Full Thesis submitted in fulfilment of the requirement for the degree:

Masters in Science Education

Title of thesis

Effects of a dialogical argumentation based instruction on grade 9 learners' conceptions of a meteorological concept: Cold Fronts in the Western Cape, South Africa.

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Key terms

1. Environmental Education
2. Meteorological Literacy
3. Meteorological Science
4. Attitudes scale
5. Weather patterns
6. Socio-economical factors
7. Outdoor Education
8. Climate Change
9. Effectiveness
10. Atmospheric understanding

Abstract:

This study looks at the effects of a dialogical argumentation instructional model (DAIM) on grade 9 learners understanding of selected meteorological concepts: Cold fronts in the Western Cape of South Africa. Using a quasi-experimental research design model, the study employed both quantitative and qualitative (so-called 'mixed methods') to collect data in a public secondary school in Cape Town, in the Western Cape Province. A survey questionnaire on attitudes and perceptions towards high school as well as conceptions of weather was administered before the main study to give the researcher baseline information and to develop pilot instruments to use in the main study.

The study employed a dialogical instructional model (DAIM) with an experimental group of learners exposed to the intervention, and recorded differences from a control group which had no intervention. Learners from the two groups were exposed to a meteorological literacy test evaluation before and after the DAIM intervention. The results from the two groups were then compared and analysed according to the two theoretical frameworks that underpin the study namely: Toulmin's Argumentation Pattern - TAP (Toulmin, 1958) and Contiguity Argumentation Theory - CAT (Ogunniyi, 1997).

Further analyses were conducted on learners' beliefs and indigenous knowledge, according to their conceptual understanding of weather related concepts used in the current NCS (National Curriculum Statement). After completing the study some interesting findings were made and based on these findings certain recommendations were suggested on how to implement a DAIM-model into classroom teaching using Indigenous Knowledge (IK). These recommendations are suggestions to plot the way towards developing a science–IK curriculum for the Natural Sciences subjects in South African schools.

Declaration

I declare that **"Effects of a dialogical argumentation based instruction on grade 9 learners' conceptions of a meteorological concept: Cold fronts in the Western Cape, South Africa"** 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.

ALVIN DANIEL RIFFEL

UNIVERSITY *of the*
WESTERN CAPE

SIGNED: …………………………………………..……. DATE: MARCH 2013

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OPERATIONAL DEFINITIONS

Worldview – To Kearney (cited by Ogunniyi, et al, 1995) "A world is a culturally organized macro-thought: those dynamically interrelated assumptions of a people that determine much of their behavior and decision making, as well as organizing much of their body of symbolic creations…and ethno-philosophy in general" (p. 818).

Science/IKS curriculum – This term refers to the new South African school science curriculum especially Outcome 3 which calls on teachers to integrate IKS with school science school science.

Language of Instruction - The language in which teaching and the learning materials are presented in, in the classroom.

Language of learning and teaching (LoLT) – The official language used in learning, instruction and in which assessment of outcomes are carried out rather than referring only to English and Afrikaans as was the case during apartheid era (DoE, 1996).

Language in Education Policy (LiEP) – A government policy within South Africa's education system which was enacted to provide a framework for the promotion and protection of all languages used in the country (DoE, 1996)

Indigenous Knowledge Systems (IKS) – A system of thought peculiar to people of a local geographic location or socio-cultural environment (Ogunniyi, 2008: 6)

Sociocultural Critical Constructivism – Constructivism that takes cognizance of learners' socio-cultural environment.

Revised National Curriculum Statement – A policy document setting guidelines for curriculum implementation in the General Education and Training band of the education system in South Africa.

Assessment – A means of evaluating students' understanding or knowledge using a form of achievement test, questionnaires or interviewing process.

Conception – A mental idea or one's perception about the nature of a given subject matter.

Meteorology (Earth Sciences / Physical Geography) - A study of the earth's atmosphere, especially of weather-forming processes and weather forecasting

Environmental Education (EE) -Is a learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action (UNESCO, Tbilisi Declaration, 1978).

Nature of Science (NOS) – All explicit or implicit underlying assumptions underpinning the epistemology of science.

Nature of Indigenous Knowledge Systems (NOIKS) - All explicit or implicit underlying assumptions underpinning the epistemologies of indigenous knowledge systems.

ABREVIATIONS USED IN THIS STUDY

A.S's – Assessment Standards

C2005 – Curriculum 2005

CAPS – Curriculum Assessment Policy Statement of 2011

CAT – Contiguity Argumentation Theory

CoW – Conception of Weather

CU - Conceptual Understanding

DAIM – Dialogical Argumentation Instructional Model

DoE – Department of Education

FGIQ – Focus group interview question

IK – Indigenous Knowledge

IKS – Indigenous Knowledge Systems

IKSW - IKS worldview

KA – Knowledge Application

LoLT – Language of Learning and Teaching

L.O's – Learning Outcomes

LTSM – Learning and Teaching Support Materials

MLT – Meteorological Literacy Test

NCS – National Curriculum Statement

NOIKS – Nature of Indigenous Knowledge Systems

NOS – Nature of Science

OBE – Outcomes Based Education

RNCS – Revised National Curriculum Statement

SAT – Science Achievement Test

SIKSP – Science and Indigenous Knowledge Systems Project

SO – Specific Outcomes

SSW - School Science Worldview

SSI – Socio-Scientific Issue

TAP – Toulmin's Argumentation Pattern

WCED- Western Cape Education Department

CHAPTER ONE: INTRODUCTION

1.1 INTRODUCTION

Although people care about the weather, they do not always understand the concepts and processes involved in weather. Especially at school level, where teachers rush to complete syllabuses and keep in trend with National Curriculum Statement (NCS) policies, learners do not always understand science concepts when they are explained in a rushed manner. It would then be useful to know, after the exposure to the dialogical argumentation instructional model (DAIM) dealing with meteorological science/IK concepts: (1) What kind of meteorological concepts do grade 9 learners hold? (2) Are grade 9 learners' meteorological conceptions related to their age, class or gender? (3) What are grade 9 learners' conceptual understandings of weather?

The aim of this study is to explore the question: what are the effects of a dialogical argumentation based instruction on grade 9 learners' conceptions of the meteorological concept of cold fronts in the Western Cape, South Africa. The research will present an overview of the methodology that was followed and findings that unfolded in the process of completing the research journey.

Human beings gather knowledge basically for two purposes: survival and meaning. We try to understand and come to grips with the environment in order to survive, and we try to find reasons for our survival that go beyond the intuitive reaction to physical threats. This is in short the basis for all kinds of activities which aim at building up knