of the learners were girls and 15 learners were boys. The age group of the learners ranged between 15-17 years old. Thirty of the learners were Xhosa speaking, 5 from Zimbabwe and spoke Shona, 2 were Afrikaans and 3 were Sotho but spoke mostly Xhosa. The Afrikaans and Shona speaking learners also understood and spoke Xhosa fluently as they were staying in a community where Xhosa was used as the communication language.

The class of the control group 1 from Bokkie Secondary consisted of 43 learners. The control group 1 consisted of 12 Boys and 18 girls between the ages of 15 to 18 years. All the learners spoke Xhosa. All the learners resided in the same area but different sections in the township, they had similar backgrounds and their performance was almost the same.

3.6.1 Analysis of learners' demographic variables

This section presents the demographic representation of the learners in the three groups who participated in the study in terms of gender, age, home language, province of origin and guardian. The study involved three groups of learners. These include: the control 1 group, the experimental group and the control 2 group.

The Table 3.2 below illustrates an intervention plan on how students were divided into three groups with sample sizes (n): Experimental group (E), control 1 group (C1), and control 2 group (C2). The experimental group and control 2 group were treated with DAAFLIM as an intervention and the control 1 group was treated with the traditional teaching method. The experimental and the control 1 groups wrote both pre-test and post-test. The control group 2 wrote only the post-test.

Table 3.2 *Intervention Plan*

Group	Pre-test	Intervention (DAAFLIM)	Post test
E (n=40)	X	X	X
C1 (n=43)	X		X
C2 (n=42)		X	X

The data was analysed using SPSS version 26. The demographic variables (gender, age, home language, province of origin, guardian) were described using frequencies and percentages. The demographic information is presented below in table 3.3 that shows dominant variables by summarising a list of 15 figures with groups that control one pre-test, experimental pre-test, and control two post-test. For variables: gender (boy, **girl**), age (**15** -16-17 years), home language (**Xhosa**, Zulu, Afrikaans,Sotho, and Shona), province of origin (Western Cape, **Eastern Cape**, and Gauteng), and guardian(**Mother only**, Father only, Mother and father, and Grandmother).

Table 3.3 *Summary of demographic information*

	Group					
Variable	**C1**		**E1**		**C2**	
Gender (Girl)		65.1%		57.5%		64.3%
Age(15years)		41.9%		55%		45.2%
Home language (Xhosa)		90.7%		87.5%		69%
Province of origin (Eastern Cape)		79.1%		55%		64.3%

Guardian (Mother only)		51.1%		67.5%		54.8%

Table 3.3 above is a summary of how each variable is described using percentages. These variables are also represented graphically using bar charts for the three groups of learners in the study. The gender, age, home language, province of origin and guardian of the learners in the three groups are represented graphically using bar charts and are described using percentages.

3.6.1.1 Demographics according to Gender

The bar chart below shows the gender composition of the learners in the three groups. As depicted in Figure 3.2, 57.5 percent of the experimental group were female and 42.5 percent were male.

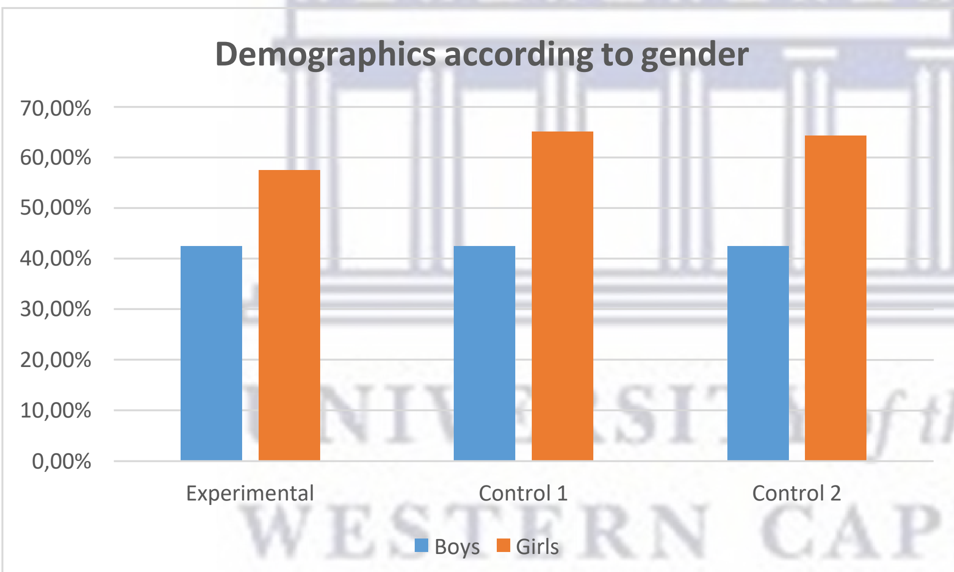


Figure 3.2 *Bar chart of demographics according to gender*

Control 1 group consisted of 65.1% female pupils and 34.9% male pupils, whereas Control 2 group consisted of 64.3 % female pupils and 35.7% male pupils. In each group the number of females was more than the number of males.

3.6.1.2 Demographics according to Age

The age of the learners in the three groups ranged from 15 to 17 years-old. The experimental group consisted of 15, 16- and 17-year olds. As illustrated in the bar chart below, Figure 3.3, the percentages for each age group was 55, 37.5 and 7.5 percent respectively.

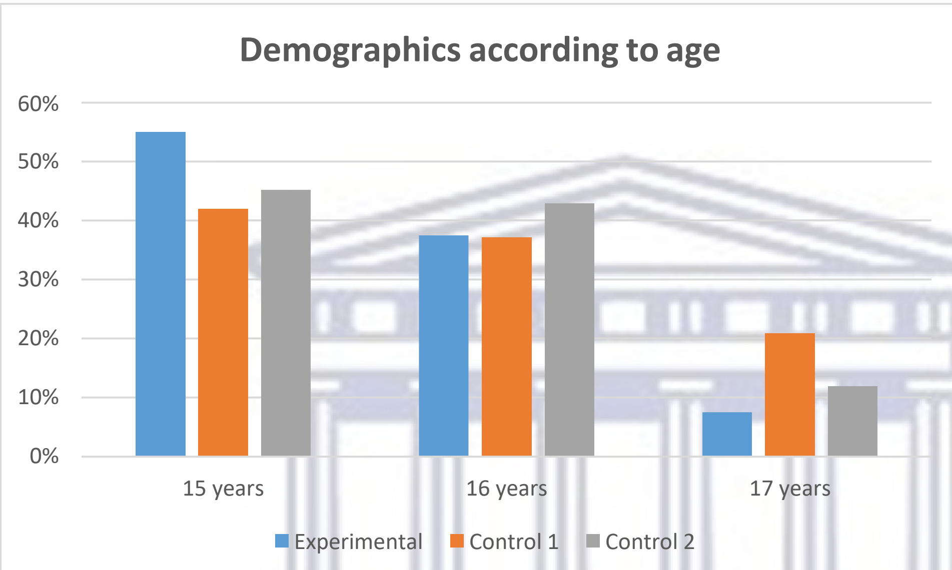


Figure 3.3 *Bar chart of demographics according to age*

In the control 1 group, 41.9 percent were 15-year-old, 37.2 percent 16-year-old and 20.9 percent were 17-year-old. The control 2 group was made up of 45.2 percent 15-year-old, 42.9 percent 16-year-old and 11.9 percent of 17 year- old learners. In each group most learners were between 15 to 16 years old.

3.6.1.3 Demographics according to Home Language

As shown in the figure 3.4 below, the home language for the experimental group comprises three home languages, namely: Xhosa, Zulu and Sotho. As can be seen from the chart below, 87.5

percent of the learners are Xhosa speaking learners. Ten percent of these learners are Sotho speaking whereas only 2.5 percent of the learners speak Zulu.

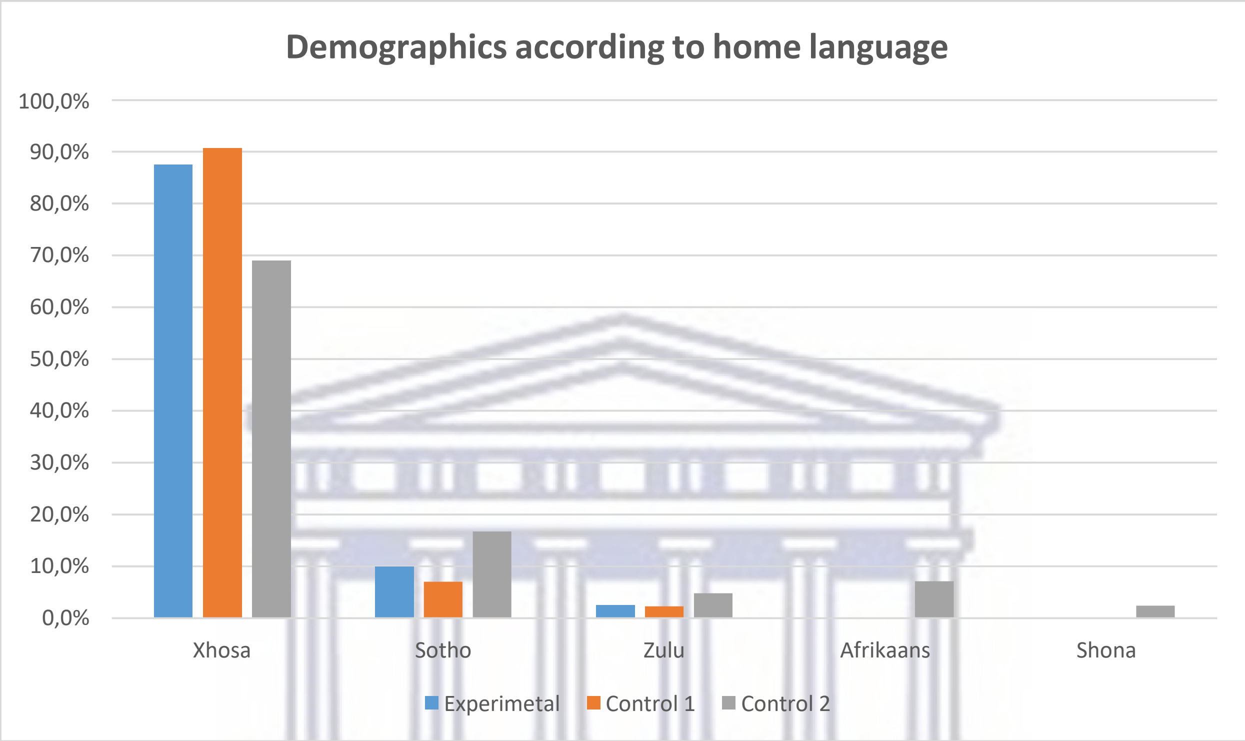


Figure 3.4 *Bar chart of demographics according to home language*

Similar to the experimental group, the home language for control 1 group comprised three home languages. These included Xhosa, Zulu and Sotho. As can be seen from table 3.4, 90.7 percent of the learners were Xhosa speaking learners. Seven percent of these learners were Sotho speaking whereas only 2.3 percent of the learners spoke Zulu. However, the home language for C2 consisted of five home languages. These included, Xhosa, Zulu, Sotho, Afrikaans and Shona. As can be seen from table 3.4, 69 percent of the learners were Xhosa speaking learners. About Seventeen percent of the learners were Sotho speaking whereas 4.8 percent of the learners used Zulu as a home language. The percentage of learners who speak Afrikaans and Shona were 7.1 and 2.4 respectively.

3.6.1.4 Demographics according to Province of Origin

The most dominant native home language in all the groups was IsiXhosa. The majority of the learners originally came from the Eastern Cape Province where IsiXhosa is the main language spoken. The Eastern Cape Province is mostly a rural area where people still believe and practise the indigenous ways of doing things. As depicted in Figure 3.5 below, the province of origin for the experiment was mainly from two provinces. These two provinces were the Eastern Cape and the Western Cape. The Eastern Cape was the province of origin for 55 percent of the learners whereas the Western Cape was the province of origin for 45 percent of the learners.

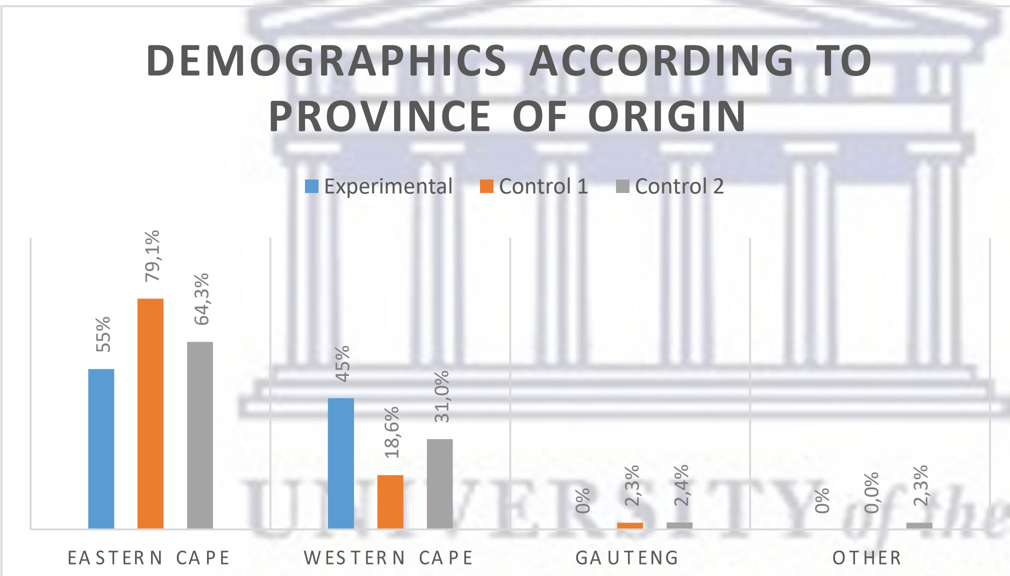


Figure 3.5 *Bar chart of demographics according to province of origin*

The province of origin for C1 group comprised three provinces: the Western Cape, the Eastern Cape and Gauteng. The Eastern Cape was the province of origin for 79.1 percent of the learners.

The Western Cape was the province of origin for 18.6 percent of the C1 learners whereas Gauteng was the province of origin for 2.3 percent of the learners.

The province of origin for C2 comprised several provinces The Eastern Cape was the province of origin for 64.3 percent of the learners. The Western Cape was the province of origin for 31 percent of the C2 learners whereas Gauteng was the province of origin for only 2.4 percent of the C2 learners. The remaining 2.3 percent were from other provinces or countries.

3.6.1.5 Demographics according to Guardianship

The bar chart below shows the guardian composition for the three groups. As illustrated in Figure 3.6 below, 67.5% of these learners had mother only as a guardian. While 25 percent of the learners had mother and father as guardians, 2.5 percent of the learners had father only as a guardian and 5 percent had grandmother as a guardian.

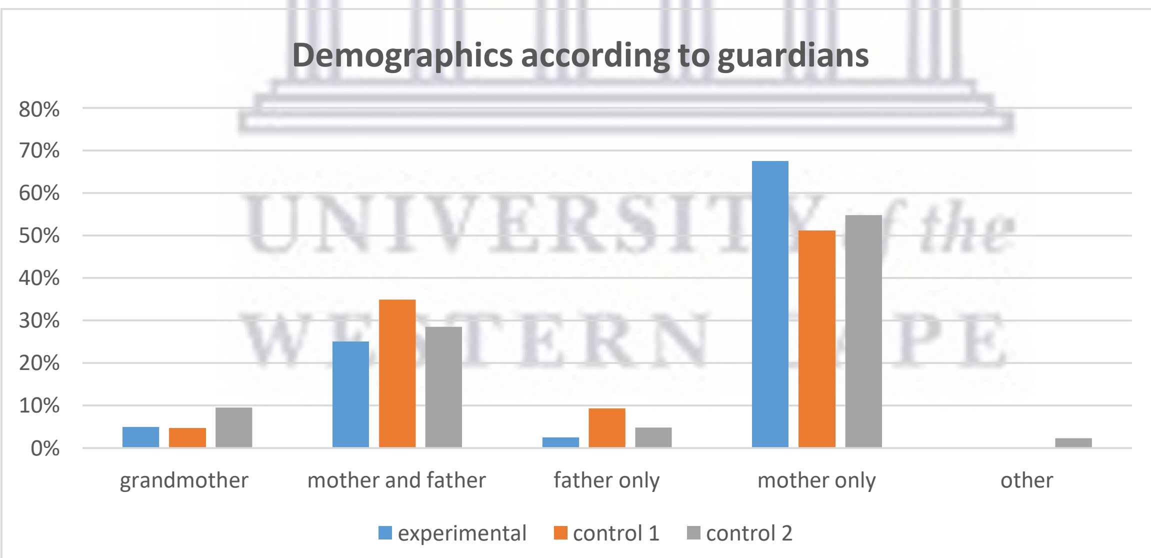


Figure 3.6 *Bar chart of demographics according to guardian*

About fifty-one percent of the control 1 group learners had a mother only as a guardian. About thirty-five percent of the learners had both mother and father as guardians. Whilst 9.3 percent of these learners had father only as a guardian, only 4.7 percent had grandmother as a guardian.

About fifty-five percent of group C2 learners had a mother only as a guardian. Whilst 28.6 percent of the learners had mother and father as guardians, 9.5 percent had grandmother as a guardian. About 5% of the learners had a father only as a guardian whereas only 2.3% percent had others as a guardian.

In terms of guardianship of the learners, it was discovered more than 50% of the households where the learners grew up are led by single mothers. This implied that most of the children had no father figures at their homes. Only about five percent of learners in each group were staying with their grandmothers. In the Xhosa culture it is believed that the grandparents are mostly the ones that help the children to hold on to their indigenous knowledge as they are the ones passing on the information to the younger ones so that the culture is preserved.

3.7 The Research Instruments

The main purpose of the study was to find out the effect of DAAFLIM in Grade 10 physical science learners' conception and performance in the topic of electrostatics. The design of the instruments and their respective test items was highly influenced by the integration of indigenous knowledge with school science regarding electrostatics, specifically lightning.

Table 3.4 below shows which instrument was used to answer each of the research questions above. The Conceptions of Lightning Questionnaire (COLQ), Beliefs about Lightning Questionnaire (BALQ) and the Interview were used as instruments to collect data and answer the research question 1. The Science Achievement Test (SAT), Beliefs about Lightning Questionnaire (BALQ) and the interview were used as instruments to collect data and answer the research question 2. The

Science Achievement Test, Beliefs about Lightning Questionnaire and Conceptions of Lightning Questionnaire were used as instruments to gather data and answer the research question 3.

Table 3.4 *Instruments used for the research questions*

Research question	**Instrument**
Question 1	COLQ, BALQ, Interview
Question 2	SAT, BALQ, Interview
Question 3	SAT, BALQ, COLQ

Each research question was assigned an instrument that would best try to answer the question. The instruments were chosen based on the questions that the learners had to answer. In seeking an answer for the research question 1, the data collected using COLQ, BALQ and Interview were used. Data collected using SAT, BALQ and interview were used to answer research question 2 whereas data collected using SAT, BALQ and COLQ were used to answer the third research question.

3.7.1 Questionnaires

The design of the instruments and the science achievement test items were influenced by the title of this thesis and its purpose. The aim of the questionnaires was to determine learners' indigenous beliefs about lightning, as well as their pre-existing knowledge on electricity and therefore were administered to the experimental group and control 1 group before the teaching of the topic. The same questionnaire was administered to all the three groups after teaching the topic.

In order to avoid language barriers, the questions in the questionnaires were also translated to Xhosa in order to help learners to understand the questions so that they could provide relevant information. This was done so as to ensure that any misconceptions that arise were not due to the language of instruction. According to Oyoo (2007), analysis of language in research instruments used in some studies of possible sources of learners' misconceptions in learning science revealed that language itself can be a profound variable in the understanding of science concepts even to those who learn in their first language.

The learners were also allowed to respond in Xhosa so that they could provide as much information as possible and their responses were translated to English. According to Vygotsky (1978), Lemke (1990) and Mortimer & Scott (2003), a learner should be able to use spoken and written language to articulate and defend their knowledge claims during the argumentation process.

3.7.1.1 Science attitude questionnaire (SAQ)

This questionnaire was used to gather learners' views about science. Learners were required to answer questions based on their attitude towards science by stating whether they strongly agree, agree, disagree or strongly disagree with the given statement as well as give a reason for the choice of answer given.

The Science attitude questionnaire (SAQ) was designed to determine the learners' attitude towards science and their culture and which of the two they use most in their daily lives. The questionnaire had 5 questions where the learners had to write down what their attitude is towards science and had to give reasons for their choice of feeling.

The learners were presented with scientific statements made up by the researcher relating to their general attitudes towards school science and IKS. Some of the items were derived from Liphoto

(2012) as well as "after the myth" categories by McComas (1998). It was hoped that the learners' answers on these items would help in stimulating the learners' awareness of the nature of science and IKS.

The learners had to read the statement provided and decide whether to agree or disagree with the statement on a 4-point scale agreement. **Strongly agree** meant that the learners' views match perfectly with the given statement. **Agree** meant the learners' views tend to agree with the given statement. **Disagree** the learners' views tends to disagree with the statement given. **Strongly disagree** - The learners' views are strongly in dissimilarity to the statement given.

The questionnaire also had space for learners to provide a reason in support of the choice of the answer that they made. The written responses were used as a means for the researcher to obtain qualitative data in order to interpret the learners' reasons in terms of the TAP and CAT categories.

3.7.1.2 Conceptions of lightning questionnaire (COLQ)

This questionnaire collected the biographical data of the learners to institute whether there was a connection between their conceptions and their socio-cultural backgrounds. The questionnaire had two sections. Section A was about the learners' biographical data. This section had five questions. These included: (1) age; (2) gender; (3) learner background; (4) parents' education background and (5) parents' qualifications.

The purpose of the questionnaire was to extract information relating to the learners' demographic profiles, their conceptions of selected school science concepts and their attitudes towards science and the nature of science and the nature of indigenous knowledge. This was also used to measure the comparability of learners as they were coming from two different schools as well as to establish if the learners had common conceptions of lightning.

3.7.1.3 Beliefs about lightning questionnaire (BALQ)

This was section B, question 6 to question 10 in the questionnaire and was about the learners' beliefs about lightning. The questions aimed at determining the learners' beliefs about lightning and whether they associated lightning with static electricity. The questionnaires were administered before and after the lightning lessons with the experimental group and control group 1 and only the post-test was administered with the control group 2.

The questionnaire required learners to answer questions asked as their claim and gave their reasons for their answer as the evidence to their claim. They also had to choose the source of information to support their reasons. The questionnaire was both in English and Xhosa for learners to provide relevant information as much as possible.

A pre and post-test of the same questionnaire was administered before and after the teaching of the topic. This was done so as to check if there was any change in the learners' responses after the lessons as well as to determine whether learners would have a better understanding of lightning from the scientific view after they have been taught using argumentation as a teaching and learning method.

3.7.1.4 Science achievement test (SAT)

This was a set of questions set up to assess learners' knowledge on static electricity and lightning. Section A of the test consisted of questions 1.1 to 1.7. These questions consisted of stories about lightning and how one can protect themselves during a lightning storm. The learners had to support their opinions with reasons and were told that the important thing was to express their opinions freely and honestly.

Section B of the test consisted of questions 2.1 to 2.10. These questions of the science achievement test (SAT) were syllabus and curriculum orientated. These questions were used to determine the learners' performance in physical sciences' topic of electrostatics. The questions were taken from past question papers of physics exams. The SAT also intended to determine whether the learners could recall the observations and explanations made during the practical activities done in class. It also aimed at finding out if the learners could apply the knowledge in similar situations.

The SAT was developed and administered as a pre-test and post-test to the experimental group and control group1. It was also administered to the control group 2 who wrote only the post-test. This test was different from the other questionnaires as the questionnaires focused on the learners' contextual conceptions which were drawn from their everyday experiences about lightningwhereas the test focused on the scientific worldview facet of static electricity.

The control 1 group from Blokkie secondary school was provided with the same learning materials on the topic of lightning as the experimental group and control 2 group. This therefore meant that both groups were exposed to the same content of work. The only difference was that the teacher used his own teaching style in delivering the content to the learners.

At the school that hosted control group 1 was not very far from the school that the researcher taught at, the researcher also managed to arrange to observe some of the lessons of the control group so as to ensure that the same content was taught and that IKS was integrated in his lessons. With consent from the teachers and learners involved, the lessons were also video recorded in order to get an immaculate view of the treatment and also to allow for a meditative assessment of the lessons.

3.7.2 Piloting of instruments

According to Fraenkel & Wallen (1996), the main purpose of a pilot study is to trial the envisioned processes, identify problems so as to find appropriate solutions. Teijlingen & Hundley (2001) reckon that the role of a pilot study is to check the efficacy of the research instruments and the feasibility of the main study.

Preceding the study, a pilot study was conducted at the third high school in the area. The school had similar conditions as the other two schools that were involved in the main study. All the questionnaires and interview questions were piloted and checked for clarity and were improved as a result of the piloting. Items that gave learners problems were left out. These included questions that the learners found difficult to answer because the language used was too ambiguous for them. Repeated questions were also taken out from the questionnaires.

3.7.3 Interviews

Interviews were used to identify any deviations that had occurred before and after the intervention. They allowed the learners to answer questions in the presence of the researcher and that enabled the researcher to probe responses, follow-up ideas and scrutinize motives and feelings that a written instrument cannot do. How learners respond to questions in an interview can provide information that a written word would obscure. During the interview process the participants had the freedom to answer questions. This helped learners in providing a richer account of their personal thoughts and experiences concerning the question asked.

Interviews for this study were intended to determine the effects of using a dialogical argumentation instruction method and assessment for learning (DAAFLIM) on Grade 10 learners' conceptions of lightning. These interviews also sought to identify learners' perceptions on assessment for learning and their understanding of its significance in their learning as well as to collect learners' ideas and opinions about lightning.

A semi-structured interview schedule involved a set of open questions, which were phrased in such a way as to allow a participant to answer relatively freely (Fontana & Frey, 2000). The interviews were tape-recorded in order to capture the exact words of the interviewee to prevent loss of data. Before the interview the learners were encouraged to be at ease and to speak freely as reinforced by Adler & Clark (2008), who believed that when you encourage a learner to elaborate having given an answer increases their personal involvement in the interview and not feel like a machine producing wrong or right answers to questions.

The interview schedule consisted of eight open-ended questions prepared to elicit the learner's views on the use of argumentation and assessment for learning practices. These questions allowed the researcher to follow up questions so as to have a better understanding of reasons the learners gave for holding certain views about lightning. Since some of the learners could not express themselves well in English, interviews were done in both English and Xhosa languages in which they expressed themselves well.

The main purpose was to facilitate the verbal communication process by the learners as suggested by Shilongo (2007). Moreover, scientific terms were pronounced in English so that learners could be acquainted with scientific concepts that they had developed during the learning process. The interviews took place after the lightning lessons and were recorded with the permission of the respondents. The recorded interviews were then transcribed and codes were used for each subject to maintain anonymity.

The table below shows a summary of the instruments used, measurement scales as well as interpretation methods used in the study.

Table 3.5 *Instruments, their measurements and interpretation method*

Instrument	**Measurement scale**	**Analytical interpretation**
The Science attitude questionnaire (SAQ)	4-point agreement scale. Worldview responses analysis	Quantitative t-tests. TAP and CAT analysis.
Conceptions of lightning questionnaire (COLQ)	4-point agreement scale CAT categories sub-scales Worldview responses analysis	Quantitative t-tests. TAP and CAT analysis.
Beliefs about lightning questionnaire (BALQ)	4-point agreement scale CAT categories sub-scales	Quantitative t-tests TAP and CAT analysis
Science achievement test (SAT)	4-point agreement scale	Quantitative t-tests. TAP and CAT analysis.
Classroom observations	Learners responses and excerpts	Qualitative.
Interviews	Learners responses and excerpts	Qualitative

As can be seen from Table 3.5 above, the science attitude questionnaire (SAQ) was used to gather data about the learners' attitude towards science. The concept of lightning questionnaire was used to collect data about learners' conceptions on lightning. Beliefs about lightning questionnaire collected data on the beliefs that learners had about lightning and the science achievement test was used to compare the performance of the learners before and after the intervention. The analytical interpretation column shows how the data collected was analysed.

3.8 Research methods

Quantitative and qualitative research methods were used in the study. The instruments used to collect the data were questionnaire, interview and classroom observation. The Questionnaire had four sections and these were the Science attitude questionnaire (SAQ), Conceptions of lightning questionnaire (COLQ), Beliefs about lightning questionnaire (BALQ) and the Science achievement test (SAT). The data collected was derived from the learners' performance scores and written responses in the pre and the post-tests. The experimental group and the control group1 wrote both the pre and post-test and the control group 2 wrote only the post-test.

3.8.1 Quantitative data collection

In quantitative research results are more readily analysed and interpreted (Schumacher & McMillan, 1993). It also investigates relationships and studies cause-effects phenomena. Itpresents statistical results presented with numbers.

The experimental group and control group C2 were trained on argumentation before the lessons started so as to familiarize the learners to the argumentation process. This was done to make sure that by the time the study started the learners were confident in using argumentation.

The learners were then taught using the dialogical argumentation and assessed using assessment for learning. The Activity worksheets for learning that were used with the experimental group and control 2 group were based on Toulmin's Argumentation Pattern writing frames. In the worksheets individual learners had to make their claims about lightning from the stories given, giving reasons and warrants and backings.

In all the lessons the learners were divided into groups of five or six in a group and each learner in the group was given individual activity that they had to complete first then had to discuss each learner's claims in the group. Afterwards each group had to report their unanimity arguments to the whole class. The whole class then discussed the group's claims and arguments. The teachers of the experimental and control 2 groups facilitated the process and voice recorded all the arguments presented by the learners. The control group 1 was taught using traditional teaching methods by their teacher in Blokkie secondary school.

3.8.2 Qualitative data collection

A research method that is designed to build knowledge is said to be more qualitative, hence it was used in this study. A qualitative research method branches from the anti-positivist interpretive approach as it is holistic in nature and its main aim is to understand social life and the meaning that people attach to everyday life (Schurink, 1998). Tuckman (1994) advocates that the use of qualitative methods provides the opportunity to have direct contact and get closer to the learners under the study. According to Best and Kahn (1993), qualitative research describes events without the use of numerical data. It is more open and receptive to the subjects than quantitative methods.

A questionnaire with both close and open- ended questions was conducted to find out if using dialogical argumentation and assessment for learning as an instructional model had an effect on Grade 10 learners' conceptions of lightning. The questionnaire also tried to establish how learners handle the conflicting traditional and scientific conceptions of lightning. The questionnaires also intended to determine what the learners already knew about static electricity as well as their indigenous beliefs about lightning. The questionnaires were translated in Xhosa and administered before and after the topic was taught.

3.9 Validity and Reliability of instruments

In order to improve the degree to which the data collection instruments allowed for appropriate interpretations about the respondents perceptions, the procedures described below were used.

3.9.1 Validity

The validity of an instrument is the degree to which an instrument measures what it intends to measure (Polit & Hungler, 1993). Using numerous instruments for data collection promotes the trustworthiness of a study. Validity of the research instruments was done during the piloting of the instruments. The instruments used in the study to collect data in order to answer the research questions were the Conceptions of lightning questionnaire, Science attitude questionnaire, Beliefs about lightning questionnaire, the Science achievement test on lightning as well as interviews.

The validity of the interview questions was examined by the members of the SIKSP group and five science teachers. The necessary adjustments were then made in accordance with their opinions and recommended suggestions. The five science teachers agreed that eight of the ten questions were answerable, clear, and straight to the point and could answer the research questions. Interviews, according to McMillan (2004), are a more intrusive form of data collection procedure.

Using multiple instruments to collect data secured an in-depth understanding of the phenomenon as well as contributed to the validity of the study as it added thoroughness, breadth and depth to the investigation (Stake, 1998). This was also buttressed by Anderson & Burns (1989) who said that ‘when corroborative evidence results from multiple sources, the quality of evidence is enhanced. To contribute to the validity of the study, extensive note taking also took place during the interview process, even though the interviews were recorded. This was described by Maxwell (1992) as a means of achieving primary descriptive validity as it observes behavior as well.

Data was collected over a period of 6 weeks which was divided into 4 lessons a week as required by the physical sciences curriculum for Grade 10; this was done so as to attain validity and to reduce the Hawthorne effect. Notes were also taken after the lessons, as the lessons were videotaped in order to know which areas needed improvement. Learners were encouraged to fill in the questionnaires using the language they were most comfortable with as McMillan & Schumacher (1993) also stressed that it is important to take into account the participants' language.

They also concur that when research is conducted in the natural setting of the participants it allows the participants to reflect on the reality of their life experience more accurately especially during the interviews. Because of this, the study was conducted in their schools where the learners were familiar with everything and free to express themselves. The learners in the study all lived in the same neighborhood as where the schools were located and it was determined that their families were of similar socioeconomic status.

The experimental and the control groups were randomly selected without perspicacity as one class was designated as the experimental group, and the other one was allotted as the control group. Subsequently the learners in the experimental and control groups were doing similar subjects and were taught in similar classrooms. There was also no difference regarding the setting in the study as the data was collected in the learners' own classroom settings for both experimental and the control groups. The data collection instruments did not change during the research process. The use of the control group 1 in the study also reduced the testing effect. The learners were also taught by their own teachers whom they were used to.

3.9.2 Reliability

Polit and Hungler (1993) described reliability as the degree of consistency with which an instrument measures the attribute it is designed to measure. In light to this, reliability of the instruments was done through a series of strategies. The strategies used are discussed below.

1. The instruments were examined by physical sciences colleagues from my school and the cluster in which the school belongs. This was done so as to determine the content related issues on the questionnaires and to check whether the science achievement test reflects what was outlined in the syllabus on the CAPS science content document for Grade 10.

2. The SIKSP group from UWC helped to determine and construct related evidence of the beliefs about lightning questionnaire and conceptions of lightning and some items were cut off and others were reconstructed.

3. The learners' statements were quoted verbatim even with spelling errors so as to ensure validity of the interpretations of the data.

4. Xhosa statements were also cited and then translated in English.

For further reliability, all the questionnaires were subjected to the Conbach Alpha co-efficient on the Statistical Package for Social Sciences (SPSS) version 26. The items were found to have an alpha value close to that of 0.72 for both groups. In order to determine whether parametric or non-parametric statistical procedures were to be used in analysing the data, the pre and post- tests of the science achievement test of all three groups were exposed to the Kolmogorov-Smirnov test. This test was used to describe whether the data was normal or non-normal.

3.10 Intervention

Knowledge constructed in an interpretive study is determined by the researcher's interactions with the participants, this then provides quality interpretation from the participants' own interpretations of how they make sense of their socio-cultural surroundings and activities (Borko, 2007). Taking into consideration the explanation above, the purpose of the study was to construct an interpretation with quality arguments on views of the learners about lightning and for theresearcher to gain a deeper appreciation and understanding of the learners' perceptions and beliefson science, indigenous knowledge and lightning. The researcher was also able to capture individualparticipant's beliefs, emotions and implicit norms which explained the rationale behind their views and interpretations.

Data was collected over a period of 6 weeks. The periods in both schools were 60 minutes for each lesson. The lesson plans for the lessons gave a wide-ranging guidance to the teacher concerning the materials and apparatus needed, the group sizes, the way to divide the learners, the tasks learners should do and the way to assign the tasks and the approximate time activities were expected to last.

Learning is best achieved in a setting where two or more individuals engage in a discourse about a topic (Kelly, 2007). Interaction between learners promotes learning and improves cognitive structures by exposing the learners to different and maybe contradicting ideas. The different ideas motivate learners to reflect on and re-examine their ideas and possibly restructure and modify them. According to Good & Brophy (1995), the need to communicate ideas with others in a group compels learners to articulate their ideas more clearly and realize new links that lead to a better differentiation and organization of their cognitive structures.

This view of learning therefore suggests that assessment for learning can be achieved by making it part of the learning process, as well as a collaboration between teachers and learners. In this study peer collaboration and mentoring became useful strategies for both instruction and assessment for learning. Peer collaboration and coaching facilitate learning by modelling effective ways of thinking and scaffolding complicated performance. It also allows for constructive mutual feedback and the valuing of critical thought (Dietel, 1991).

In the lessons, the different stages of DAAFLIM were followed (See figure 2.1). Stage 1 of a DAAFLIM lesson comprises of the introduction of the topic of discussion or activity and the earners use the KWL chart to state what they Know, what they Want to know and what they have Learned. This is when the teacher makes the aims of the lesson clear to the learners. Stage 2 involves the individual task (intra-argumentation) as this allows for individual thinking space. Each learner is provided with stimulus material, then the learner is prompted to engage with the material through a set of questions. These questions promote internal argumentation (intra-argumentation). An accessible writing frame is provided to the learner to record claims, backings, warrants and rebuttals.

In Stage 3, the learners take part in small group discussions (inter-argumentation). This is to allow for individual sharing space with other members of the group. Each learner is invited to present his or her ideas, thus encouraging each group member's voice to be heard. After the group debate, an internal consensus (cognitive harmonization) is achieved for presentation to the class. Peer marking and group feedback takes place at this stage. Stage 4 is when small group presentations allow for general discussion space. The group leader is chosen and presents the arguments, counter-claims, rebuttals, evidence and warrants of their group.

Stage 5 is managed by the teacher, who assists in identifying trends and patterns by advancing a cognitive harmonization during the whole class mediation. Stage 6 allows for a reflective space. An interview process, managed by the teacher, is held with a random selection of learners. According to Vaughn, Schumm, & Snagub (1996), this is done in order to reflect on the process of argumentation and the understanding of the issue.

Following the stages above, during the DAAFLIM lessons in class learners had to complete tasks on lightning individually (intra-argumentation). The tasks presented various perspectives on the phenomena of lightning and static electricity. Small group tasks followed afterwards (inter-argumentation) where learners shared their individual task answers with the learners in their various groups and also got the opportunity to defend their own views and to convince each other of possible feasible solutions to the problem statements and come to an unanimity as the group.

Each group would then choose a member to present their consensus claims and backings to the whole class for a whole class discussion leading to whole class argumentation. Amalgamation of the lesson by teacher where an attempt is made to make a smooth border crossing from an IK worldview to the school science worldview. The class group discussions were video and audio taped for in-depth analysis of learner's discussions.

In the experimental group and control group 2, assessment for learning practices were encompassed in the lessons. As mentioned in chapter two assessment for learning has four main elements: (i) explaining learning objectives and success criteria; (ii) increasing the quality of inquiry; (iii) increasing the quality of marking, feedback and recordkeeping and (iv) using self and peer assessment.

3.10.1 Assessment for Learning practices used in DAAFLIM lessons

1. Explaining learning objectives and success criteria. At the beginning of each lesson, an explanation was provided to the learners about the objectives of the lesson and what they were going to learn that particular day. The lesson's learning outcomes were discussed and shared with the learners. Learners were always reminded about the learning outcomes during the lesson as well as at the end of each lesson. At the end of each lesson, learners were asked to deliberate what they had learned in the lesson. Learners were also informed about the success measures necessary to be considered successful in the class activities. In the traditional method, the learners are not made aware of the lesson objectives. The teacher focuses on the learners getting high marks in a test. The success of the lesson is measured by only the marks obtained by the learners.

2. Increasing the quality of inquiry. To increase the quality of inquiry and dialogue, dialogical argumentation and cooperative group work was used in the lessons in order to improve dialogue amongst the learners. The groups were formed in a heterogeneous manner by the teachers. Factors such as learners' gender, achievement status and affective characteristics were taken into consideration when choosing the groups. During the lessons, learners were encouraged to think and often asked questions that measured high-level thinking skills. It was also important that learners were given a maximum time of 20 seconds to think before they responded to questions. The teacher randomly asked the learners to answer the questions as the learners were not allowed to raise their hands. This was done in order to increase participation by all learners.

3. Increasing the quality of marking, feedback and record keeping. In order to increase the quality of marking and feedback, learners' class activities were assessed using comments instead of marks or points only. Learners were then given ample opportunities to improve their activities using the teacher's feedback and were praised for improvement on an individual basis but not in comparison to each other.

4. Using self and peer assessment. Self and peer assessments were frequently encompassed throughout the lessons. At the end of each component of work done, self and peer assessment practices were applied. The learners were informed on how to conduct self-assessments and peer-assessments. There were also consultations with those learners whose completed activities did not meet expected standards.

3.10.2 Assessment for learning Agreement Circles technique

Keeley (2008) defines agreement circles as a teaching technique based on assessment for learning. When using this technique, the teacher presented some conceptually correct and incorrect statements regarding static electricity in order to apply the technique. Incorrect statements were meticulously selected among frequent misconceptions of learners.

During the implementation, learners stood in a circle facing each other. The teacher read the statements one by one. Learners who agreed with the statement read to them took one step inside of the circle; the ones who did not agree remained in their position. The teacher then divided the ones who agreed from those who disagreed and put them into smaller groups and asked them to justify their opinion regarding the statement to each other.

While the small groups were in discussion, the teacher moved among them and noted down the opinions of the learners. When the discussions were over, learners were given the opportunity to reposition themselves if they wanted to. The learners agreeing with the statement stood inside the circle, the ones disagreeing on the circumference; the teacher then noted the changes. After the teacher had taken down the notes regarding the changes, a new circle was formed for the next statement and the same steps were repeated.

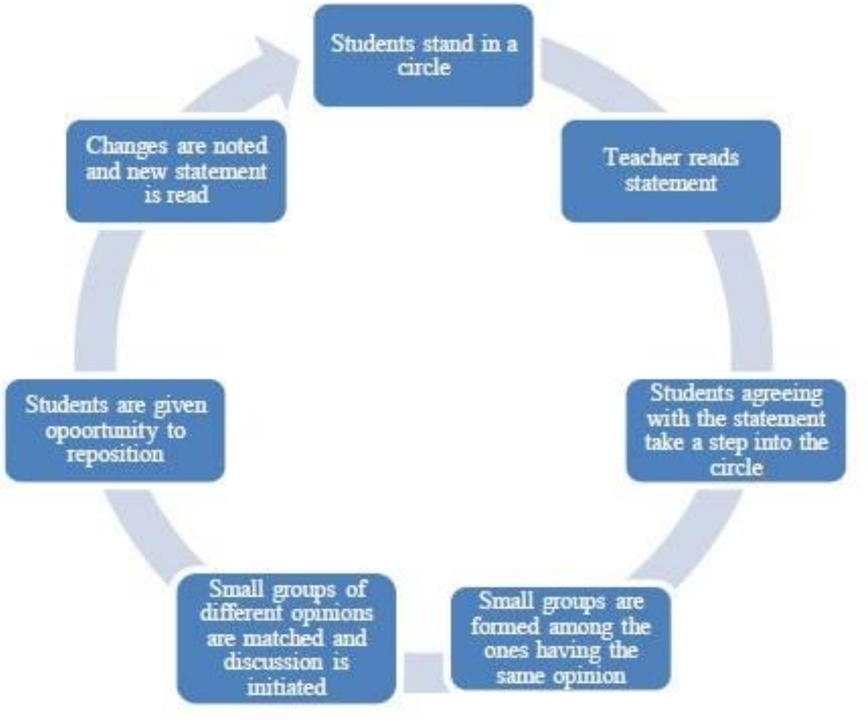


Figure 3.7 *Agreement circles technique implementation diagram (adapted from Kelly, 2007)*

This technique encouraged the learners to contemplate their opinions thoroughly and was implemented according to statements about static electricity and lightning concepts. It also gave learners the opportunity to develop the existing opinions and to create new and original ideas while advocating their point of view. The teacher also obtained information regarding their conceptual understanding levels.

Assessment for learning is a means by which teachers can provide continuous instructional feedback to learners with the aim of bridging learning gaps in what learners currently know and what they should know. The agreement circle technique revealed the lack of knowledge and misconceptions of learners regarding lightning. Therefore, in order to increase the learners' conceptual understanding levels, static electricity activities were also administered.

This research came up with an intervention that was intended to help learners acquire argumentation skills and then use the skills to integrate knowledge on lightning from different worldviews.

3.11 Data analysis

The SPSS-26 package program was used to analyse the data from the questionnaires using descriptive and inferential statistics. Normality assumptions were controlled using the descriptive statistics. At the beginning of the study an inferential statistics independent sample t-test was used to check if there was significant difference between the experimental and the control group 1 performances.

3.11.1 Analysis of the questionnaires

Toulmin's Argumentation Pattern (TAP) was used in evaluating the learners' practical arguments as required for school science, while the Contiguity Argumentation Theory (CAT) helped in stimulating the learners' cognitive stances and the exposition of how learners bridged between their IK worldviews and those of school science.

The pre and post questionnaires were analysed using the CAT as espoused by Ogunniyi (2007a) as it focuses on logical and non-logical or traditionally entrenched arguments. Analysis of the questionnaires was done so as to find common cultural beliefs of lightning held by learners of the two schools where the study took place. The responses written in Xhosa were translated to English.

Similar beliefs held by the learners were grouped together and presented in a table for discussion, to answer these research questions:

(1) What conceptions of static electricity were held by Grade 10 learners before and after being exposed to dialogical argumentation-assessment for learning instructional model (DAAFLIM)?

(2) Is there any significant difference in performance and conceptions of static electricity held by the learners exposed to DAAFLIM and those not so exposed?

According to Diwu (2010), the CAT categorises the responses of the learners depending on whether the statement chosen by the learner is more scientific or more on the IKS worldview. Learners' responses were categorised into the 5 cognitive categories of the CAT framework. As discussed in chapter 2, these five CAT categories are: dominant, suppressed, assimilated, emergent and equipollent.

The worksheets completed in class gave an idea of what the learners' understanding about lightning were, both culturally and scientific. The pre and post questionnaires were used to compare the learners' understanding of lightning and static electricity prior and after the argumentation intervention. The learners' pre and post responses were analysed. This was used to check whether they changed their beliefs as well as to see if their knowledge about lightning and static electricity has improved and if they recognize the link between lightning and static electricity.

Toulmin's Argument Pattern (TAP) was used to identify the construction of arguments demonstrated by the learners throughout each lesson. The learners' arguments were categorized according to the TAP levels as illustrated in the table below.

***Table 3.6** Analytical Framework used for TAP*

Level 0 Non-oppositional
Level 1 Argument involved a simple claim versus counterclaim with no grounds or rebuttals.
Level 2 Argument involved claims or counterclaims with grounds but no rebuttals.

Level 3 Argument involved claims or counterclaims with grounds but only a single rebuttal challenging the claim.

Level 4 Argument involved multiple rebuttals challenging the claim but no rebuttal challenging the grounds (data, warrants and backing) supporting the claim.

Level 5 Argument involved multiple rebuttals and at least one rebuttal challenging the grounds

Level 6 Argument involved multiple rebuttals challenging the claim and/or grounds.

Both the experimental and control group 1 wrote the same pre and post-tests at the end of the teaching. Control group 2 only wrote the post- test. The paired sample t-test was done at 95% confidence level in order to determine the effectiveness of the materials in influencing conceptual change.

The audio and video tapes that were used to collect data were listened to after the lessons and relevant information were recorded for analysis. The audios were transliterated and the Xhosa responses were translated to English for analysis. The videotapes helped analyse and interpret the involvement of the learners in the lessons as well as their body language. The videotapes helped with observing how learners interacted with each other in their groups and the discussions that took place during the lessons; all these were used in the discussion of the results.

3.11.2 Analysis of the Interviews

The interview tapes were transcribed and analysed to answer research questions 2, 3 and 4. The interviews took place after the lessons, consequently they were used to determine if the learners had a divergent or better understanding of the scientific view of lightning after the use of

DAAFLIM and IKS amalgamated lessons and the discussions that they had or whether they did not change their views at all.

3.12 Data coding

Data derived from all the instruments in the study was analysed subsequently in terms of quantitative and qualitative descriptions. For the quantitative data, Statistical Package for Social Sciences (SPSS) version 26 was used to code and to interpret both the quantitative and qualitative data. The items of the questionnaires were coded and given nominal scales as shown in the table below.

Table 3.7 *SPSS Data of Learner Questionnaire*

Gender	Home language	Province originally from	Type of Area	Guardian	Educational Background of guardian	Learner response
Male= 1 Female= 2	Xhosa= 1 English= 2 Sotho= 3	Western Cape= 1 Eastern Cape= 2 Gauteng= 3 Lesotho= 4	Urban= 1 Rural= 2	Mother= 1 Father= 2 Grandmother= 3 Grandfather= 4	Never= 1 Primary= 2 Secondary=3 Diploma= 4 Degree= 5	Strongly agree = 1 Agree= 2 Disagree =3 Strongly disagree = 4

3.13 Ethical considerations

Social science researchers need to be ethical when undertaking the processes of data collection, data analysis and in disseminating findings (Denscombe, 2007). In response to this, the researcher followed the ethical guidelines provided by the Ethics Committee of the University of the Western Cape. These guidelines aimed to ensure that the research was carried out honestly; the necessary permission was sought and the research participants and institutions to which the research is conducted were informed and protected. As such the researcher:

1. Sought and was granted ethical approval from the school to undertake research within the faculty.

2. Sought ethical approval from the ethics committee of the Western Cape Education Department (WCED) to undertake research with the learners at the schools and it was approved.

3. Obtained verbal and written consent from the learners to participate; be observed and be audio/video taped.

4. Provided information on the study to the participants of the study.

5. Assured participants of anonymity and confidentiality and that the information obtained will be used exclusively for research purposes.

The learners were not disturbed in their day to day lessons as the study took place during school hours in their normal periods. The group of learners that participated in the study were given consent forms to sign. The consent forms informed them about the general nature of the research as well as assured them of their anonymity and confidentiality of what would be collected. In this regard the schools involved were given fictitious names in order to protect the schools' identities. At the end of the study a summary report of the findings of the study will be submitted to the Western Cape Department of Education (WCED) and to the school principals of the schools that participated in the study.

3.14 Summary

This research is placed within the interpretive paradigm. The interpretive research aims to understand how people make sense of their world. The construction of knowledge in interpretive research is characterized by the active interaction between the researcher and the participants.

The Solomon-three group was used as a research design. One experimental and two control groups participated in the study. The experimental group wrote both the pre-test and the post-test and was treated with DAAFLM. Whilst one of the control group wrote both the pre and post-tests and was not exposed to DAAFLM, the other control groups wrote only the post-test and was treated with DAAFLM.

The study was conducted in two schools under the Metro East region of the Western Cape Education Department. Due to time and financial constraints, a convenient sample of 125 learners was selected from the two schools. The background of the two schools participated in the study was similar. Data was collected using Questionnaire, interview and classroom observations. The questionnaire had four sections. These include the science attitude, conception of lightning, beliefs about lightning and a science achievement test.

The research methods used were also outlined in-order to determine the effects of DAAFLIM to teach electrostatics. Both quantitative and qualitative methods were used to analyse the data collected. The quantitative data was described descriptively using bar charts. A paired t-test was also used to analyse the data. The paired sample t-test was done at 95% confidence level in order to determine the effectiveness of the materials in influencing conceptual change. The qualitative data was analyzed using the two theoretical frameworks CAT and TAP.

Throughout the study all the necessary ethical requirements were strictly adhered to. Permission was obtained from the Western Cape Department of Education and the schools that participated in the study. Consent was obtained from the subjects themselves. Anonymity, self-determination and confidentiality were ensured during the administration of the instruments. Reliability and validity of the instruments were improved by pretesting the questionnaire and the interview questions. The next chapter will deal with the exhibition and scrutiny of the results.

Chapter 4

Results and Discussions

4.1 Introduction

This chapter focused on the conceptions of static electricity (lightning) that were held by Grade 10 learners before and after being exposed to dialogical argumentation and assessment for learning instruction model and how they dealt with conflicting IKS views and Science views about lightning. It also looked into whether or not there is significant difference in conceptions and performance of static electricity held by the learners exposed to DAAFLIM and those not so exposed. Moreover, it looked into whether or not there are differences in the learners' conceptions and performance of static electricity in relation to their gender, age and interest in science.

Data was obtained through open-ended questionnaires and semi-structured group-interviews, as well as field notes from observations conducted when the argumentation and AFL tasks were administered to the learners. Learners' perceptions are described and excerpts from questionnaire responses are used to illustrate the sources of the perceptions. Interviews and observation field notes were also used.

This study employed a pre-posttest Solomon three experimental design. In light of this, the learners' conceptions before and after the two intervention strategies were assessed. As a reminder the three research questions that this thesis addresses are as follows:

1. What conceptions of static electricity were held by Grade 10 learners before and after being exposed to dialogical argumentation and assessment for learning assessment instructional model (DAAFLIM)?
2. What is the difference in performance and conceptions of static electricity held by the learners exposed to DAAAFLIM and those not so exposed?
3. To what extent are the differences in the learners' conceptions and performance of static electricity related to their gender, age and interest in science?

4.2 Research Question 1:

What conceptions of static electricity wereheld by Grade 10 learners before and after being exposed to dialogical argumentation and assessment for learning assessment instructional model (DAAFLIM)?

In order to answer research question 1, the learner's conceptions of static electricity before and after being exposed to DAAFLIM were gathered using the COLQ, BALQ and Interview schedule. The control 1 and experimental groups completed the pre- and post- tests of the questionnaires. The control 2 learners only completed the post test. The interviews were done with the experimental group and the control 2 group only as they were the only groups exposed to the DAAFLIM.

4.2.1 Learners' attitude towards science

Learners' attitude towards science were gathered from question 1 to 5 of the COLQ. The learners had to agree or disagree with the given statements. Most of the learners in each group indicated that science is interesting at both pre and post-test levels. As can be seen in Table 4.1, about 70% of the learners in the control 1 group and 80% of the learners in the experimental group indicated that science is interesting at pre-test. At post-test the number of learners who indicated so increased by 4.7% and 7.5% for the control 1 group and the experimental group respectively. The percentage of the learners in control 2 group who indicated that science is interesting was 90.5%.

When asked if they understand science through IKS better, 83.7% of the learners in the control 1 group and 77.5% of the learners in the experimental group indicated that they understand science through IKS better at pre-test. The percentage of the learners in the control 1 group who indicated so decreased to 67.4% at post-test by 16.3% whereas the percentage of the learners in the experimental group increased to 82.5% at post-test by 5%. Two-third of the learners in control 2 group indicated that they understand science through IKS better.

Table 4.1 *Comparison of learners' pre- and post-test attitude towards science*

Category	**Group**	**Agree**	**Disagree**
Science is interesting	**C1 pre-test** **post-test**	**30** **32**	**13** **11**
	E pre-test **post-test**	**32** **35**	**8** **5**
	C2 **post-test**	**38**	**4**
Understanding Science through IKS	**C1 pre-test** **post-test**	**36** **29**	**7** **14**
	E pre-test **post-test**	**31** **33**	**9** **7**
	C2 **post-test**	**28**	**14**
Relevance of Science in real life	**C1 pre-test** **post-test**	**36** **30**	**7** **13**
	E pre-test **post-test**	**33** **30**	**7** **10**
	C2		

	post-test	**38**	**4**
Believe in IKS than Science	**C1** pre-test post-test	**21** **21**	**22** **22**
	E pre-test post-test	**22** **15**	**18** **25**
	C2 post-test	 **19**	 **23**
Use Science only for exam purposes	**C1** pre-test post-test	**21** **25**	**22** **18**
	E pre-test post-test	**20** **10**	**20** **30**
	C2 Post-test	 **17**	 **25**

About 84% of the learners in the control 1 group believed that science is relevant in real life whereas 82.5% of the learners in the experimental group believed the relevance of science in real life at pre-test. The number of learners who believed in the relevance of science in real life decreased in both groups at post-test. The number of learners decreased to 69.8% for the control 1 group and to 75% for the experimental group. More than 90% of the learners in the control 2 group believed in the relevance of science in their daily life.

When asked if they believe more in IKS than in science, 48.8% of the learners in the control 1 group believed more in IKs than in science whereas 55% of the learners in the experimental group believed more in IKs than in science at pre-test. Whilst the number of learners in the control 1 group who believed more in IKs remained the same at post-test, the number of learners who believed more in IKs than in science decreased to 37.5% at post-test by 17.5%. About 45% of the learners in the control 2 group believed more in IKs than in science.

About 49% of the learners in the control 1 group and 50% of the learners in the experimental group indicated that the use of science is only for exam purposes at pre-test. Whilst the number of learners in the control 1 group increased to 58.1% at post-test by 9.3%, the number of learners who believed that science is used only for exam purposes decreased from to by 25%. About 40% of the learners in the control 2 group believed in the use of science only for exam purposes.

The results show that the learners who were exposed to DAAFLIM considerably increased a positive attitude towards science and developed more interest in science than those who were not so exposed. The finding of the study is similar to the research studies that were done by King (2003) and Tekin (2010) on assessment for learning. Learners come to science classrooms with prior knowledge- scientific or cultural. This prior knowledge is acquired through school science or the traditional and cultural practices of the society they live in. The socio-cultural background of the learners, as pointed out by Jegede (1995), is one of the factors that has an effect on what the learners believe in. When learners' cultural beliefs and experiences are included as examples when teaching science, it has an advantage of drawing learners' attitudes into the learning of science topics (Pabale, 2006).

Argumentation, as argued by Driver et al. (2000), is a genus of discourse that is central to doing science. The inclusion of IKS through DAAFLIM allowed learners to reflect on their prior learning while constructing a new learning. This helped the learners to see the relevance of science in their daily life and realise that the purpose of science is not only limited to exams. When learners engage in argumentation, they master content about which they are arguing. Engaging learners in argumentation helped them learn to argue and evaluate arguments better. Also noted by Siegel (1995) is that, argumentation plays a central role in the building of explanations, models, and theories as scientists use arguments to relate the evidence they select to the claims they reach through use of warrants and backings.

During the DAAFLIM lessons, the learners were allowed to express themselves in IsiXhosa as that way, more participants were guaranteed as English is still a barrier with the township learnersas they only speak it at school therefore sometimes it is difficult for them to express themselves freely. Using DAAFLIM in class made learners feel comfortable and were able to share their ideaswith others and the lessons became interesting for them and therefore it was easier to remember what they had learnt. In Traditional instruction learners can only share their views and allowed totalk in class when asked questions by the teacher.

When you control the learning and use of language, as pointed out by Fatnowa and Pickett (2002), you control the way how people relate to and see the world around them. Mahapa (2002) also agreed that learners should be encouraged to use the language they understand better in order to respond to questioning.

4.2.2 Learners' conceptions of lightning

The learner's conceptions of lightning were gathered using the Conceptions of Lightning Questionnaire (COLQ). Both the control 1 and the experimental groups completed the same pre- and post-test questionnaires. Control 2 group only wrote the post-test. Initial conceptions of lightning were collected using the pre-test questionnaire. The learners were asked to respond to each questionnaire with questions relating to lightning.

The questions for the COLQ were derived from questions 6 to 10 in the Learners' Conceptions of Lightning questionnaire. The first question asked the learners if they believed there is a relationship between lightning and electricity. Question two asked if they believed that lightning was caused by witches. The third question was based on the dangers of lightning and asked if the learners believed that the effects of lightning could kill a person. The fourth question was on the explanation of the lightning phenomenon, the learners had to choose whether they believed that science or traditional belief explains lightning better. The fifth question asked if it helps to cover mirrors during a lightning storm.

Each question had four alternative response choices to which learners had to decide whether they were in agreement or disagreement with the statement. The Likert scale for the options was: **(SA)** = Strongly Agree; **(A)** = Agree; **(DA)** = Disagree; **(SD)** = Strongly Disagree. The conceptions about lightning were gathered from a group of 125 learners. Forty-two learners were from the control 1 group (C1), 43 learners were from the control 2 group (C2) and 40 were from the experimental group (E).

The data was collected before and after the learners had been exposed to Dialogical Argumentation and Assessment for Learning Instructional Model (DAAFLIM) or traditional teaching method. For ease of reference learner 1 (E1) to learner 40 (E 40) represented the learner in the experimental group, learner 41 (C1:41) to learners 82 (C1: 82) represented learners in the control 1 group and learner 83 (C2: 83) to learner 125 (C2:125) represented learners in the control 2 group.

The learners' scientific and IKS-based views of lightning which are taken from conceptions of lightning questionnaire (COLQ) are summarised in table 4.2 below. In order to identify the learners' views about lightning, the learners' responses to each question are classified into two- "agree" i.e. a combination of agree and strongly agree or "disagree" i.e. disagree and strongly disagree. This section focuses on the views of the learners from both the control 1 group and the experimental group in terms of the relationship between lightning and electricity. It also discusses how the learners back their claims or explain their views.

Table 4.2 *Learners' pre-test conceptions of lightning*

Category	Group	Agree	%	Disagree	%
There is Relationship between lighting and electricity.	C1 E	37 31	86 77.5	6 9	16 22.5
Lightning is caused by witches.	C1 E	15 25	34.9 62.5	28 15	65.1 37.5
It is not necessary to protect yourself from lightning because it cannot kill you.	C1 E	11 10	25.6 25	32 30	74.4 75
Scientific explanation of lightning is better.	C1 E	37 32	86 80	6 8	14 20
It helps to cover mirrors during lighting strikes.	C1 E	40 30	93 75	3 10	7 25

4.2.3 Relationship between lightning and electricity

More than three-quarters of the learners in each group believed that there is a relationship between electricity and lightning. Eighty-six percent of the learners in the control group believed that there is a relationship between lightning and electricity whereas 77.5% of the learners in the experimental group believed that there is a relationship between the two. A small percentage of learners from the two groups, i.e. 16% of the learners from the control 1 group and 22.5% the experimental group did not believe that there is a relationship between electricity and lightning. It was evident that both groups of learners believed that there is a relationship between lightning and electricity. Below are some of the reasons that these learners gave.

Learner E10: Agree, We call it the same; so they are the same and they both shock you.

Learner C1:54: Agree, Lightning and electricity both have sparks.

Learner E5: Disagree, Lightning is natural, made by God. Electricity is made by humans.

Learner E30: Disagree, Witches make lightning and Science makes electricity.

According to some of these learners, there is a relationship between lightning and electricity in the sense that they both have sparks or cause shocks. Some of the learners believed that lightning and electricity are the same. They claimed that lightning and electricity are the same because the two have the same name in their language. In IsiXhosa language, lightning and electricity use the same term (umbane) this makes it difficult for learners to differentiate between the two.

The learners who disagreed that there is a relationship between lightning and electricity seemed to believe that lightning has nothing to do with electricity. Some of these learners backed their claims by saying that lightning is natural whereas electricity is man-made. Hence, there is no relationship. Others backed their claims by saying that witches make lightning and Science makes electricity.

Most studies that dealt with cultural issues or indigenous knowledge highlighted that African learners experience a problem in understanding science concepts. During the study, it was evident that some learners from the experimental group experienced some difficulties in expressing themselves in English and they often resorted to code switching or speaking IsiXhosa. During the DAAFLIM lessons, the learners were allowed to use a language they were comfortable in and they all understood so as to get maximum participation. This also helped in the learners expressing their views freely about the topic during the lessons. The teacher also used code switching during the lessons in order to explain. Compared to traditional teaching, learners are usually not comfortable in voicing their views as they have to do in English which they have trouble expressing themselves in. As a result the teacher is mostly the one talking in class.

Learners should be allowed to use a language that they are comfortable to express themselves with. When you control the learning and use of language, as argued by Fatnowna & Pickett (2002), you control the way in which people see and relate to the world around them. Other researchers believe that the use of more than one language in science teaching can improve teaching and learning. Maselwa (2004) investigated the effect of prior knowledge about lightning in the teaching of electrostatics and his findings showed that some learners could be reluctant to give their views because of lack of proficiency in English, which was the medium of instruction.

The findings in this particular question suggested that for the majority of learners, the cultural worldview differed from the science worldview and they have different ways of resolving such conflicting views. Aikenhead (1999) refers to this cognitive setting as collateral learning because learners are learning something in a school setting that might be in conflict with their indigenous knowledge from home. Therefore, for these learners, learning about lightning in science means constructing a potentially conflicting idea in their long term memory.

4.2.4 Causes of lightning

Learners from both the control and the experimental groups shared similar views regarding the cause of lightning. As can be seen from table 4.2, about 35% percent of the learners from control 1 group and 62.5 % of the learners from the experimental group believed that lightning was caused by witches. The number of learners in the experimental group was much more than those learners in the control group who believed that lightning was caused by witches. About 37% of the learners in the experimental group and about 65% of the learners in the control 1 group did not believe that lightning is caused by witches. In total, almost half of the learners from both groups believed that lightning is caused by witches. Below are some excerpts of their responses from both groups.

Learner C1: 45: **Strongly disagree,** Lightning is caused by the attraction of negative and positive charges.

Learner C1: 73: **Disagree,** Lightning is not caused by witches the lightning happens when different charges meet.

Learners C1: 64: **Agree**, because sometimes the unnatural causes that science cannot even prove it is a fact so that culture is believed to be an evil source like witches and traditional doctors are causes.

Learner E32: **Disagree,** because we don't have much sure that I think lightning was created by God.

Learner E23: **Agree,** Yes in our religion we believe that lightning is caused by witches and tradition doctors to try and kill you.

Learner E19: Strongly disagree, because lightning is formed by the charges (electrons). If there are charges, others are negative and others are positive. There will be attraction between the earth and the sky, so they attract each other and then there will be lightning.

Learner E17: **Agree,** Yes it is caused by witches and traditional doctors because witch can make lightning when they want to hurt someone they hurt.

About 62% of learners from both groups believed that lightning is not caused by witches. Only 38 percent of the learners believed that lightning is caused by witches or witch doctors.

Learner C1: 60: Agree, because traditional doctors can send lightning to you and your family. Witches send it when wanting to kill someone.

Some of these learners claimed that lightning is not natural, it is caused by witches when they want to kill someone or the whole family. Very powerful witches can send lightning to you wherever you are. Most of these claims were from the learners coming mostly from the rural areas of the

Eastern Cape. Other learners believed that lightning is sent by witches and traditional doctors when they want to kill someone they do not like. These learners can be categorised as possessing a dominant IK view.

Some of the learners believed that lightning is also caused by traditional doctors whereas others believed that it is natural and is caused by God. According to these learners God sends lightning when he is angry. Others claim that it can also be caused by scientists but could not back their claims. Some of the learners claimed that there are two types of lightning. According to these learners there is one that lasts a few minutes (caused by witches) and another that lasts longer. However, some learners backed their claim saying that lightning is caused by charges. It is evident that some of these learners were backing their belief scientifically whereas others did not.

Upon comparing the demographic data of the learners, it was revealed that the learners coming mostly from the rural areas of the Eastern Cape believed that lightning is sent by witches and traditional doctors when they want to kill someone who is their enemy. These learners can be categorised as possessing a dominant IK view as Van der Linde (2010) has indicated that a conception becomes dominant when it is the most adaptable to a given situation.

4.2.5 Protective measures of lightning

About three-quarters of the learners from each group believed that it was necessary to protect yourself from lightning because it can kill you. These learners suggested both scientific and IKS views ways of protecting oneself from being struck by lightning. In both groups, most learners believed that lightning is very dangerous and burns people to ashes. Some of these learners mentioned that the ancestors will not be able to recognise them in such an instance.

In IsiXhosa culture, people believe that the ancestors keep watch over the living at all times. It is, therefore, mandatory for the living people to ensure that the link with the ancestors is kept viable through constant worship or sacrifice. In return, the ancestors protect the family from dangers such as lightning that is sent by witches. The Xhosa people believe that there are safety procedures that can be taken against lightning.

Most of the learners believed that lightning is not only caused by witches but also perceived it as an evil act. Some learners in both groups believed that "no matter how much you try to protect yourself, when witches want to kill you your protection will not work". According to these learners, nothing can protect you once a witch is angry and decides to send lightning to you. Therefore, people must avoid provoking witches. However, there were learners who believed that lightning is caused by witches and that traditional doctors can help or protect you from being struck by lightning. Others believed that asking a priest to pray for your house protects you from lightning as God is the only one who can help chase the evil away.

Many seemed to believe that putting a motorcar tyre on top of the roof of a house protects one from lightning strikes. Moreover, some learners suggested that when a small piece of a tyre is burned, it chases the evil spirits and hence it chases away the lightning. When asked to explain how this method of protection works, their claims were warranted by tales they heard from their grandparents who believed that burning a tyre calls the ancestors and chases lightning away. Some said that the rubber absorbs the lightning. Others said that just like a car's tires protect you when lightning strikes a car, it protects the house in the same way.

When asked to agree or disagree with the statement: "It helps to cover mirrors during lightning strikes", most of the learners in both groups agreed. Three-quarters of the learners from the experimental group and 93% of the learners from the control 1 group believed that it helps to cover mirrors during lightning. Some of these learners mentioned that their grandmothers told them to always cover mirrors during lightning because if lightning hits the mirror everything in the house will be destroyed. These learners believe that a mirror attracts lightning and when it hits a mirror it reflects and bounces back and destroys the surroundings. Learners from both groups seemed to hold the same traditional views about protective measures of lightning. Below are the pre-test excerpts from control 1 and the experimental groups about protective measures from lightning.

Learner C1: **59**: Strongly agree, you should protect yourself from lightning could kill you.

Learner E9: Agree, when there is lightning I hide myself and don't wear clothes with bright colours because it is more attracted to bright colours.

Learner E21: Agree, lightning comes to you when it wants to come to you

Learner E19: Strongly disagree, if you have a metal on you, you must protect yourself.

Learner C1: 66: Strongly disagree, Lightning can kill you because it is electricity.

Learner E2: Agree, When your mirror is not covered the lightning will strike it.

Learner C1:47: Strongly agree, when it is lightning you must cover shiny things because they will attract the lightning and it will hit you and kill you.

Learner C1:58: Disagree, we always put a motor car tyre on the roof. If there is a tyre on the roof the whole house is protected.

When asked to agree or disagree with the statement, "Scientific explanation of lightning is better", most learners from both groups agree. Eighty- six percent from the control 1 group and 80% from the experimental group believed that scientific explanation of lightning is better than IK's. Nevertheless, it was evident that most of these learners from both groups believed that covering of mirrors during lightning helps to protect oneself from being struck. There has been no scientific evidence on how mirrors attract lightning but it is culturally believed that mirrors or any shiny material attracts lightning. Therefore, the learners' belief was that 'mirrors need to be covered when there is a lightning storm as shiny materials attract lightning to you'.

The data from the pre-test showed that learners do come to science classrooms with some prior knowledge and experiences about natural phenomena, such as lightning, which they have acquired from their community (Rennie, 2011). When learners' cultural beliefs and experiences are included as examples when teaching science, it has, as noted by Pabale (2006), an advantage of drawing learners' attitudes into the learning of science topics. It was also noted that even though the learners come from different backgrounds, they seemed to have common cultural views about lightning.

The findings above also indicated that the learners from both the experimental group and control 1 group held similar cultural views about protecting oneself from lightning. The protective measures mentioned by the learners were similar to the findings in the studies done by Liphoto (2008) and Nanghonga (2012). For instance, these studies also found that learners believed that white and other bright objects attract lightning and that mirrors must be covered as they attract lightning as they reflect lightning.

4.2.6 Learners' cognitive shifts in conceptions of lightning

The scientific view of lightning was taught during the lessons in both the control and the experimental group classes. The experimental group and control 2 group were exposed to the dialogical argumentation- assessment for learning instructional model (DAAFLIM) and thecontrol 1 group was taught the traditional way of chalk and talk.

4.2.6.1 Lightning and electricity (post-test)

In this section, the focus is on the post- test views of the learners about the relationship between lightning and electricity from the three groups after they have been exposed to the different teaching strategies The table 4.3 below presents the learners' post- test responses to the concepts of lightning questionnaire. The post- test of this questionnaire was administered after the experimental and control 2 groups were exposed to the DAAFLIM and the control 1 group was taught using the chalk and talk method.

Table 4.3 *Learners post-test conceptions of lightning*

Category	**Group**	**Agree**	**%**	**Disagree**	**%**
There is Relationship between lighting and electricity.	C1 C2 E	38 36 35	88.4 85.7 87.5	5 6 5	11.6 14.3 12.5
Lightning is caused by witches.	C1 C2 E	20 16 10	46.5 38.1 25	23 26 30	53.5 61.9 75
It is not necessary to protect yourself from lightning as it cannot kill you.	C1 C2 E	9 9 8	20.9 21.4 20	34 33 32	79.1 78.6 80
Scientific explanation of lightning is better.	C1 C2 E	37 34 35	86 81 87.5	6/9 8 5	14 19 12.5
It helps to cover mirrors during lightning strikes.	C1 C2 E	40 34 32	93 81 80	3 8 8	7 19 20

As can be seen from table 4.3, 88.4% of the learners from the control 1 group believed that there is a relationship between electricity and lightning after they have been exposed to chalk-and-talk instructional methods. This was 86% at a pre-test level. However, 87.5% of the learners from the experimental group believed that there is a relationship between electricity and lightning at post-test level. The percentage increase for the control 1 group is 2.4% whereas the percentage increase for the experimental group is 10%.

After being exposed to DAAFLIM, 85.7% of learners in the control 2 group believed that there is a relationship between lightning and electricity. Some of the learners from the control 1 group who believed that there is a relationship between electricity and lightning provided reasons for their beliefs as shown in the excerpts below:

Learner C1: 67: Agree, because when electricity shocks you it is like you have been struck by lightning. They are the same.

Learner C1: 72: Strongly Agree, Lightning is attracted by electricity, if you hold your phone when there is lightning, lightning will strike you. Therefore, there is a relationship.

Some of the control 1 group learners believed that there is a relationship between lightning and electricity. Their reasons included that lightning is attracted by electricity. According to these learners, it is dangerous to use electrical appliances when there is a lightning storm. This is because they believed that the electrical appliances attract lightning and get ruined. Other learners believed that it is also dangerous to use a cell phone during a lightning storm as lightning will strike you. In terms of CAT, the learners' explanations can be classified as a science dominant view. This showed that the learners had changed their views to a more scientific belief.

The learners in control 1 group showed that they believed the protective measures against lightning and electricity are the same. They also believe that it is dangerous to use electronic appliances such as cell phones during a lightning storm as they attract lightning. This is, as pointed out by Trengove & Jandrell (2015), a common misconception in South Africa that it is dangerous to speak on a cell phone during a lightning storm because it attracts electricity. During the post-test the learners made similar claims and reasons as in the pre-test that was administered. This showed that the learners did not have such strong backing as their claims were not warranted with valid scientific evidence. Therefore, their statements could be seen as evidently IK suppressed into science.

Some learners in the experimental group also agreed that there is a relationship between electricity and lightning and their claims and reasons are as follows:

Learner E37: Agree, Yes there is a relationship between lightning and electricity because when lightning happens you should not touch electricity because it will hurt you.

Learner E12: Strongly agree, because lightning is still electricity and electricity is a current electricity, it works or transferred through conductors and lightning is the reaction between a negative charge and a positive charge in the clouds and the ground.

Learner E21: Agree, because if you are watching a television while there is lightning, the television could get burned.

The learners above are some of the learners in the experimental group that agreed that there is a connection between lightning and electricity. Their excerpts revealed that these learners based their arguments mostly on the similarities in the formation of electricity and lightning. They claimed that both electricity and lightning are formed by charges that attract each other. The learners seemed to give more scientific reasons for their claims. Therefore, one can conclude that the learners in the experimental group who were exposed to DAAFLIM gave more scientific reasons to their claims with regards to the relationship between lightning and electricity than those who were exposed to the traditional teaching method.

The learners who took part in the dialogical argumentation and assessment for learning activities showed evidence of having made significant conceptual gains regarding the relationship between lightning and electricity as compared to the control 1 group. It revealed that, in terms of CAT, the reasons that the learners gave are more scientific. Therefore, it was evident that these learners had a dominant science worldview in the CAT classification.

However, the learners who said that there is no relationship between lightning and electricity backed their claims based on different grounds. Some said that lightning is formed by charges in the clouds but electricity is made of coal. Hence, there is no relationship between the two. Other learners said that there is no relationship between the two because lightning is dangerous whereas electricity is used positively as a source of energy. It was evident that these learners saw lightning and electricity as two different entities that are not related.

The control 2 group wrote only the post test, and was taught using DAAFLIM. The results showed that 85% of learners in the control 2 group believed that there is a relationship between lightning and electricity.

Learner C2 101: Agree, because lightning is labeled as a static electricity, but electricity that is stored.

Learner C2 92: Strongly Agree, electricity and lightning do have a relationship, the shock you experience by electricity is the same as when shocked by lightning. You must not touch metal when using electricity and when there is lightning you must stay away from metals or you will get shocked.

Most of the learners in the control 2 group gave more scientific reasons as to why they believed that there was a connection between lightning and electricity. Some said that, because both have the same effect when they come into contact with you they are similar. They said that both lightning and electricity are attracted by metal objects. They believed that you must not touch a metal when working with electricity and one must stay away from metal objects when there is a lightning storm.

As the control group 2 was exposed to the DAAFLIM, during the lesson discussions using argumentation the learners were exposed to the other learners' views about lightning. The other learners who did not agree with the scientific view gave IK explanations for their views. It was noticeable that their views were influenced by their local worldview presuppositions.

4.2.6.2 Causes of lightning (post-test)

This was question two in the conceptions of lightning questionnaire. The aim of the question was to find the learners' views about the cause of lightning. They were asked whether they believed that lightning was caused by witches. In the pre – test, 35% of the learners in the control 1 group agreed with the statement whereas in the post – test this number increased to just over 46%. This increase meant that the thought system of the learners still holds on to the indigenous worldview. Ogunniyi (2007a) explains this as the learners prevailing in the socio-cultural environment regardless of their awareness of the scientific concepts presented in class.

Learner C1 52: Agree, yes it is caused by witches and traditional doctors because a witch can make lightning when they want to hurt someone who is their enemy.

Learner C1 62: Strongly Agree, as a black Xhosa person, we believe that lightning is caused by witches and sangomas (traditional doctors) and not science.

In the five categories of CAT, these learners can be regarded as falling under the dominant indigenous worldview as it can be seen in the excerpts above.

The learners in the experimental group showed a decrease in the number of learners that believed that lightning is caused by witches. In the pre – test, there were twenty- five learners who believed that lightning is caused by witches. The post – test showed that the number decreased by more than 30%. The noticeable cognitive shifts can be a result of the teaching method (DAAFLIM) that was implemented before the post test. Ogunniyi (2011) attributes the change as a result of internal dialogue argument in an individual's working memory to resolve the conflict between competing thought systems. The learners in the experimental group can therefore be categorized to be falling under the assimilated worldview as the learners are regarded to have abandoned their initially indigenous presupposition and adopted the new science concepts in the class during the DAAFLIM lessons.

The use of DAAFLIM provided the learners with an opportunity to share their experiences with the other learners. One of the learners that still had a dominant IKS view claimed that their beliefs were due to personal experiences therefore they believe that witches do cause lightning strikes.

Learner E 25: Strongly Agree, A boy in my village stole a witchdoctor's car. The witchdoctor told him that he would strike him with lightning and the boy was struck by lightning the next day.

Another learner explained that:

Learner E 38: Agree, lightning is sent by witches, because it can struck and killed somebody even if it is not raining and it is a sunny day.

The belief that witches can create man-made lightning that differs from natural lightning, is something that is impossible to disprove. Lightning is said to be sent by witches for evil purposes, but nobody would ever confess to being a witch or to being able to send lightning, because then they would be killed or driven out of their community.

In the control 2 group, 38% of learners agreed that lightning is caused by witches and the majority of the learners believed in the scientific cause of lightning.

4.2.6.3 Protective measures of lightning (post – test)

Learners in the control 1 group mostly disagreed with the statement that lightning cannot kill you. In the pre –test, 74% of the learners agreed that one has to protect themselves from lightning as it is very dangerous. At the post– test, the number increased to 79%. The experimental group learners moved from 75% to 80% at post – test and when the control 2 group was asked the same question, over 78% of the learners highlighted the importance of protection against lightning.

Learner E 47: Strongly disagree, lightning can kill you because it is very dangerous. You must protect yourself from lightning.

The next question referred to covering mirrors: control 1 group learners did not change their stance on covering mirrors when there is a lightning storm. Ninety- three percent of learners in both the pre and post-tests believed that mirrors should be covered during a lightning storm. In the experimental group, 75% of the learners at pre – test increased to 80 % at post– test for those who cover their mirrors in a lightning storm. Control 2 group had 81% of learners also believing in the covering of mirrors.

The learners in all the groups gave similar reasons as to why they cover all mirrors in the house when lightning strikes. The learners said that mirrors are shiny objects and therefore attract lightning. During the DAAFLIM lessons with the experimental and control 2 groups, some learners argued that all shiny objects like pots need to be covered. They said that was the reason why people must not cook when a lightning storm is coming. When asked for the source of information for their claims, most said the information was passed on by their elders and it was their cultural practice or belief. Cobern (1996), argues that a lot of learners simply wall off the concepts that do not fit their natural way of thinking. He believes that when the learners are at school, they will accept the scientific truth as a fact, but when at home they will revert to their original belief.

In the CAT classifications, all the three groups can be regarded as possessing the equipollent worldview. This is when a learner holds on to both indigenous and scientific worldview presuppositions and the worldviews tend to co-exist in the learner's mind without necessarily resulting in a conflict. This happens when the learner expresses their views flagrantly depending on the context they find themselves in.

Learner C1 58: Agree, lightning will get reflected on the mirror and may hit a person, it can also cause fire or kill someone.

Learner C2 121: Agree, when lightning identifies something shiny it will come to your house.

Learner E 12: Strongly agree, my culture says that we must cover shiny things because of lightning.

Mirrors attracting lightning is one of the most common misconceptions about lightning in South Africa. Most people from the different cultural groups have recollections of their grandmothers covering the mirrors during a thunderstorm. Most of the learners in the study said that they cover up mirrors when there is lightning. One of the reasons given for this claim was that mirrors reflect lightning and reflected lightning could kill you.

When asked to agree or disagree with the statement, "Scientific explanation of lightning is better", most learners from all three groups responded agree at post-test. Eighty- six percent from the control 1 group, 87.5% from the experimental group and 81% from the control 2 group believed that scientific explanation of lightning is better than IK's. The learners in the experimental group who believed scientific explanation is better increased from 80% at pre-test to 87.5% at post-test by 7.5% whereas it remained the same for control 1 group.

4.3 Research question 2:

What is the difference in performance and conceptions of static electricity held by the learners exposed to DAAAFLIM and those not so exposed?

The purpose of this study was to assess the effects of Dialogical Argumentation – Assessment for Learning Instructional Model (DAAFLIM) on Grade 10 learners' conceptions and performance on static electricity. This study used a quantitative quasi-experimental design, specifically, the Solomon three research design to obtain learner's conceptions on lightning before and after being exposed to the intervention. Collected data was properly captured in the computer for analysis using SPSS version 26. Research question 2 is answered below.

4.3.1 Learners' conceptions of Static electricity (lightning)

Appropriate statistical techniques such as paired t-tests have been applied with the help of SPSS version 26 and results were determined as per the level of significance. The paired t-test was selected based on the nature of the data (Measurement from Gaussian Population) that were collected, and a comparison of two paired groups were needed to answer the question: What conceptions of static electricity were held by Grade 10 learners before and after being exposed to dialogical argumentation-assessment instructional model (DAAFLIM)? The findings about the learner's conception and performance of static electricity are presented below.

4.3.1.1 Learners' Conception of Electrostatic: Experimental vs Control 2

In this section, both the experimental group and the control 2 group learners' conception of electrostatic or lightning were compared. As shown in Table 4.4, i.e. in the Paired Samples Statistics table, the mean for the experimental group at post-test was 1.2670. The mean for the control 2 group was 1.4807. The standard deviation for the experiment was 0.14504 and that of control 2 was 0.14364. The number of participants in each condition (N) is 40.

Table 4.4 *Paired Samples Statistics - experimental vs control 2*

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	E_PsT	1.2670	40	.14504	.02293
	C2	1.4807	40	.14364	.02271

Normally to determine the effect that the pre-test has had upon the treatment. If the post-test results for these two groups differ, then the pre-test has had some effect upon the treatment. Hence, a paired-samples t-test was conducted to compare E_PsT and C2. As can be seen from table 4.5, there was a significant difference in the scores for E_PsT (M=1.2670, SD=0.14504) and C2 (M=1.4807, SD=0.14364); t(39)= -6.745, p = 0.000. These results suggest that dialogical argumentation-assessment instructional model (DAAFLIM) influences the conception of static electricity held by Grade 10 learners, at 95% confidence interval of the difference.

Table 4.5 *Paired Samples Test - experimental vs control 2*

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	T	df	Sig. (2-tailed)
Pair 1 E_PsT - C2	-.21371	.20041	.03169	-.27781	-.14962	-6.745	39	.000

4.3.1.2 Learners' Conception of Electrostatic: Control 1 vs Control 2

The comparison between the group C1 post-test and the group C2 post-test showed whether the pre-test itself has affected behaviour, independently of the treatment. If the results are significantly different, then the act of pretesting has influenced the overall results. To assess whether there was any significant difference in conceptions of static electricity held by the learners exposed to DAAFLIM and those not so exposed, a paired-samples t-test was conducted. There was a significant difference in the scores for C1_PsT (M=1.2287, SD=0.16800) and C2_PsT (M=1.4815, SD=0.14193); t (40) =-7.681, p = 0.000.

Table 4.6 *Paired Samples Statistics - control 1 vs control 2*

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	C1_PsT	1.2287	41	.16800	.02624
	C2	1.4815	41	.14193	.02217

The table below 4.7 represents the paired differences between the control 1 group and the control 2 groups. The results show that the SD = 0.21082 and the Mean = -0.25287.

Table 4.7 *Paired Samples Test - control 1 vs control 2*

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	T	df	Sig. (2-tailed)
Pair 1	C1_PsT C2	--.25287	.21082	.03292	-.31942	-.18633	-7.681	40	.000

These results suggest that there was a significant difference in conceptions of static electricity held by the learners exposed to DAAFLIM and those not so exposed, at 95% confidence interval of the difference. Even though the control 1 group had a pre-test, the control 2 group had a better understanding of static electricity than the control 1 group.

As discussed above, the experimental group's conception of lightning was better than that of control 2 group and the control 2 group's conception was better than that of control 1 group. This implies that the experimental group's conception of lightning is better than that of control 1 group. This shows that the learners who were exposed to DAAFLIM have a better understanding of static electricity than those who were not exposed to it.

4.3.2 Learners' performance in static electricity (lightning)

In seeking an answer for the research question 2, the performance of the learners was analysed using the data obtained from the Science Achievement Test (SAT). In this section, the performance of each group is discussed. A comparison, using paired sample t-tests, between the groups was made to see if there was a significant difference in their performance. Moreover, a test was made to see if there was a significant difference in the performance of the experimental group before and after being exposed to DAAFLIM. Similarly, a comparison of the performance of the control1 group before and after being exposed to the traditional teaching method was done.

Appropriate Statistical techniques such as Paired t-tests have been applied with the help of SPSS version 26 and results were determined as per the level of significance. Paired-samples t-tests were conducted to compare scores on two different variables but for the same group of cases, while independent-samples t-tests were conducted to compare scores on the same variable but for two different groups of cases, and with equal variance assumed.

4.3.2.1 Learners' Performance: Experimental vs Control 1 (Pre-test)

The performance of learners from the two groups was compared using a paired t-test using the data collected from the Science Achievement Test. This was done to see whether or not there was significant difference among the two groups in terms of their knowledge about static electricity at the start of the study.

The null hypothesis was then tested against the alternative hypothesis to see if there was significant difference in the mean score of the two groups at pre-test level – experimental and control 1.

H_O: there is no difference between the mean score of the two groups

H_A: there is difference between the mean scores of the two groups

Table 4.8 *Statistical Table of EX_PRE and C1_PRE*

Test	Group	Mean	Sd	Mean Diff	t-value	p-value	Remark
(It-test)	EX_PRE	8.75	3.440	1.122	1.594	0.115	NS
	C1_PRE	7.63	2.968				

The pre-test results in Table 4.8 above, show that the difference between the mean scores (8.75 and 7.63) and the standard deviations (3.44 and 2.968) for the experimental and control 1 groups are small. The t-ratio value of 0.115 is less than the t-critical value of 1.594 at $p < 0.05$, which indicates that the null hypothesis, which expects no significant differences between mean scores of the groups, can be accepted.

Therefore, it can be concluded that there was no statistical significant difference between the two groups at the pre-test stage of the study, suggesting the comparability of the two groups before the two groups were being exposed to or treated with DAAFLIM or traditional method of teaching. However, it can also be assumed that both groups did have some understanding of the selected concepts, because both groups scored an average score of 8.75 and 7.63 respectively in the pre-test.

4.3.2.2 Performance of Learners: Experimental (Pre-test vs Post-test)

In this section a comparison of the performance of the experimental group is made. The learners' performance of the group at post-test was compared with their performance at pre-test level. As depicted in the table 4.9 below, the mean score of the experimental group was 8.75 with a standard deviation of 3.440. The mean score of the learners increased at post-test level to 15.03 with a standard deviation of 2.019. The mean difference between the scores of the learners in this group at pre-test and post-test level was -6.275.

Table 4.9 *Statistical Table of EX_PRE and EX_POST*

Test	Group	Mean	Sd	Mean Diff	t-value	p-value	Remark
(Pt-test)	EX_PRE	8.75	3.440	-6.275	-14.812	0.000	Sig @ 5 %
	EX_POST	15.03	2.019				

A t-test at 5% level of significance shows that there is a significant difference between the performance of the learners in the pre-test and the post-test. This is mainly attributed to the teaching methodology that they are exposed to which in this case is DAAFLIM. The standard deviation decreased from 3.440 to 2.019. It is evident that this method enabled the learners not only to improve their performance as a group but also to narrow variability among the performance of individual learners.

4.3.2.3 Performance of Learners: Control 1 (Pre-test vs Post-test)

In this section a comparison of the performance of the control 1 group is made. The learners' performance of the group at post-test was compared with their performance at pre-test level. As depicted in the table 4.10 below, the mean score of the group was 7.57 with a standard deviation of 2.981. The mean score of the learners increased at post-test level to 13.02 with a standard deviation of 3.227. The mean difference between the scores of the learners in this group at pre-test and post-test level is -5.452.

Table 4.10 *Statistical Table of C1_PRE and C1_POST*

Test	Group	Mean	Sd	Mean Diff	t-value	p-value	Remark
(Pt-test)	C1_PRE	7.57	2.981	-5.452	-9.507	0.000	Sig @ 5 %
	C1_POST	13.02	3.227				

A t-test at 5% level of significance showed that there was a significant difference between the performance of the control 1 group learners in the pre-test and the post-test. This was mainly attributed to the teaching methodology that they are exposed to which in this case is traditional teaching method. The standard deviation increased from 2.981 at pre-test level to 3.227 at post-test. Even though it is evident that the traditional teaching method enabled the learners to improve their overall performance in the SAT, it did not narrow the variability among their individual performance.

4.3.2.3 Performance of Learners: Experimental vs Control 1 (Post-test)

The experimental group was exposed to DAAFLIM whereas the control 1 group was treated with the traditional teaching method. In order to see if there was a difference in the performance of the learners from these two groups after being exposed to DAAFLIM or traditional methods, a t-test was used.

As shown in table 4.11 below, the mean score of the experimental group at a pre-test level is 15.03 with a standard deviation of 2.019. The mean score of the control 1 group was 13.02 with a standard deviation of 3.227. The mean score of the experimental group was higher than the meanscore of the control 1 group with a mean difference of 2.001.

Table 4.11 *Statistical Table of EX_POST and C1_POST*

Test No	Group	Mean	Sd	Mean Diff	t-value	p-value	Remark
(It-test)	EX_POST	15.03	2.019	2.001	3.347	0.001	Sig @ 5 %
	C1_POST	13.02	3.227				

The null hypothesis was then tested against the alternative hypothesis to see if there was a significant difference in the mean score of the two groups at post-test level for the experimental and the control 1 group. These two hypotheses were:

H_O: there is no difference between the mean score of the two groups

H_A: there is difference between the mean scores of the two groups

A level of significance of 5% was used. The t-test result showed that there was a statistically significant difference in the score mean of the two groups at pre-test level. This means that the performance of the learners from the experimental group was better than those of control 1 group. As discussed earlier there was no significant difference in the performance of SAT at the pre-test level. The difference in performance was attributed to the teaching method that was used in teaching these two groups. Therefore, it is evident that the DAAFLIM was more effective than the traditional teaching method in teaching static electricity (lightning).

Moreover, a further analysis showed that the standard deviation of the experiment changed from 3.440 at pre-test to 2.019 at post-test level whereas the standard deviation of the control 1 group changed from 2.968 to 3.227. The standard deviation showed how the individual learners' score of both groups deviated from the mean score of their respective group. Whilst the standard deviation of the experimental group decreased, the standard deviation of the control 1 group increased. This shows that DAAFLIM was more effective in bridging the gap between the learners IKS views and science views. The DAAFLIM not only provides a platform for learners to share their views but also construct new scientific learning using their prior knowledge.

4.3.2.4 Performance of Learners: Experimental vs Control 2 (post-test)

Both the experimental group and the control 2 group were exposed to DAAFLIM. The experimental group wrote the pre-test whereas the control 2 group did not. In order to see if there was a difference in the performance of the learners among these two groups, a t-test was done.

As shown in table 4.12 below, the mean score of the experimental group at post-test level was 15.03 with a standard deviation of 2.019. The mean score of the control 2 group was 10.78 with a standard deviation of 3.328. The mean score of the experimental group was higher than the mean score of the control 2 group with a mean difference of 4.245.

Table 4.12 *Statistical Table of EX_POST and C2_POST*

Test	Group	Mean	Sd	Mean Diff	t-value	p-value	Remark
(It-test)	EX_POST	15.03	2.019	4.245	6.919	0.000	Sig @ 5 %
	C2_POST	10.78	3.328				

At a level of significance of 5%, the t-test result showed that there was a statistically significant difference in the performance (score means) of the two groups. This means that the performance of the learners from the experimental group was better than those of control 2 group. The difference in performance could not be attributed to the teaching method that was used as the two groups were both exposed to DAAFLIM. The difference could be attributed to the pre-test.

4.3.2.5 Performance of Learners: Control 1 vs Control 2 (post-test)

Both the control 1 group and the control 2 group wrote the post-test. Whilst the control 1 group was exposed to the traditional teaching method, the control 2 group was exposed to DAAFLIM. In order to see if there was a difference in the performance of the learners among these two groups, a t-test was done.

As shown in table 4.13 below, the mean score of the control 1 group at post-test level was 13.02 with a standard deviation of 3.227. The mean score of the control 2 group was10.78 with a standard deviation of 3.328. The mean score of the control 1 group was higher than the mean score of the control 2 group with a mean difference of 2.243.

Table 4.13 *Paired Samples Statistics*

Test	Group	Mean	Sd	Mean Diff	t-value	p-value	Remark
(It-test)	C1_POST	13.02	3.227	2.243	3.118	0.003	Sig @ 5 %
	C2_POST	10.78	3.328				

At 5% level of significance, a t-test result showed that there was statistically a significant difference in performance (score means) between the two groups. This means that the performanceof the learners from the control 1 group was better than those of control 2 group. The difference inthe performance might be attributed to the pre-test that was administered to control group 1 or thelevel of understanding of static lightning among the two groups were not the same or comparablebefore the beginning of the study.

As discussed earlier the control 1 group and the experimental group were comparable at the pre-test. The experimental group, after being exposed to DAAFLIM performed better than the control 1 group that was treated with the traditional method of teaching. The results showed that the conceptions and performance of the learners who were exposed to DAAFLIM were significantly better than those treated with the traditional teaching method. Some researchers concluded that assessment for learning and argumentation methods significantly increases the academic achievement of learners by enabling them to participate in the lesson (For example, Shepard, 2000; Taras, 2007; Wylie & Ciafalo, 2010; Yeh, 2009; Kingston & Nash, 2011).

4.3.3 Learners' beliefs about lightning

In this section, the learners' change in views is discussed. These views were collected using the Beliefs about lightning questionnaire (BALQ). This questionnaire consisted of questions that were compiled to find out the beliefs of learners about lightning. The learners' responses were then categorised as being either more scientific or traditional or cultural knowledge (IKS). This was also based on the reasons that they gave as to why they chose a certain answer. The table 4.14 below shows the number of learners from all groups who had scientific or IKs beliefs before and after being exposed to DAAFLIM or traditional method of teaching.

Table 4.14 *Learners' views about lightning*

		Scientific	IK
Cause of lightning	Control 1: Pre	27	16
	Post	32	11
	Experimental: Pre	29	11
	Post	37	3
	Control 2: Post	34	8

Protection from lightning	Control 1: Pre Post	6 11	37 32
	Experimental: Pre Post	19 27	21 13
	Control 2: Post	19	23
Traditional doctor pointing	Control 1: Pre Post	17 25	26 18
	Experimental: Pre Post	23 32	17 8
	Control 2: Post	26	16
Reasons for standing in a tree	Control 1: Pre Post	28 35	15 8
	Experimental: Pre Post	27 35	13 5
	Control 2: Post	31	11
Handling water during lightning	Control 1: Pre Post	18 20	24 23
	Experimental: Pre Post	19 24	21 16
	Control 2: Post	21	21
	Control 1: Pre	15	28

Football players inured by lightning	Post	20	23
	Experimental: Pre Post	0 9	40 31
	Control 2: Post	15	27
Outdoor place to hide from lightning	Control 1: Pre Post	36 38	7 5
	Experimental: Pre Post	23 28	17 12
	Control 2: Post	35	7

As can be seen from the Table 4.14 above, the learners in control 1 group who had IKS views about the cause of lightning decreased from 37.2% at pre-test to 25.6% at post-test whereas the number of learners in the experimental group who held an IKS view about cause of lightning decreased from 27.5% to 7.5%. The learners in the control group 2 who had IKS beliefs about the cause of lightning was 19%. Many learners believed that lightning is caused by witches. Some believe that it is created by traditional doctors. A few believed that it is caused by *Impundulu* (lightning bird).

Most of the learners who held IKS views regarding protection from lightning believed that putting a motor- car tyre on top of the house or burning a tyre in the house is the best way to protect oneself from lightning. This is a common misconception in the Eastern Cape. Most houses have old tyres that are put on the roof of the houses. The people believe that putting a tyre on the roof of a house chases the lightning away.

Some believed that praying to God protects from lightning. Others believed that getting a *muthi* (traditional medicine) from a traditional doctor protects one from being struck by lightning. Among those who believed in a traditional doctor, a few believed that consulting a traditional doctor does not guarantee the protection from lightning. According to these learners, the traditional doctor needs to be stronger than the witches in order to get protection from lightning.

The learners in control 1 group who have traditional beliefs of means of protection from lightning decreased from 86% at pre-test to 74.4% at post-test whereas the number of learners in the experimental group who held cultural views about protection decreased from 52.5% to 32.5%. The learners in the control group 2 who held belief about protection from lightning were 54.8%.

Regarding the question of a famous traditional doctor who pointed his spear in the direction of lightning while performing a ritual and got struck by lightning, the learners in control 1 group who had IKS views decreased from 60.5% at pre-test to 41.9% at post-test, whereas the number of learners in the experimental group who held cultural views decreased from 42.5% to 20%. The learners in the control group 2 who had IKS views was 38.1%.

Of those who held traditional beliefs, some believed that he was bewitched by other stronger traditional doctors who were jealous of him. Others believed that the ancestors were angry with him. A few said he was not a qualified traditional doctor. According to these learners, had he been a qualified traditional doctor he would not have been struck by lightning.

When asked why it is not good to stand under a tree when there is lightning, most of the learners who held IKS views believed that witches use the tree to hide their muthi. The learners in control 1 group who had IKS views regarding the question standing under a tree decreased from 34.9% at pre-test to 18.6% at post-test whereas the number of learners in the experimental group who held traditional views about this question decreased from 32.5% to 12.5%. The learners in the control group 2 who had traditional views regarding standing under a tree during lightning was 26.2%.

Regarding the question why people are advised not to handle water when there is lightning, the learners in control 1 group who had IKS views regarding handling water during lightningdecreased from 58.1% at pre-test to 53.5% at post-test whereas the number of learners in the experimental group who held traditional views regarding this question decreased from 52.5% to 40%. The learners in the control group 2 who had cultural views about handling water during lightning was 50%.

Regarding the question of a football player who was struck by lightning and died while playing, most learners held IKS views. These learners believed that the player who died was struck because the other players were jealous of him. It is, as noted by Mahapa (2006), a common belief amongst Black people that when someone is jealous of your achievements they will ask a witchdoctor to send lightning to you. The learners in control 1 group who had IKS views decreased from 65.1% at pre-test to 53.5% at post-test whereas the number of learners in the experimental group who held cultural views about this question decreased from 100% to 77.5%. The learners in the control group 2 who had traditional beliefs about handling water during lightning were 62.3%.

Most of the learners chose the scientific explanation regarding the outdoor places to hide from lightning. Nevertheless, the reasons provided were not scientific. The learners believed that it is safe to be in a car because the tyres of the car protects them. The learners in control 1 group who had cultural beliefs regarding outdoor places to hide from lightning decreased from 16.3% at pre-test to 11.6% at post-test whereas the number of learners in the experimental group who held IKS views about this question decreased from 42.5% to 30%. The learners in the control group 2 who had traditional views regarding the question were 16.7%.

The results of the study showed that many of the learners held IKS views about lightning. In most of the explanations given during the argumentation activities and discussions, evidence provided by the learners for people that got struck by lightning was that it was because of jealousy from others. On a personal take, when my mom lost her twin sons by lightning, on the same day she believed that as well as the family that the lightning was sent by an aunt whom she had argument with and she promised to get back at her somehow, and the next day the twins were struck by lightning in broad daylight.

We have seen that learners held IKS beliefs about lightning. It is important to see the cognitive shift that these learners undergo when confronted with science views. In the next section I will discuss the category under which the learners who were exposed to DAAFLIM fall when confronted with the two conflicting views, i.e. IKS views and science views, in terms of contiguity argumentation theory (CAT).

4.3.4 Learners' category of contiguity argumentation classifications

The interviews partially answered research question 2. They were intended to determine the effects of using the DAAFLIM intervention as well as identifying learners' perceptions on the use of assessment for learning in their everyday lessons. Interviews were conducted with learners in the experimental group and control group 2 as these two groups of learners were exposed to the intervention. The interview questions focused on the learners' views about lightning before and after the use of DAAFLIM intervention and how the use of DAAFLIM impacted on the learners' views.

The experimental group (E) and the control group 2 (C2) took part in the focus group interviews to determine the learners' argumentation patterns and contiguity argumentation. The interviews were also used to identify the learners' perceptions on the use of assessment for learning in their everyday lessons. The learners taking part in the interviews were randomly selected from each group to form part of the interviews.

The interview took place after the two groups were exposed to the DAAFLIM intervention. The questions of the interview focused on the learners' views about lightning before and after the use of the intervention. The interview was also directed at finding out whether the use of the intervention impacted on the learners' views.

All the learners that we interviewed had been exposed to both the indigenous and scientific views through their dealings with the community they stay in and through the science lessons at school. The learners had also been exposed to the DAAFLIM intervention that used dialogical argumentation to get the views of the learners through discussions in class and assessment for learning as an assessment model which gave them a voice in how they are assessed during activities in class.

Most learners' initial responses were that lightning is caused by witches. Some of the learners said that they are aware that there is a scientific explanation of lightning but in the community they believe in the lightning that is sent by witches. Aikenhead (2002) elucidates that learners bring their own ideas when they come to class. Post DAAFLIM lesson, some learners said that their views had changed and now said that they believed in the scientific view of lightning but some reported that they had not changed their initial views. Some learners said they believed in both the scientific and IK views about lightning. These learners can be described as exhibiting the equipollent category according to CAT.

The control 2 learners showed a scientific view. In terms of CAT, the learners had assimilated the traditional view and had changed to the scientific view. This change can be attributed to the intervention used. Some based their change in views as a result of working and sharing ideas with the other learners. Responses that the learners gave for the interview questions are presented below.

The first interview question was based on getting the learners' view about the cause of lightning. The responses of the learners were analysed according to the CAT categories as espoused by Ogunniyi (2007a).

4.3.4.1 The assimilated world view

The assimilated worldview is experienced when the learner abandons his initially indigenous assumption and adopts the new science concepts in the class after being taught in class. Some learners from both the experimental and the control 2 groups fell under the category of the assimilated view according to the CAT categories. These learners believed that lightning is caused by witches prior to the intervention. They believed that the lightning is sent by a witch when they want to kill someone when there has been a stalemate.

In the post – test after being exposed to DAAFLIM, the same learners seem to have changed their views and now believe that lightning is caused by friction in the clouds. This means that the learners had abandoned their initial indigenous world view and moved to the more scientific explanation of the cause of lightning. Ogunniyi (2007a) explains that this happens when a less powerful idea is assimilated into a more powerful one in terms of the persuasiveness or adaptability of the dominant idea. Below are the excerpts of the learners from both groups:

Learner E1 (prior- intervention): I think that lightning is something that is formed by witches to be dangerous. It is also created by God to bring rain.

Learner E1 (post intervention): I now believe that lightning is a natural disaster, it happens because of forces between particles.

Learner C2: 1(prior- intervention): Caused by witches when they want to bewitch you.

Learner C2:1 (post - intervention): It is now due to static electricity.

Learner C2: 6 (prior- intervention): Caused by traditional doctors.

Learner C2:6 (post intervention): Positive and negative meet together and form lightning through friction.

Learner C2: 9 (prior- intervention): Caused by God when He is angry at certain people at a certain area.

Learner C2: 9 (post intervention): Attraction between electrons and protons, they meet and form spark light and the sound they make is thunder.

Learner E1 believed that even though lightning is caused by witches, it can also be created by God when He wants to bring rain. These are the same beliefs also held by learner 5. These two learners believed in both God and witches as the cause or source of lightning. In their post intervention responses, they both changed their views from being cultural to now believing that lightning is caused by forces of rubbing between particles.

Learner E2 (prior- intervention): Lightning produces a bright light when witches are angry.

Learner E2 (post intervention): When it is raining, lightning is caused by the meeting of positive and negative charges.

Learner E4 (prior- intervention): I thought when there is lightning the witches are sending it to kill someone. We must cover our mirrors and not use cell phones.

Learner E4 (post intervention): I now believe that lightning is caused by the friction of clouds.

Learner E9 (prior- intervention): Someone asks and buys a witchdoctor to send lightning to their enemy.

Learner E9 (post intervention): I now believe it is caused by small water particles hitting each other.

Other learners with the assimilated view said that lightning is made and sent by witches when they want to kill someone who is their enemy. **Learner E4** also added that mirrors and use of phones attract lightning, therefore must not be used during a thunderstorm. **Learner E9** believed that one can give money to a traditional doctor so that they send lightning to an enemy. It is evident from the learners' responses that lightning is believed to be made and sent by witches and traditional doctors to settle scores between enemies. Post the intervention these learners now believe that lightning is caused by friction in the clouds, which is the scientific explanation of the cause of lightning.

4.3.4.2 The emergent view

There may be circumstances where no prior knowledge about a phenomenon exists and new knowledge has to be acquired as is the case with many science concepts. One learner (**Learner E3**) started with a traditional worldview explanation prior to the intervention by saying that lighting is used to damage peoples' properties because of jealousy at pre-test. Then the learner said that it is a natural thing. Even though the learner could not provide a scientific explanation of cause of the lightning, he shifted from believing lightning as something that is man-made to believing that it is natural.

Learner E3 (prior- intervention): I thought lightning was witchcraft used by people who are jealous of each other to damage each other's property or cattle.

Learner E3 (post intervention): It is a natural thing.

Learner C2:3 (prior- intervention): It happens in the clouds.

Learner C2:3 (post intervention): I still believe in my traditional knowledge.

After the intervention the learner was introduced to the scientific explanation of lightning. His comment reveals an attempt to explain the phenomenon in a scientific way, but he ended up with an alternative conception. This shows that he was trying to alter their responses by reconstructing their original worldview under the influence of the newly encountered worldview of school science The two learners seemed to have contrasted their traditional beliefs with the scientific one encountered in the science class, and then altered and reconstructed it under the influence of the new scientific knowledge.

This learner was categorised under the emergent worldview, as the learner was confronted with a new way of looking at a phenomenon and ended up being confused and not knowing which view to believe in.

4.3.4.3 Dominant Scientific view

Dominant view is a powerful idea that effectively explains or predicts facts, or resonates with an acceptable social norm and a sense of identity, in this case, scientific views or IKS views. The learners below showed that they had the dominant scientific worldview, as the learners' thought systems agree with the science concepts as presented in the science lesson in class. Below are the excerpts of some of the learners who fall under the dominant scientific view.

Learner E6 (prior- intervention): Lightning is caused by God and Science.

Learner E6 (post intervention): Is now caused by static electricity (friction)

Learner E10 (prior- intervention): It is created in the clouds by friction.

Learner E10 (post intervention): It happens when friction has taken place.

Dominant IKS view

Learner E8 thought system evidently holds on to the indigenous worldview. Even though the learners were presented with the scientific explanation in class the learner still believed in their cultural view as shown below.

Learner E8 (prior- intervention): It is made by our ancestors. It is how they send their messages when they are not happy about something.

Learner E8 (post intervention): I still believe it is still caused by witches.

Learner C2:2 (prior- intervention): Lightning is natural.

Learner C2:2 (post intervention): It is still natural, nothing changed.

4.3.4.4 Equipollent worldview

Equipollent worldview is when a learner's worldview is influenced by two competing and or co-existing worldviews e.g. science and IK with comparably equal intellectual force without necessarily resulting in cognitive dissonance (Ogunniyi, 2007a). In an equipollent worldview, a learner will hold on to both the indigenous and scientific beliefs. The learner expresses their views depending on the context in which they find themselves. **Learner E7** below did not want to choose between the two schools of thoughts and therefore decided to believe in both. When in school, he would give the scientific view whilst still believing that lightning is caused by witches.

Learner E7 (prior- intervention): It is caused by witches when angry with each other.

Learner E7 (post intervention): I believe in both science and my culture.

Learner C2:10 (prior- intervention): Created by witches to send to kill someone.

Learner C2:10 (post intervention): I now know it is caused by negative and positive charges meeting but I also believe witches send it.

From the excerpts of the learners above one could conclude that most of the learners believe that lightning is caused by witches. These learners believed that the witches use lightning when they are angry either to kill people or kill each other. In other words, witches use lightning when there is a stalemate. According to these learners, witches have to be angry to strike lightning and are used merely as a punishing weapon to whoever witches are angry at. Most of these learners mentioned anger as a factor for witches to use it. One could see that these learners believed that witches create lightning.

There was only one learner, **Learner E8,** who believed that lightning is made by ancestors. According to this learner lightning is used by ancestors to send messages. The learner believed that ancestors use lightning when they are unhappy. However, the learner did not explicitly say that they use it to harm but rather to warn. This learner's response is similar to those who believed it is caused by witches in the sense that lighting occurs in the presence of anger. However, they differ their views as to what lightning is used for.

Some of the learners believed that the presence of shiny or glittery materials causes lightning. According to these learners it is possible to avoid lightning by covering shiny materials such as mirrors and cell phones. Some of these learners, see **Learner E4** excerpt, believed that lightning is sent by witches to kill people, however, people could protect themselves by covering mirrors and avoiding the use of cell phones during thunderstorms. Others did not explain what causes lightning but only suggested that covering all mirrors and shining things and switching off cell phones are the measures one should take whenever there is lightning to avoid harm.

Some of the learners believe that lightning is caused by witches and traditional doctors. Some of these learners believed that witches use it when they want to bewitch someone. Some of these learners believe that lightning is natural but is manipulated by witches to cause harm to people whereas others believe that it is created by witches to kill people.

These learners, similar to learners in experimental groups, believe that the witches use lightning to kill or harm people. However, unlike learners from the experimental group, they did not mentionthat witches have to be angry in order to strike lightning. Nevertheless, only one learner, see excerpt for **Learner C2:9**, believed that it is caused by God when angry at some people.

Some of the learners believed that lightning is natural and happens in the cloud. Others believed that lightning occurs when the sun and rain meet, see excerpt **Learner 8 E**. According to this learner, lightning occurs when it rains in the presence of sunshine. Some learners believed that lightning can be avoided by covering a mirror when there is a storm. According to these learners, it is possible to avoid the harm of being struck by lightning.

Most of the learners had a scientific view of lightning in the Post test. About seventy-three percent of the learners had developed scientific reasons for the causes of lightning. Some of the reasons given by these learners included, among others, that lightning is a natural disaster that happens because of forces between particles. Lightning is caused by small water particles hitting each other. It means two objects rub against each other and cause sparks so rapidly. Whereas some believed that lightning is caused by the friction of clouds, others highlighted that lightning happens when friction takes place.

As per the excerpts of the learners, it is evident that most of the learners in the experimental group believed in their traditional views about lightning. In the post test it showed that the learners had changed their views to the more scientific view. The change in views could be attributed to the use of the intervention method DAAFLIM that the experimental group learners were exposed to. The learners said that their change in beliefs were because of the use of argumentation as it was easier for them to share their ideas with others through the group work sessions and they learned a lot from each other.

The post-test of the control 2 group showed that there was not much change in the views of the learners about the topic. Their beliefs remained the same for most of them as the excerpts revealed.

4.3.5 Learners' TAP classifications

In the DAAFLIM lessons, lightning activities were generated in order to support argumentation as an instructional method. The lessons were introduced by the teachers and the learners had to complete individual tasks. This allowed for individual thinking space for each learner. The learners were then put into groups of five where each learner was invited to present his or her ideas. This thus encouraged each group member's voice to be heard. After the group debate, the learners had to reach a consensus as they had to present their arguments to the class. The group leader chosen then had to present the arguments, counter-claims, rebuttals, evidence and warrants if any. The group presentations allowed for a general discussion space.

The arguments of the learners from the activities in the experimental group and in the control group 2 were classified using Toulmin's Argumentation Pattern (TAP). A few statements made by the learners in both groups fell on the level 1 classification. These are the arguments that only had a claim but there was no evidence given to back up the claims made. The claims made also had no grounds or rebuttals. A learner in the control 2 group when discussing the causes of lightning said that lightning is caused by God when He is angry. The statement of the learner can be categorised as level 1 argumentation, as level 1 argumentation consists of arguments that are a simple claim versus a counter-claim or a claim versus a claim. Some level 1 arguments came from learners who also said that lightning is caused by witches but had no data to back their claims and just said it is their beliefs.

According to TAP, most of the arguments made by the learners can be classified as Level 2 and Level 3 arguments. Level 2 argumentation has arguments consisting of a claim versus a claim with either data, warrants, or backings but do not contain any rebuttals. Level 3 argumentation has arguments with a series of claims or counter-claims with either data, warrants, or backings with an occasional weak rebuttal.

When asked about the cause of lightning in the activity, **learner 25** from the experimental group claimed that lightning is caused by witchdoctors. When there were rebuttals challenging his claim, his warrant was that when a boy in his village stole a witchdoctor's property. The witchdoctor told him that he would strike him with lightning and the boy was struck by lightning the next day. Another learner from the control group 2 claimed that, lightning is sent by witches because it can strike and kill someone even if it is a sunny day. The learners seemed to base the grounds of their claims from personal experiences hence they did not change their claims in the post test. Kuhn

(2008) did a study that showed that instructional methods that engage learners in argumentation help them learn to argue and evaluate arguments better.

Learners also discussed ways in which one can protect themselves from lightning. A popular claim made by the learners in terms of protection against lightning was the covering up of mirrors during a lightning storm as well as putting a motor car tyre on top of the roof of the house. The learners believed that hence this was a common practice amongst their households as instructed by the elders, therefore it was the best method of protection. Another justification to the claim was that a mirror could reflect the lightning and the reflected lightning could kill you.

When using argumentation, it is evident that learners are driven by cognitive conflicts which arise between their views and those of others.

Some rebuttals to the claim were that there is no scientific rationale to the belief that mirrors attract lightning. Covering mirrors does not in any way protect a person against being injured or killed by lightning. Putting a motor car tyre on the roof was also claimed to protect a house from lightning. A counter claim was that since a car has tyres therefore you are also safe inside a car during a lightning storm. Other learners rebutted that some people can be hit by lightning inside the house even though they have a tyre on the roof. A warrant to that was that the lightning must have been sent by a very powerful witch.

Jegede (1995) reckons that the socio-cultural background of the learner may have a greater effect on education than does the subject content in class. He supported that most learners will believe in science at school and their traditional beliefs at home.

One of the purposes of dialogical argumentation is to improve learners' understanding of the nature of science. This can be accomplished through learners experiencing the argumentative nature of science as they discuss with each other through argumentation activities. According to Chinn &

Clark (2013) engagement in argumentation can result in educational benefits that include: motivation, content learning, argumentation skills and knowledge building practices.

4.3.6 Learners' views about DAAFLIM

Discussed below is what has transpired during the DAAFLIM lessons via class observation. The four main elements of assessment for learning were observed during the lessons and that included the assessment method. These are explaining learning objective and success criteria, increasing the quality of dialogue, increasing the quality of marking and feedback, and self and peer assessment.

In order to explain the learning objectives and success criteria the following was adhered to: At the beginning of each lesson, an explanation was provided to the learners about what they were going to learn that day. The lesson's learning outcomes were discussed and shared with the learners. Learners were reminded about the learning outcomes during and at the end of each lesson. At the end of each lesson, learners were asked to discuss what they had learned in the lesson. Learners were informed of the success criteria necessary to be considered successful in the classroom activities.

To increase the dialogue amongst the learners and the teacher, the teacher used group work to conduct the lessons so as to improve the dialogue between the learners and for them to get used to working together. The groups were diversely formed in terms of performance and to keep those who are friends apart. The groups were changed every day so that the learners don't get used to each other. During the group work, learners were not allowed to raise their hands when a question was asked. This tactic was envisioned to help to increase the participation of all the learners as well as to allow the learners some time to think about their responses before they could give an answer.

Assessing the learners using comments instead of scores or marks allowed learners a chance to improve their work by using the feedback given by the teacher rather than just getting a score. Peer assessment was also conducted to assess some of the activities done at the end of a lesson.

After being exposed to DAAFLIM, 25 learners of which 15 learners from the experimental group and 10 learners from the control 2 group took part in the focus group interview. The table below is a summary of the learners' responses for both groups when asked if they preferred being graded with comments only, marks only or both comments and marks.

Table 4.15 *Grading with or without comments results*

Grading	Experimental	Control 2
Comments only	10	0
Marks only	1	2
Comments and marks	4	8

The majority of the learners in the experimental group preferred comments only whereas most learners in the control 2 group preferred both comments and marks. Two-third of the learners in the experimental group preferred to be graded with comments only whereas 80% of the learners from the control 2 group preferred to be graded with both comments and marks. Most of the learners in both groups acknowledge the importance of comments in the learning process as they help them to rectify their mistakes.

Below are some excerpts of the learners from both groups that explains why they believe that comments are important.

Learner E9: comments make you feel guilty and bad for your wrong answers but it is also good to know what you did wrong so that you correct it and never forget.

Learner E10: comments help you to do better in the next activity as you know exactly what you did wrong than just getting marks and not knowing what you did wrong.

Learner C2:86: through comments and marks I get to know the teacher's views on how I have performed.

Learner C2:83: I prefer comments and marks so that I can know where I have to correct and it feels good to get positive comments. It motivates you to perform better. Even if you did not do well, the teacher's comments will tell you where you made a mistake and how to correct it rather than just a cross or tick.

A further analysis showed that in total 40% of the learners in both groups preferred to be graded with comments only. Whilst 48 % preferred to be graded with both marks and comments, only 12% of the learners preferred to be graded with marks only. Some of the learners who preferred both marks and comments gave reasons for their preference by saying whilst marks tell us how well we performed, comments help us to rectify our mistakes. From these interviews, it was evident that most learners preferred to be graded with not only just ticks and crosses but the teacher must make comments as well, that way they get to see and correct their mistakes immediately.

However, there was a small percentage of learners who said that they were uncomfortable with being marked using comments. The main reason they mentioned why they are not comfortable with comments was that comments given by teachers were harsh at times. These learners seemed not to like harsh comments. They said that teachers need to be sensitive and sensible when commenting. They should focus on rectifying learners' mistakes rather than being angry on how a learner thinks and avoid giving harsh comments.

Upon hearing the learners' views about being graded with comments, the researcher realised that it is of importance that teachers give comments about the learning progression based on the learning goals. Teachers should therefore provide learners with comments that are evidence-based and feedback that is linked to the intended instructional outcomes and criteria for success. Teachers also need to identify the common misconceptions and try to understand how learners learn. The main purpose of giving comments should be to assess learners' knowledge and skills, to assess the teaching method, and to promote learning with understanding.

From the classroom observations it was evident that the learners who were exposed to DAAFLIM were taking responsibility for their own learning instead of just trying to get good marks. The learners were also afforded an opportunity to discuss the learning outcomes of the lessons at the beginning of each lesson and they were reminded of such again during the lesson. This provided an opportunity for learners to reach for their objective and to evaluate what they are doing to reach the goal.

Instigating group work in the teaching-learning process provided the development of collaboration and interrelation skills instead of individual competition among learners. As Griffin (1995) noted, when learners work in groups they explain their thoughts and reasoning, and receive feedback from peers and the teacher and in the process improve their intellectual competencies.

On their thoughts and views about the use of self and peer assessments lessons, the learners said that they found self and peer assessments very useful. It was revealed that it provided an opportunity to see their own mistakes and that it gave them a chance to compare themselves with their friends. Some learners mentioned that they were embarrassed for other learners to see their mistakes and wrong answers as they might make fun of them. Sadler (1998) claims that scores may be counterproductive to assessment for learning in that they are focused on what has been accomplished and not what needs to be done. Taras (2002) also argues that scores often have the effect of distracting learners from what they should be focused on, which is learning.

The teacher in the experimental group found that the group work conducted during the class was relatively useful. During the interviews, the learners responded positively when asked what they thought about group work during the lesson. The learners also revealed that group work also helped them to learn more about each other and could freely share their experiences, that way increasing participation and the lessons were more fun. The observations I had made also supported these findings.

Below are some excerpts from the learners' responses:

L 23: Working in groups was very helpful, it forced us to work together and we were able to better understand the work we were doing.

L 43: It is very nice to hear others talking in class and learning their views.

4.4 Research Question 3:

To what extent are the differences in the learners' conceptions and performance of static electricity related to their gender, age and interest in science?

In this section, the learners' conceptions and performance of static electricity is discussed in terms of age, gender and interest in science. The effect that gender, age, and interest in science have in learners' conceptions and performance of all the three groups. Research question 3 of the study explored learners' conceptions and performance in static electricity. This question related the performance to their age, gender and interest in science using the data collected from the COLQ questionnaire.

As the main purpose of research question 3 was to see the effect of gender, age and interest in science in learners' conception and performance of static electricity, the type of instruction that the learners were treated with was not relevant. Hence, the effect of these three factors on the conception and performance of learners in static electricity using the pre-test result for the experimental and the control 1 groups. A post-test result was used for the control 2 group to see the effect.

The statistical analysis performed on this question divulged that there was a significant difference in the performance of the learners that were exposed to DAAFLIM (experimental and control 2 groups) than those that were not so exposed (control 1 group) in the post test that was written. A paired sample t-test that was conducted showed that there was a difference in scores for control 1 and control 2 groups with M = 1.2287 and SD = 0.16800 for control group 1 and M = 1.4815 and SD = 0.14193 for control group 2 at (N) = 40. In terms of interest in science, the statistics showed that the girls showed more interest in science than boys with F (1.37) = 6.574, P < 0.05. For age, there was no significant difference in interest in science amongst the different age groups.

4.4.1 The learners' conceptions and performance of static electricity related to their gender, age, and interest in science for control 1_pre-test group

The table below is a statistical summary for the test between subjects' effects for the control 1 group at post-test where the dependent variable is interest in science.

Table 4.16 *Tests of between-subjects effects for control 1_pre-test group*

Dependent Variable: science is interesting					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2.884[a]	5	.577	1.699	.159
Intercept	108.174	1	108.174	318.716	.000
q1_gender	2.231	1	2.231	6.574	.015
q2_age	.294	2	.147	.433	.652
q1_gender * q2_age	.171	2	.085	.252	.779
Error	12.558	37	.339		
Total	136.000	43			
Corrected Total	15.442	42			
a. R Squared = .187 (Adjusted R Squared = .077)					

Assuming alpha =0 .05, the output in table 4.16 shows that there was a significant difference in gender between girls and boys who were interested in sciences with F (1,37) = 6.574, P < 0.05. while for main effect of age, F (2,37) = 0.433, p> 0.05 and the gender*age interaction F (2,37) = 0.252, p > 0.05 they were not significant.

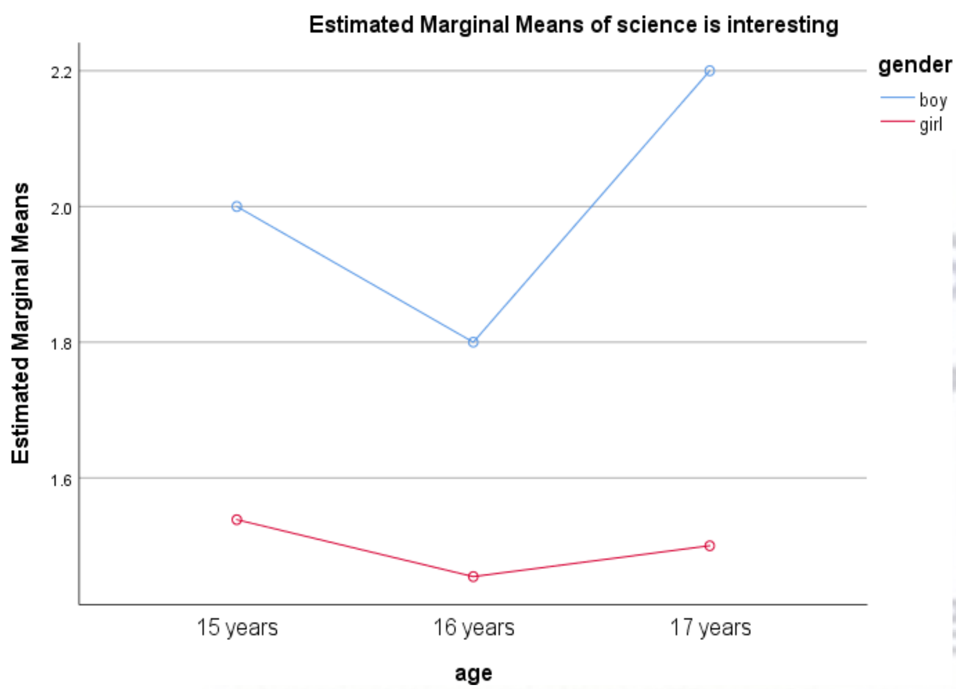


Figure 4.1 *Graph of estimate marginal means of science is interesting for control 1 pre- test group*

Figure 4.1 illustrates that the lines that are describing the simple main effects are parallel, then a possibility of an interaction does not exist. The presence of non-interaction was confirmed by the significant interaction in the summary table.

4.4.2 The learners' conceptions and performance of static electricity related to their gender, age, and interest in science for control 2_post-test group

The table below is a statistical summary for tests between subjects' effects for control 2 group, at post-test where the dependent variable interests in science.

Table 4.17 *Tests of between-subjects' effects for control 2_post-test group*

Dependent Variable: science is interesting					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	3.910[a]	5	.782	2.359	.060
Intercept	52.546	1	52.546	158.507	.000
q1_gender	1.558	1	1.558	4.701	.037
q2_age	1.238	2	.619	1.868	.170
q1_gender * q2_age	.001	2	.001	.002	.998
Error	11.603	35	.332		
Total	125.000	41			
Corrected Total	15.512	40			
a. R Squared = .252 (Adjusted R Squared = .145)					

The result in Table 4.17 above indicates that there was a significant difference in gender between girls and boys who were interested in sciences with $F(1,35) = 4.701$, $P < 0.05$. While there was no significant difference for the main effect of age, F (2,35) = 1.868, p> 0.05 and for the gender*age interaction F (2,35) = 0.002, p > 0.05.

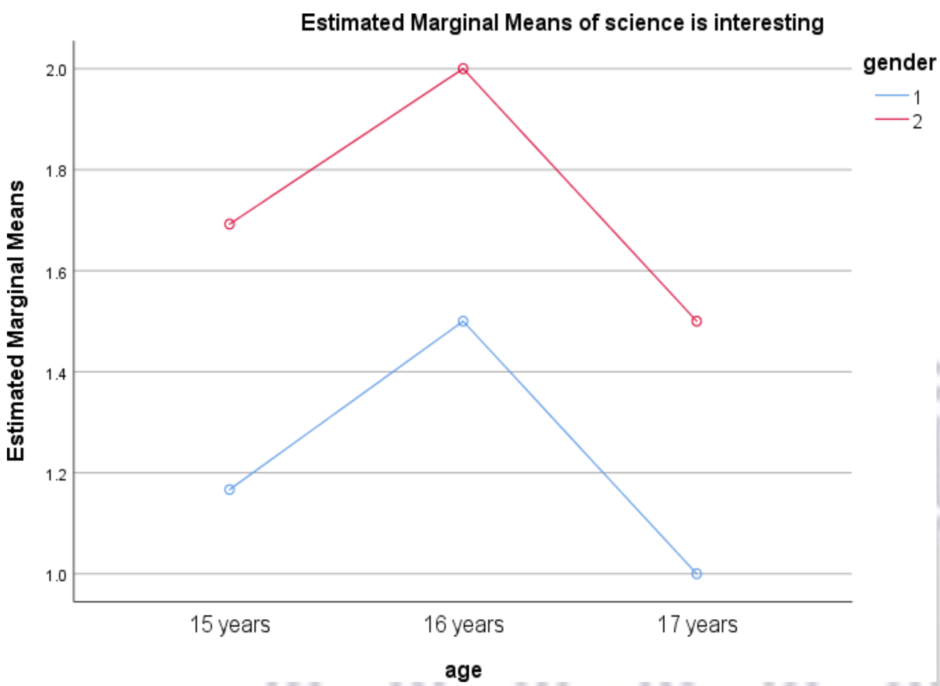


Figure 4.2 *Graph of estimate marginal means of science is interesting for control 2_post-test group*

Figure 4.2 reports how the simple main effects are parallel, hence the confirmation of non-interaction from table 4.17.

4.4.3 The learners' conceptions and performance of static electricity related to their gender, age, and interest in science for Experimental pre-test group

Table 4.18 *Tests of between-subjects' effects for experimental-test group*

Dependent Variable: science is interesting					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	6.206[a]	4	1.551	2.446	.065
Intercept	69.426	1	69.426	109.483	.000
q1_gender	.129	1	.129	.204	.654
q2_age	5.424	2	2.712	4.276	.022
q1_gender * q2_age	.001	1	.001	.002	.967
Error	22.194	35	.634		
Total	158.000	40			
Corrected Total	28.400	39			
a. R Squared = .219 (Adjusted R Squared = .129)					

The Table 4.18 above shows that there was a significant difference in age between 15, 16,and 17 years old who were interested in sciences with F (2,35) = 4.276, P < 0.05. While there was no significant difference for main effect of gender, F (1,35) = 0.204, p> 0.05 and for the gender*age interaction F (1,35) = 0.002, p > 0.05.

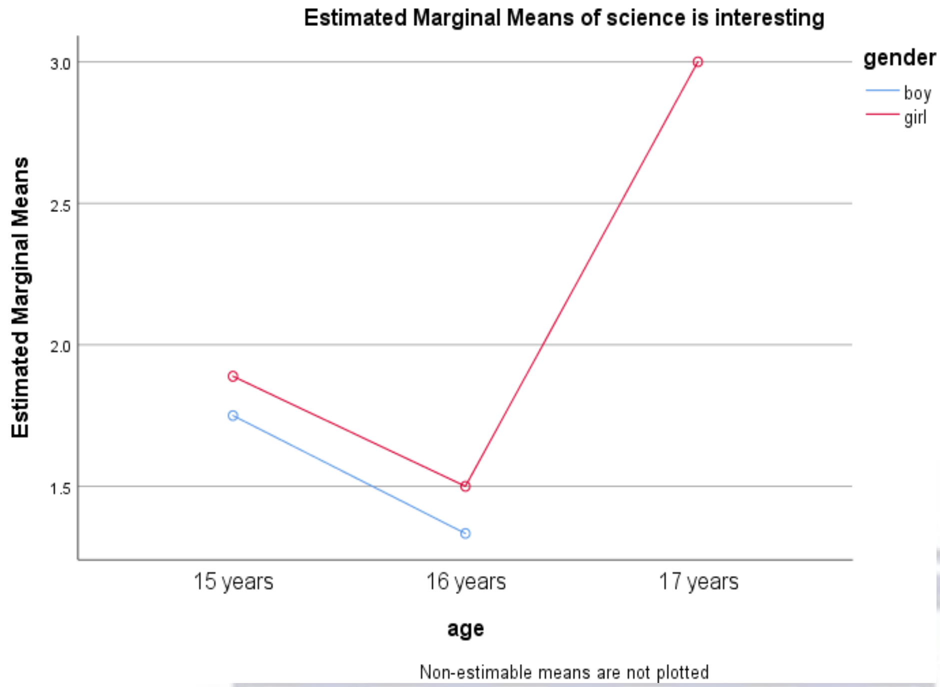


Figure 4.3 *Graph of estimate marginal means of science is interesting for experimental pre-test group*

The change in the simple main effect of one variable over levels of the other is most easily seen in the graph from figure 4.8 of the interaction. As the lines describing the simple main effects are parallel, then a possibility of an interaction does not exist. The presence of non-interaction was confirmed by the significant interaction in the summary table.

4.5 Chapter Summary

The demographic representation of the learners who participated in the study is discussed in terms of gender, age, province of origin, home language and guardianship. The gender of the learners comprises boys and girls. There were more girls than boys in each group- control 1, experimental and control 2. The age of the learners ranged between 15 and 17 years old. The province of origin for the majority of the learners is the Eastern Cape. Most of the grandparents of the learners stay in the Eastern Cape and the learners always go to visit their grandparents during summer holidays and that is where they get to share the cultural experiences with their grandchildren.

Most of the prior knowledge of the learners come from their experiences when they are at home. The home language of the learners was IsiXhosa and that this is the language they use mostly at home. The language of instruction at school was English therefore the learners had to translate their thoughts to English when at school. More than half of the learners in each group had a mother only as a guardian. In the Xhosa culture it is believed that the grandparents are mostly the ones that help the children to hold onto their indigenous knowledge.

Learners come to the school learning environment with their own traditional and religious ideas about lightning into the school science classroom. Some of these ideas do clash with school science. The learners had prior ideas about the nature of lightning, how it is formed, how it is controlled, how it behaves, and how one can avoid being struck by lightning. Learners had both scientific and traditional conceptions about lightning. Other learners had already drawn a delineation between lightning as understood in the scientific setting and lightning as theorized by tradition. The scientific conception of lightning was referred to as natural or school lightning while the traditional one was referred to as man-made lightning.

The findings of the study showed that learners held myths and IKS beliefs about lightning. Some of the common misconceptions regarding lightning included lightning is caused by witches; witches send lightning when they are angry or jealous to kill a person or destroy his property; mirrors and shiny materials attract lightning; consulting with traditional doctor or getting muthi (traditional medicine) from a traditional doctor can protect a person from lightning; praying protects from lightning; putting a motor car tyre on roof of a house protects one from lightning.

This study showed that the learners who were exposed to DAAFLIM developed more positive attitudes towards science than those who were not exposed. Most of the learners who took part in the focus group indicated that including comments when tasks are marked help them to rectify their mistakes and assess their learning progress. The findings of this study also showed that the conceptions and performance of the learners in the learners who were exposed to DAAFLIM were significantly better than the ones treated with the traditional teaching method of chalk and talk.

The results of the study also showed that learners do bring their traditional conceptions of lightning to the science classroom. It was discovered that learners do not actually leave their traditional ideas at home as some authors suggested. Also some of the learners come with some scientific conceptions about lightning. The scientific worldview is rather supplemented collaterally and contiguously to the learners' cognitive domain and then conversations begin to take place between the two. It was found that for some learners the conversations resulted in the learners rejecting or accepting either conception depending on their believability and intelligibility.

The finding of the study also showed that interest in science has an impact on the conceptions and performance of the learners in static electricity (lightning), whereas age and gender do not have a significant impact on the learners' conceptions and performance.

Chapter 5

Conclusion, Implications and Recommendations

5.1 Introduction

When the South African Department of Basic Education (DBE) tracks learner performance through the Annual National Assessment (ANA), the results indicate that learner performance of most disadvantaged children is unacceptably low (DBE, Republic of South Africa, 2016). The results are always tilted in favour of the schools that are well resourced and these schools are not financially accessible to the majority of children in South Africa.

Research done by Mullis (2007) revealed that in many under-resourced schools in South Africa, learners are failing to meet the required academic standards. This is according to the Trends in International Mathematics and Science Study (TIMSS) and the Progress in International Reading Literacy Study (PIRLS), as well as in terms of matriculation results. One of the reasons for the poor performance of the learners, as noted by Van der Berg (2008), is that teachers struggle to provide a quality teaching and learning experience for learners. Effective instructional methods can help learners to perform better (Spaull, 2013; Wood & Olivier, 2008).

This research was conducted in Grade 10 physical sciences classes at two secondary schools with a similar background to find out the effect of DAAFLIM on conceptions of static electricity that were held by Grade 10 learners before and after being exposed to dialogical argumentation-assessment for learning instructional model. The study also sought to establish whether or not there is a significant difference in conceptions and performance of static electricity held by the learners exposed to DAAFLIM and those not so exposed. It also attempted to see if there was any difference in conceptions and performance of the learners in relation to gender, age and interest in science.

This chapter apices the major findings of this study with the aim of putting up an amalgamation of the findings which stemmed from each of the research questions. In the previous chapter, data gathered using the questionnaires, the science achievement test and the data that was generated from the classroom observations and the focus-interview group were analysed and discussed. A conclusion that is made based on the findings of the study will be presented. The implications of DAAFLIM for teachers, recommendations for future research, the impact of DAAFLIM for underachieving learners, curriculum development, policy and limitations are discussed.

5.2 Findings of the study

This section deliberates the conclusion regarding the findings of the study. Firstly, a conclusion on the findings of the impact of DAAFLIM on the learners' conceptions about lightning that were held by learners before and after being exposed to DAAFLIM are deliberated. Secondly, a conclusion of the findings on the conceptions and performance of static electricity of the learners who were exposed to DAAFLIM in comparison to those who were not so exposed is made. Finally, a conclusion on the conceptions and performance of the learners in relation to their gender, age and interest in science is made.

5.2.1 The findings on Learners' conceptions of lightning

Learners come to school with prior knowledge and this prior knowledge could be the one that is acquired at school or through traditional and cultural practices. The findings of the study show that the learners when coming to a class, they already have their own views about lightning whether scientific, cultural or religious. Some of the opinions that have arisen from this research are discussed in this chapter. The scientific explanation of lightning is that it is a very powerful electrical discharge that is made during a thunderstorm.

The study showed that learners held myths and IKS beliefs about lightning before and after being exposed to DAAFLIM. Some of the most common misconceptions regarding lightning that emanated from the study were that lightning is caused by witches; witches send lightning when they are angry or jealous, to kill a person or destroy his property; mirrors and shiny materials attract lightning; consulting with the traditional doctor or getting a *muthi* (traditional medicine) from a traditional doctor can protect a person from lightning; praying protects from lightning; putting a motor car tyre on roof of a house protects one from lightning.

The most common belief regarding lightning was that witches can send lightning to kill people or destroy their property when they are angry or jealous. Such belief, as noted by Pabale (2006) is found amongst people from different backgrounds, including those who are educated. The use of traditional medicine and praying are some ways of protecting oneself from lightning that is sent by witches. Some believed that covering mirrors can protect one from being struck by lightning. Others believed that putting a tyre on a roof or burning a tyre in a house protects against lightning.

Learners' misconceptions of lightning do not only impede the learning of science but also may pose danger to the learners and their community if not identified and addressed properly. DAAFLIM played a role in addressing such issues as it primarily provided learners an opportunity to share their views in a classroom. Some of the misconceptions were harmless, for example covering mirrors and avoid the use a cellphone during lightning. However, the belief that lightning is caused by witches poses damage to those accused of being witches. The belief that motor tyre and *muthi* protects against lightning might give learners a false sense of safety that will increase the risk.

The scientific safety measures include minimizing the risk by being indoors during lightning. The houses need to have reinforcing steel, metal plumbing or electrical wiring that can provide a path for a lightning current to ground. The houses also should not have thatched roofs that can easily be set alight and cause more severe damage by lightning. Some of the misconceptions of lightning do not only impede the learning of static electricity but also can be dangerous.

The findings of the study showed that the learners who were exposed to DAAFLIM developed more scientific conceptions of lightning than those learners who were not so exposed. Most of the cultural beliefs do not have explanations and such beliefs are not meant to be questioned in a traditional society. DAAFLIM provided learners with a platform to express their views and reflect on them. Such a platform helped them to see the relevance of science in real life and thereby develop a positive attitude towards science. This in turn provided them to reason out about their own beliefs, compare their beliefs with the scientific explanations and rectify the misconceptions.

5.2.2 The findings on learners' performance in static electricity (lightning)

DAAFLIM did not only help the learners to develop a positive attitude towards science but also improved their performance in static electricity. It was evident in this study that assessment for learning improved learners' attitudes toward learning because it focused primarily on helping them understand their learning levels. It also increased their desire for learning, boosted their confidence, and responsibility towards their learning. The findings of the study on the effect of DAAFLIM supports the findings of Irons (2008) on assessment for learning.

The findings of the study showed that the academic achievements through the test scores of the learners in the experimental group where DAAFLIM was applied were significantly higher than the ones in the control group 1 where no intervention methods were applied.

Dialogical argumentation provided the learners an opportunity to reflect on the two views- the science view and the IKS view and enhance their critical thinking. The argumentation helped them to resolve some conflicting views they had. Regardless of the strength of the scientific explanation of lightning, some learners opted to hold on to their IKS beliefs. However, while holding onto their beliefs their performance improved as they knew what is expected of them in school science through assessment for learning. Assessment for learning afforded learners an opportunity to evaluate their progress in terms of the learning goals and also gave them a chance to realise what was expected of them in school science. It also guided them towards the learning goals and this in return enabled them to rectify their mistakes during the learning process.

One can therefore infer that the rudiments applied in assessment for learning practices, which include prioritizing the learning and marking with comments instead of scores, teaching using group work which necessitates sharing and cooperation instead of individual efforts, and assessing learners in accordance with individual development levels in order to help learners develop positive attitudes towards science.

In literature, it is shown that some studies were done by Andrews (2011); Collins (2012) and King (2003) established that assessment for learning did not significantly affect learners' academic achievement in a positive way; nonetheless, the influence in the studies can be regarded as being not statistically significant. Yin (2008) found that assessment for learning did not lead to a significant influence on learners' achievement, motivation, and conceptual changes; however, this stemmed from the difficulty of effective implementation of assessment for learning rather than its effectiveness. Tuominen (2008) also concluded that assessment for learning did not significantly increase learner academic achievement, and attributed this to the short duration of the study as well as the variety in teachers' different practices.

5.2.3 The findings on learners' conceptions and performance in relation to gender, age and science in attitude

In the study, it was also established that the attitudes of the learners toward physical science in the experimental group where the DAAFLIM practices were applied were significantly higher than the ones in the control 1 group where no DAAFLIM practices were applied. This supports the findings of the study by McKenna (2011) which examined learners' attitudes toward science class in a study conducted with grade seven science students in secondary school, and found that 96% of the learners viewed assessment for learning as a positive influence on their attitudes.

The findings of the study showed that interest in science had an impact on the conceptions and performance of the learners in static electricity (lightning) whereas age and gender did not have a significant impact on the learners' conceptions and performance.

When the effect of DAAFLIM practices on learners' attitudes towards the science class was evaluated in conjunction with the results obtained from the present research and the results in the literature, it was clear that DAAFLIM significantly improved learners' attitudes towards science classes. One can then surmise that the rudiments applied in the DAAFLIM practices, including prioritizing the learning and making up of deficiencies instead of grading, group work and assessing learners in accordance with individual development levels instead of comparing them to each other all helped learners to develop a positive attitudes and interest towards a science class.

5.2.4 Findings on the learners' cognitive shift

Argumentation as an instructional tool is an effective means for self-expression and for resolving conflicting ideas (Erduran, Simon & Osborne, 2004; Ogunniyi, 2007a, b). Argumentation, as noted by Erduran, Simon and Osborne (2004), requires learners to engage with data or evidence, to make claims based on these and to weigh the extent to which others' claims can be substantiated.

A good argument, as described in Simon, Osborne, & Erduran, (2003) by Toulmin (1958), is one that supports a particular point of view in a logically consistent manner. Argumentation is the process of linking evidence to a claim. It requires learners to externalise their thinking (Kuhn, 1992). Therefore, when learners understand the relationship between claims and warrants, their ability to think critically in scientific concepts is sharpened (Erduran et al., 2006). To understand the connection between evidence and claim is to understand the relationship between claims and warrants and to sharpen children's ability to think critically in a scientific context, preventing them from becoming blinded by unwarranted commitments (Quinn, 1997).

The arguments of the learners from the activities in the experimental group and in the control group 2 were classified using Toulmin's Argumentation Pattern (TAP). A few statements made by the learners in both groups fell on the level 1 classification. These are the arguments that only had a claim but there was no evidence given to back up the claims made. The claims made also had no grounds or rebuttals. According to TAP, most of the arguments made by the learners can be classified as Level 2 and Level 3 arguments. Level 2 argumentation has arguments consisting of a claim versus a claim with either data, warrants, or backings but do not contain any rebuttals. Level 3 argumentation has arguments with a series of claims or counter-claims with either data, warrants, or backings with an occasional weak rebuttal.

The findings of the study show that learners come to class with IKS views and when confronted with scientific views they have different ways of resolving these two conflicting views. Despite the learners' achievement in their conceptions of static electricity (lightning) from the SAT, the qualitative data from the questionnaire and the focus group interviews indicated that their thought systems seemed to indicate that some of these learners had undergone some cognitive shifts in their worldviews presuppositions.

The categories that collaborated with CAT's (Ogunniyi, 2007a) categories included Dominant Indigenous worldview, Equipollent Worldviews, and Assimilated. The learners' responses from the focus group interviews showed the learners shifting between worldviews supporting Ogunniyi (1997) notion that worldviews are dynamic and depend on the situation at that point and time. Only one of the learners in the focus group interview could display evidence of scientific worldview thus confirming the difficulties experienced by non-western learners in trying to learnscience topics (Ogunniyi, 1997).

5.3 Implications of DAAFLIM for teachers

Teaching science involves introducing learners to the ways of talking and thinking of the science community. Through dialogical argumentation, a teacher is able to attend to the learners' points of view which might be IKS as well as to the school science view. Argumentation helps teachers to move from a situation where learners understand little or nothing about science concepts to one where they are able to talk and think about the concepts themselves. The central role of argumentation in doing science is to engage learners in strategies that enhance decision-making about controversial issues in science and to do so they need to understand how evidence is used to construct explanations. They also need to understand the criteria that are used in science to evaluate evidence.

Teachers should learn to prioritize concept teaching and comprehension of learners regarding related concepts and inter-conceptual associations in order to develop their scientific reasoning skills. Teachers should also plan their lessons accordingly for an efficient concept teaching, using methods such as assessment for learning and argumentation which improves learners' conceptual understanding levels and interactive feedback that reveals prior knowledge and misconceptions. To use classroom techniques of argumentation and assessment for learning developed for an easier and more effective application.

When using DAAFLIM as an instruction method, teachers need to use appropriate activities and teaching strategies that can provide a means of promoting a wider range of goals, including social skills, reasoning skills and the skills that are required to construct arguments using evidence (Osborne, Erduran, & Simon,2004b; Simon, Erduran & Osborne,2006). Teachers need to emphasis teaching science to incorporate argumentation, educators must adopt a more dialogic anapproach that involves learners in discussion (Alexander, 2005; Mortimer & Scott, 2003).

Learners should be able to engage in decision-making about controversial issues in science, and to do so they need to understand how evidence is used to construct explanations. They also need to understand the criteria that are used in science to evaluate evidence. Therefore, there is a need for them to be educated about the scientific worldview – seeing science as a distinctive and valuable way of knowing. This shift in emphasis requires that teaching of science focus more on the nature of science and on the evidence and arguments for scientific ideas, and help learners develop skills of engaging in prolific argumentation.

For teachers to improve their learners' achievements with appropriate help and support; they need to minimize the competition between the learners because it disrupts the motivation of learners who find it difficult to achieve learning goals. Brookhart et al. (2009) reckon that while learners across the achievement spectrum should benefit from the integration of assessment for learning practices, the effects, as argued by Boston (2002) and Ruston (2005), should be more notable for the lower achieving learners.

Teachers, through DAAFLIM, should be able to know what learners know and the misconceptions that these learners hold and devise their teaching strategy accordingly. Moreover, teachers need to be sensitive and sensible in applying assessment for learning. Teachers should find out what the learners know, understand how learners learn and focus on assessing learners' performance against the goals and objectives of the topics. Teachers also need to monitor self and peer assessment with caution and make sure that they are implemented properly.

Levasseur (2003) regards thinking and not memorising as an integral to understanding science and mathematics, as memory is the residue of thought. Therefore, the role of a teacher, as noted by Willingham (2009), is to stimulate the thinking process, by planning resources that allow learners to raise questions and ensuing the flow of ideas and that way changing their way of thinking and learning.

Results obtained from an interview with a teacher who applied the assessment practices correlated to limitations and applicability of using assessment for learning showed that the teacher thought assessment for learning had no limitations and he suggested that it would increase the success even more if used with technology.

Teachers need to be trained through workshops on the assessment for learning practices so that can be widely used. The classroom tasks, activities and homework should also be assessed using comments instead of marking things as incorrect and assigning marks or scores. Lessons should as much as possible be conducted through collaborative group work in order to improve the dialogue between learners.

5.4 Recommendations

5.4.1 Future research

Although there is confirmation that DAAFLIM practices had a significant impact on learners' performance, there is still a need for further research. Even though there have been studies to research on the effect assessment for learning and dialogical argumentation as instructional methods, there are very few studies that combine the two methods in one lesson.

More research should be conducted on improving learners' conceptual understanding levels and their scientific cognitive skills. Further studies on conceptual understanding by making use of assessment for learning probes, which are proven to be efficient in determining learners' conceptual understanding levels and misconceptions can also be useful.

Similar research with a higher sample number and using pre-test and post-test control group design in order to obtain more general results about the effect of assessment for learning on conceptual understanding of learners should also be conducted.

Evidence shows that assessment for learning procedures has a significant impact on learning, but there is a need for further research. To be addressed by future research may be the impact of assessment for learning on learner achievement. Even though Black and Wiliam (1998) provided convincing evidence that assessment for learning is highly effective in raising standards of learner achievement, the research can be reinforced by including both quantitative and qualitative studies of AFL approaches. Studies should also be carried to find the impact of assessment for learning methods on underperforming learners especially in schools with large classes. Keeley (2005) used multiple-choice questions as an assessment for learning probes in order to spot misconceptions in science lessons, before teaching a new concept. This can also be researched further to determine if it can be helpful to increase the performance of science learners.

Research should also be conducted on effective AFL tactics for learners based on gender, ethnicity, socio-economic status and age. This study has shown that there is a need for more advanced knowledge of what works for learners in different socio-economic groups, this was evident during the argumentation lessons. The research may explore the conditions under which different learners succeed on competition, or in more complaisant situations as well as exploring the extent to which principles of teaching work well for a certain group, transfer to other groups of learners. Studies in this zone may be important to address the equity gaps visible in learner achievement.

5.4.2 The impact of DAAFLIM methods for underachieving learners

Numerous research studies have shown that dialogical argumentation and assessment for learning procedures have a stronger impact on underperforming learners. The studies show reasonably stronger improvements from learners who were previously underperforming. Additional research in this area may have suggestions for teachers that have very large numbers of underperforming learners in their classes.

5.4.3 Curriculum development and policy

In order for the policy to draw upon the knowledge to acclimatize and improve strategies and deepen impact, it is recommended that researchers pay attention to the success of numerous dissemination and enactment strategies.

The notion that assessment can sustenance learning is not a new idea. The overriding role of assessment has always been seen as that of only recording learner achievement, this study has shown that assessment for learning with argumentation can be used for the improvement of instruction by teachers therefore, improving the results of learners. This proves that assessment could extensively improve learning as it increases learner engagement.

The department of education should make provisions in the curriculum for the use of assessment for learning as an overriding assessment approach in primary as well as in secondary schools. When class assessments are conducted, learners should be evaluated according to their level of development rather than being compared to each other.

Tasks and activities are done or homework should be assessed using comments instead of marks. Group work should be encouraged amongst the learners to improve their working together skills. The impact of assessment for learning on academic accomplishment and attitude toward classes should be examined within the context of different classes. Also, the stimulus of assessment for learning on different dependent variables should be studied. The degree to which teachers have included or will include assessment for learning practices in their current practice in the teaching-learning process should be tested through qualitative studies.

Some of the major barriers to a wider practice of assessment for learning that emerged from studies done include the still high visibility of summative tests that are intended to hold schools accountable for meeting standards, and that may hold particular consequences for low or underperforming schools. A lack of connection between the systemic, school and classroom approaches to assessment and evaluation. Assessment for learning offers an influential revenue for meeting goals for high-performance and for providing learners with knowledge and skills for lifelong learning.

DAAFLIM could be applied more effectively and efficiently if combined with technology, this would also help to include more sensory organs, and that way provide better learning. William & Black (2003) claim that assessment for learning is the only way for which a strong evidential case can be made for improving learning. They also emphasized that assessment for learning practices integrated with technology would make the class more enjoyable and increase learners' learning by appealing to more sensory organs. In a similar experimental study in Taiwan, Hwang and Chang (2011) established that mobile learning aided assessment for learning significantly increased the interest and attitudes of year five secondary school learners toward learning in a culture class.

5.5 Limitations

Limitations were acknowledged during the data gathering and analysis. The specific limitations for the study need to be shared and stated so that the findings of the study can be read in the context of the limitations.

Learners at both schools in the study were English second language and the language of instruction was English and sciences were also taught in English, therefore, the learners had problems expressing themselves during the argumentation lessons. If the learners are limited in their understanding and use of English as the language of communication, teaching and learning, then language would become a barrier to the success of the intervention which depended heavily on discursive discourses (Poliah, 2009). The learners were then allowed to use IsiXhosa and code switch whenever the need arose to answer the questionnaires as it was a language they felt comfortable in and their responses were translated to English.

The use of argumentation-based teaching and formative assessment tasks were a new experience for the learners. Therefore, a longer period of data collection was needed so as to promote familiarity of the teaching–learning method for the teachers and learners to form elaborate perceptions. It was noted by Hord (1987) that change is not an event but a process that often needs a long time to take effect. Hord further warns that possible and permissible change may be effected only to a limited extent because of demands placed on individuals dealing with change and the pressure to produce results from innovations.

Only learners were interviewed on the perceptions of using the DAAFLIM model of instruction and not the teachers who are the ones to implement the teaching and assessment model. Therefore, teachers can also be interviewed to also find ways on how the DAAFLIM method can be improved.

As this was a case study, it was very useful within the practical dimensions of the situation even though findings do not directly contribute to the general body of education knowledge due to the limiting nature of a case study (Isaac & Michael, 1997). Therefore, weaknesses of a case study are applied in this study as the findings of this research cannot be generalised. The findings of the study were derived from data that was acquired from township schools which are part of the underprivileged rural areas. That means the findings might not hold true for children from affluent areas. Nonetheless, the findings can still benefit learners and teachers from the same cultural background.

As I was using my learners in my school for the experimental and control 2 groups, this may have affected the results in the sense that the learners might have given answers that they thought their science teacher wanted to hear.

The time factor was also a problem that might cause a lot of anxiety on the part of the researcher as sometimes due to unforeseen circumstances the periods would be cut short and that would interfere with the lessons.

5.6 Conclusion

The aim of the study was to investigate the conceptions of static electricity that were held by Grade 10 learners before and after being exposed to dialogical argumentation and assessment for learning instructional model (DAAFLIM). This study also sought to establish whether or not there was any significant difference in the conceptions and performance of the learners regarding static electricity between those who were exposed to DAAFLIM and those treated with the traditional method of teaching. Moreover, the study attempted to see whether or not there were differences in the learners' conceptions and performance of static electricity related to their gender, age and interest in science.

The study showed that learners held myths and IKS beliefs about lightning both before and after being exposed to DAAFLIM. The most common misconceptions about lightning were that; lightning is caused by witches and that covering mirrors during a lightning storm protects one against lightning as well as putting a motor car tyre on roof of a house for protection from lightning.

A cross-cultural instructional approach integrates school science with knowledge customary in the socio cultural environment of the learners. It combines scientific and traditional worldviews about natural phenomena in a holistic manner. According to Aikenhead and Jegede (1999), learners negotiate and resolve cognitive conflicts caused by infusion of school science and traditional views through cognitive border crossing. The findings of the study indicated that the learners' thought systems had undergone some cognitive shifts in their worldviews presuppositions and that collaborated with CAT’s (Ogunniyi, 2007a) categories of Dominant Indigenous worldview, Equipollent Worldviews, and Assimilated.

Toulmin (1958), cited by Simon, Osborne, & Erduran (2003), describes a good argument as one that supports a particular point of view in a logically consistent manner. However, not all arguments are amenable to logical reasoning since learners hold multiple worldview conceptions of natural phenomena. The findings of the study indicated that the learners’ argumentation pattern ranged from level 1 to level 3 according to TAP.

The main purposes of dialogical argumentation are to improve learners’ understanding of the nature of science. This can be accomplished through learners experiencing the argumentative nature of science as they discuss with each other through argumentation activities. According to Chinn & Clark (2013), engagement in argumentation can result in educational benefits that include: motivation, content learning, argumentation skills and knowledge building practices.

The findings of the study also showed that there was a statistically significant difference in the conceptions and performance between the Grade 10 learners that were exposed to DAAFLIM and those not that were not so exposed. Whilst there was no significant difference in the learners’ conceptions and performance in terms of gender and age, there was a significant difference in the learners’ conceptions and performance of the selected topic static electricity in terms of interest in science.

It was evident in the findings of the study that, the use of argumentation, as also pointed out by (Pera, 1994), is crucial in the growth of scientific knowledge as well as a vital component of scientific discourse. As concepts are building blocks of scientific procedures and scientifictheories, argumentation also plays a central role in the building of explanations, models, and theories (Siegel, 1995).

DAAFLIM helped learners to use argumentation to engage with data and evidence, to make claims based on these and to weigh the extent to which other's claims can be substantiated. The use of the DAAFLIM model also created a positive learning environment that enabled learners to participate actively in class and that led to the attainment of cognitive optimum. If learners are notgiven the chance to talk to one another and debate their ideas, it makes it difficult for them to learnscience concepts. Therefore, DAAFLIM can also be deemed essential to understanding the nature of science.

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Appendices

Appendix A: Ethical Clearance Letter from UWC

UNIVERSITY *of the*
WESTERN CAPE

60 YEARS *of hope, action & knowledge*

05 February 2021

Ms N Hlazo
SSME
Faculty of Education

Ethics Reference Number:	HS20/10/40
Project Title:	Raising standards: Effects of using dialogical argumentation instructional model and assessment for learning in teaching selected phenomena to grade 10 science learners.
Approval Period:	02 February 2021 – 02 February 2024

I hereby certify that the Humanities and Social Science Research Ethics Committee of the mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report by 30 November each year for the duration of the project.

The permission to conduct the study must be submitted to HSSREC for record keeping purposes.

The Committee must be informed of any serious adverse events and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

Director: Research Development
University of the Western Cape
Private Bag X 17
Bellville 7535
Republic of South Africa
Tel: +27 21 959 4111
Email: research-ethics@uwc.ac.za

NHREC Registration Number: HSSREC-130416-049

FROM HOPE TO ACTION THROUGH KNOWLEDGE.

Appendix B: Research Approval Letter from WCED

Education

Audrey.wyngaard@westerncape.gov.za
tel: +27 021 467 9272
Fax: 0865902282
Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 20170517 –973
ENQUIRIES: Dr A.T Wyngaard

Ms Noluthando Hlazo
64 Joepat Street
New Orleans
Paarl
7646

Dear Ms Noluthando Hlazo

RESEARCH PROPOSAL: RAISING STANDARDS: EFFECTS OF USING DIALOGICAL ARGUMENTATION INSTRUCTIONAL MODEL AND ASSESSMENT FOR LEARNING IN TEACHING SELECTED PHENOMENA TO GRADE 10 SCIENCE LEARNERS

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **04 September 2017 till 29 September 2017**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

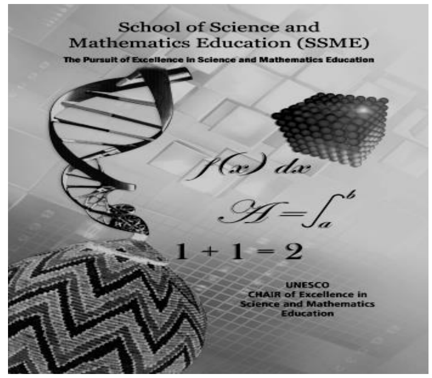
    The Director: Research Services
    Western Cape Education Department
    Private Bag X9114
    CAPE TOWN
    8000

We wish you success in your research.

Kind regards.
Signed: Dr Audrey T Wyngaard
Directorate: Research
DATE: 17 May 2017

Appendix C: Letter from supervisor

UNIVERSITY *of the* WESTERN CAPE



SCHOOL OF SCIENCE AND MATHEMATICS EDUCATION

(LETTER FROM SUPERVISOR TO DR WYNGAARD) – WCED

10 February 2017

Directorate : Research

Private Bag X 9114

Cape Town

8000

Dear Dr. Wyngaard

RE : APPLICATION FOR ETHICAL CLEARANCE

We are hereby applying for ethical clearance for Noluthando Hlazo who will be conducting research in her school on the topic: **Effects of Dialogical Argumentation – Assessment for Learning Instructional Model on Grade 10 Learners' Conceptions and Performance on Static Electricity**

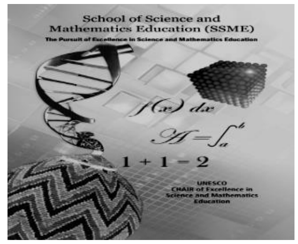
The details of the project are reflected in the attached research proposal and application.

Yours sincerely,

Dr. Cynthia Fakudze(SSME)

Appendix D: Letter to WCED for ethical clearance

UNIVERSITY of the WESTERN CAPE



SCHOOL OF SCIENCE AND MATHEMATICS EDUCATION

10 February 2017

Directorate : Research

Private Bag X 9114

Cape Town

8000

Dear Dr. Wyngaard

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN SCHOOLS

I herewith wish to request permission to conduct a research study for my PhD thesis at two secondary schools in Kraaifontein. The study will be conducted on a class of grade 10 physical sciences learners as a data gathering exercise for my thesis.

I am a registered student at the University of Western Cape with 13years teaching experience in Physical Sciences. The title of my thesis is : Raising standards: Effects of using dialogical argumentation instructional model and assessment for learning in teaching selected phenomena to grade 10 science learners.

This project will be conducted under the supervision of Dr Cynthia Fakudze.

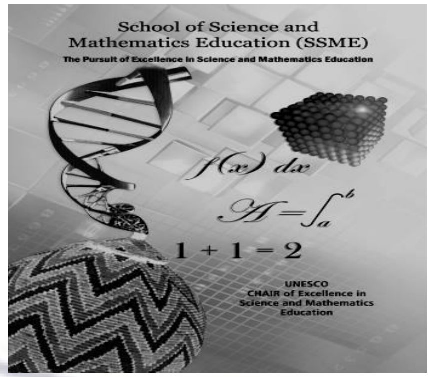
Attached is a copy of my thesis proposal. All information gathered shall only be used for research purposes. Upon completion of the study, I will provide the Western Cape Department of Education with a bound copy of the full research report.

Yours Sincerely

Noluthando Hlazo

Student no: 2968032 University of Western Cape

Appendix E: Letter to the principal and School Governing Body (School 1)



UNIVERSITY of the WESTERN CAPE

SCHOOL OF SCIENCE AND MATHEMATICS EDUCATION

10 February 2017

The Principal & SGB

Masakhane Secondary School

Kraaifontein

Dear Sir

RE: FIELD WORK FOR PhD STUDY IN SCIENCE EDUCATION

I herewith wish to apply for permission to perform a research study at your school. I have chosen the school because of its versatility and my personal attachment with the school. The school has played a huge role in my personal and professional development as a science teacher.

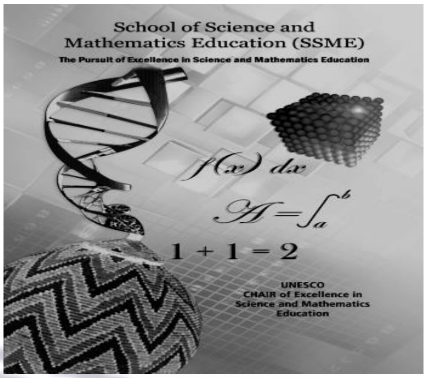
I am currently enrolled for my PhD in Science Education at the University of the Western Cape. The research study will include field work and teaching observation in two grade 10 Physical Sciences classes. All information gathered shall only be used for research purposes. The name of the school and the learners involved shall not be disclosed to anyone.

At the end of my data analysis, I will give a summary of my findings to the school. For ethical consideration in data gathering, the stamp of the school and signature will only suffice for the purpose of proof for construction and permission by school management.
Yours Sincerely

Noluthando Hlazo (Researcher)

Appendix F: Letter to principal and SGB (school 2)

UNIVERSITY *of the*
WESTERN CAPE



SCHOOL OF SCIENCE AND MATHEMATICS EDUCATION

10 February 2017

The Principal & SGB

BLOKIE HIGH SCHOOL
OLD PAARL ROAD
KRAAIFONTEIN

Dear Sir

RE: FIELD WORK FOR PhD STUDY IN SCIENCE EDUCATION

I herewith wish to apply for permission to do my field work and teaching observation in one grade 10 Physical sciences class in your school. I am currently enrolled for my PhD study in Science Education at the University of Western Cape. All the information gathered shall only be used for research purposes. The name of the school and the learners involved shall not be disclosed to anyone.

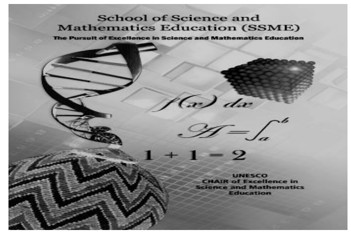
At the end of my data analysis, I will give a summary report of my findings to the school. For ethical consideration in data gathering, the stamp of the school and signature will only surface for the purpose of proof of consultation and permission by school management.

Yours Sincerely

Noluthando Hlazo (Researcher)

Appendix G: Consent letter to parents for learner participation in the research

UNIVERSITY of the WESTERN CAPE



SCHOOL OF SCIENCE AND MATHEMATICS EDUCATION

Dear Parent

Permission required for research (Grade 10 Physical Sciences leaners)
I would like to inform you that I was granted permission by the Western Cape Education Department to conduct a research exercise at Masakhane Secondary school from **04 September 2017 till 29 September 2017**. I am currently doing my PhD degree in Science Education at the university of the Western Cape. The purpose of the research is to determine the possible effects of using a dialogical argumentation, instructional model and assessment for learning intervention program in teaching electricity to grade 10 Physical sciences learners. Your permission is required to allow your child to participate in the research. The research will take place during normal school hours and learners will be observed while they engage in dialogue and hands-on activities. They will also be asked to complete a questionnaire based on their prior knowledge and the knowledge they gained during their engagement with the hands on activities and dialogical argumentation instructional model.Please complete the slip below and indicate whether your child will be allowed to participate in the research.

Yours in education
N. Hlazo (Ms)

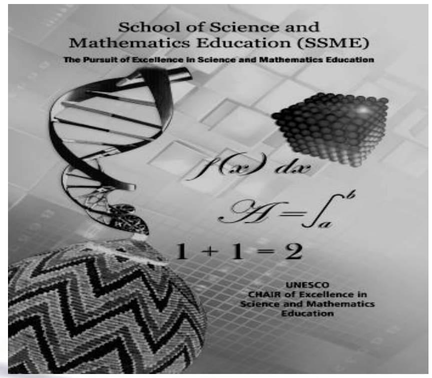
Permission slip: Indicate by making a tick (√) in the appropriate box

□ **Yes, my child can participate in the research**

□ **No, my child cannot participate in the research**

Parent signature: ……………………………….……………

Appendix H: Information letter regarding research



SCHOOL OF SCIENCE AND MATHEMATICS EDUCATION

Dear sir/madam

I am a registered PhD student at the University Western Cape and will be doing my research in a Physical sciences Grade 10 class. The title of my study is: Raising standards: Effects of using dialogical argumentation instructional model and assessment for learning in teaching selected phenomena to grade 10 science learners.

Three Grade 10 Physical sciences classes will be used to conduct the research. Two Grade 10 classes will be the experimental group and control group 1 and will be from Masakhane Secondary School and one Grade 10 class the control group 2 will be from Blokie Secondary School.

The duration of the study will be from 25 July to 29 September 2017. The researcher will teach the experimental group and control group 1. A Grade10 Physical sciences teacher at Blokie will teach the control group 2. The learners will complete a questionnaire as a pre and post-test. Focus group interviews will be done with the learners. The research will take place during normal school hours in the Physical sciences period. Permission will be sought from parents to allow their children to participate in the study.

Feel free to contact my supervisor Dr Cynthia Fakudze at 021 959 3687 or myself at 072863 6228 should you have any questions.

Yours Sincerely

Noluthando Hlazo (Ms

Appendix I: Consent letter to learners for participation in the research

SCHOOL OF SCIENCE AND MATHEMATICS EDUCATION

Dear Learner

Permission required for research (Grade 10 Physical Sciences leaners)

I would like to inform you that I was granted permission by the Western Cape Education Department to conduct a research exercise at your school from July 2017 to September 2017. I am currently a student doing my PhD degree in Science Education at the university of the Western Cape.

The purpose of the research is to determine the possible effects of using a dialogical argumentation, instructional model and assessment for learning intervention program in teaching electricity to Grade 10 Physical sciences learners. Your permission is required in order for you to participate in the research. The research will take place during normal school hours and you will be observed while you engage in dialogue and hands-on activities. You will also be asked to complete a questionnaire based on your prior knowledge and the knowledge that you gained during your engagement with the hands on activities and dialogical argumentation instructional model. Your name and identity and that of the school will not be divulged, only coded names shall be used in the final thesis, oral presentations and publications.

Please complete the slip below and indicate whether you will participate in the research.

Yours in education

N. Hlazo (Ms)

Permission slip: Indicate by making a tick (√) in the appropriate box

- □ **Yes, I will participate in the research**
- **No, will not participate in the research**

Learner signature: ……………………………..……………….

Appendix J: Instruments

1. Conceptions on Lightning Questionnaire

LEARNER'S CONCEPTIONS ON LIGHTNING (INTEGRATION OF SCIENCE AND IKS)

This questionnaire is about your ideas on lightning. There are no right or wrong answers, feel free to express your views. The information you provide will solely be used for research purposes and will not be disclosed to anyone. Your identity, and that of your school, will not be revealed. In no way is this questionnaire an assessment of you or your school. You may withdraw your participation at any time should you wish to do so. Please be honest when answering the questions. Your friendly cooperation is very much appreciated.

SECTION A: PERSONAL INFORMATION

NAME:...

GRADE 10.........

GENDER: BOY ☐ GIRL ☐

AGE: (make a cross (X) in an appropriate box)

14 YEARS	15 YEARS	16 YEARS	17 YEARS

HOME LANGUAGE :(make a cross(X) in an appropriate box)

XHOSA	ZULU	SOTHO	OTHER: (PLEASE SPECIFY)

OTHER LANGUAGES SPOKEN:...

PROVINCE ORIGINALLY FROM:...

NAME OF TOWN IN THAT PROVINCE:..

WHOM DO YOU LIVE WITH AT HOME?

MOTHER	FATHER	GRAND FATHER	GRAND MOTHER

EDUCATIONAL BACKGROUND OF PARENTS:

NEVER ATTENDED SCHOOL	PRIMARY LEVEL	SECONDARY LEVEL	DIPLOMA	DEGREE

HOW MANY TIMES DO YOU READ BOOKS OTHER THAN YOUR SCHOOL BOOKS?

ONCE A WEEK	ONCE A MONTH	ONCE A YEAR	NEVER

SECTION B: Personal views (izimvo zakho) about science

Please indicate by a cross(X) your feelings about science. Give reasons for each answer you give.

1. Science is interesting.
Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐

Reason...

....

....

2. Using my indigenous knowledge to learn science helps me to understand science better.

Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐

Reason...

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....

....

3. I can use what I learn in a science class at home.

Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐

Reason...

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....

....

4. I believe more in my indigenous knowledge than science.

Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐

Reason...

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....

5. I'm only interested in science to pass my exams.

Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐

Reason...

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....

6. There is a relationship between lightning and electricity.

Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐

Reason...

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Source of information: Science ☐ Religion ☐ Personal View ☐ Cultural View ☐

Reason...

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7. Lightning is caused by witches and traditional doctors.

Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐

Reason..
....
....
....

Source of information: Science ☐ Religion ☐ Personal View ☐ Cultural View ☐

8. It is not necessary to protect yourself from lightning because it cannot kill you.

Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐

Reason..
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Source of information: Science ☐ Religion ☐ Personal View ☐ Cultural View ☐

9. Science explains formation of lightning better.

Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐

Reason..
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Source of information:Science ☐ Religion ☐ Personal View ☐ Cultural View ☐

10. When lightning strikes we should cover our mirrors.

Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐

Reason..
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Source of information:Science ☐ Religion ☐ Personal View ☐ Cultural View ☐

2. Science Achievement Test on Lightning

SCIENCE ACHIEVEMENT TEST ON LIGHTNING

NAME:..

GRADE 10:.......... Marks: 30

Question 1

Read the stories below and indicate which statement you agree with by making a cross(X) on the boxes provided. Also indicate your source of information.

1.1 Lightning is................

(a) Caused by witches. ☐

(b) Fire ☐

(c) A large spark ☐

(d) Impundulu ☐

Reason for your answer:

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....

1.2 To protect your house from lightning you must.............

(a) Use a lightning conductor. ☐

(b) Ask a priest (umfundisi) to pray for your house. ☐

(c) Consult a traditional doctor (igqirha) to give you muthi to protect you. ☐

(d) Put a motorcar tyre on the roof of the house. ☐

Reason for your answer:

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1.3 Chitibhunga, a famous traditional doctor while performing a ritual pointed his spear(umkhonto) in all directions while there was a lightning storm. He was struck by lightning and was badly injured. After that incident people were saying that...........

(a) He was bewitched by other traditional doctors. ☐

(b) He was not a qualified traditional doctor. ☐

(c) His spear conducted charges through him. ☐

(d) The ancestors were angry with him. ☐

Reason for your answer:

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1.4 Gogo told her grandson not to stand under the tree when there is a lightning storm. The explanation for that could be....

(a) Impundulu (lightning bird) lays its eggs on a tree. ☐

(b) Tall trees attract lightning. ☐

(c) A willow tree attracts lightning. ☐

(d) Witches use the tree to hide their muthi. ☐

Reason for your answer:

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....

1.5 When there is a lightning storm, people are advised not to handle water. This is because..........

(a) Lightning bird (impundulu) lives in water. ☐

(b) Lightning likes water. ☐

(c) Water is a good conductor of lightning. ☐

(d) Water is pure. ☐

1.6 During a football match in the FNB stadium between Moroka Swallows and Celtic there was a lightning strike and many players were injured and one was killed. The player had huge wounds all over his body.

Doctors who saw the wounds explained that.....

(a) Lightning kills people in a strange way. ☐

(b) The other team members bewitched him as he was the highest goal scorer. ☐

(c) *Tokoloshe* beat him with a *sjambok*. ☐

(d) *Impundulu* scratched him with its long hard nails. ☐

Reason for your answer:

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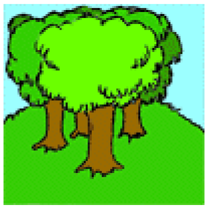
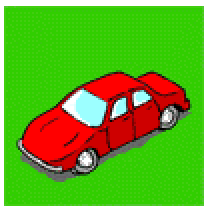
1.7 Bob has been caught outdoors when a thunderstorm suddenly forms overhead. He needs to find a safe place for protection from lightning.

In the picture below, where will Bob be the safest?

(a)  ☐

(b)  ☐

(c)  ☐

(d) 

☐

Reason for your answer:

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QUESTION 2

2.1 Zuko rubbed a plastic ruler on the sleeves of his jersey. He then brought the rubbed ruler close to small pieces of paper.

2.1.1 What will happen to the pieces of paper?

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2.1.2 Explain why this happens.

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2.1.3 Explain what happened to the ruler during rubbing?

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2.2 Two freely hanging strips which carry different charges are brought close to each other.

2.2.1 What will happen to the strips?

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2.2.2 Explain your answer.

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2.3 A positively charged metal strip is brought near another positively charged metal strip.

2.3.1 What will happen to the charged strips?

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2.3.2 Explain your answer.

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2.4 Two balloons are brought close to each other. One balloon is positively charged and the other one is not charged.

2.4.1 What charge will be induced on the uncharged balloon?

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2.4.2 Explain your answer.

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2.5 What happens when you take a jersey off in a dark room?

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2.5.1 Explain why that happens.

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2.6 During a thunderstorm, there are huge sparks followed by thunder. What is the cause of..

2.6.1 The sparks?

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2.6.2 The thunder?

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2.6.3 Why is the thunder heard long after you have seen the sparks? Explain.

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2.7 Explain how a cloud becomes charged.

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2.8 Explain how lightning is formed.

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2.9 Church buildings have a strip of copper fixed to the side of the church. This strip extends high to the church spike.

2.9.1 What is the purpose of the copper strip?

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2.10 What are the things that you must avoid during a thunderstorm? Give reasons.

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3. Interview Questions

1. What were your views about lightning before the science lesson?
2. What are your views now? / have your views changed?
3. Has arguing about the topic with other learners had any influence or impact on your views?
4. If yes how?
5. Will arguing about science topics make you understand them better? How?
6. Do you think traditional knowledge should be infused in science lessons? Why?
7. Has the use of assessment for learning during the lesson had any impact on your understanding of the topic?
8. How does being graded with comments and no marks impact on your learning?

4. Argumentation Lightning Activities

Activity: Modelling the process of dialogical argumentation using lightning as a topic.

Individual Task: Read the article and answer the questions that follow

The ref who was struck by lightning and his mother blames a witch.

By Yoliswa Sobuwa

Incidents of lightning strikes involving sever injury and death to people and livestock, damage to property and communication systems appear regularly in the press.

The following account appeared in the ***Daily Sun*** **on Monday 4 February 2008.**

“I was suddenly surrounded by blinding white light … I was in great pain ….

I remember nothing more.”

Those were the word of a soccer referee who survived being struck by lightning. He is feeling much better now and is grateful he’s still alive. But his mother insists that it was an attempt by a witch to kill him!

The ref, Kagiso Sello (24), said: “I fell over and then I don’t remember anything until I was in a strange house…”

The bolt from above struck him while he was in charge of a soccer match in Bloemfontein, Free State, on Sunday a week ago

Spectators told the *Daily Sun* said that they had never seen anything like it in their lives!

The Glen team was playing against the Mighty Blues in a local friendly.

Sipho Sibuzo, the coach of the Mighty Blues said “It started drizzling .. .We did not think it was anything serious, so we continued with the game.”

“The strange thing was that it was raining in our vicinity only”

“And all of a sudden the ref was surrounded by light and he was down”, Sipho said.

Kagiso’s clothes were torn as if someone had used scissors to rip them!

The unconscious match official was rushed to a nearby house – and from there to hospital, Kagiso’s mum Masentle Mokobi (48) said, “When I got to him he was still in hospital, but he was fine.”

“Someone wanted my child dead because he was the only one struck by lightning.”

"That usually happens when the lightning is has been sent by a powerful witch," she said.Kagiso has been discharged from Polonomi Hospital. He cannot walk properly yet as his legs are still swollen. And he has burns on his back and on his legs. He remembered that he tried to stop the match when it started raining- but the players brushed him off, saying that it would soon stop

Answer the following questions

In each case try to state your case by framing your answer in the form of an argument based on (TAP) Toulmin's Argumentation Pattern. A **claim** must be accompanied by reasons or grounds to support the claim. Further evidence may be given in the form of warrants, backings, qualifiers, counterclaims and/or rebuttals.

1.1.1 What or whom did Masentle Mokobi blame when her son was struck by lightning. What did she believe was the cause of the accident?
State you answer as a claim.

____

____

3.1.2 What evidence/ data/ reasons/ grounds did Masentle use to support her claim? **(because...)**

____

____

1.1.3 What assumptions does Masentle refer to as a warrant to support the data? State your answer as a warrant. **(Because / since/ and so. ....)**

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1.1.4 What does Kagiso remember about what happened to him when he was struck by lightning?

____

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1.1.5 What effect did the lightning have on Kagiso's body and on his clothes?

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1.1.6 Based on the circumstances of the incident, the coach Sipho Sobuwa's account and the type of injuries Kagiso sustained what scientific explanation would you propose as to the cause of the accident? State your answer as a rebuttal to Masentle's claim.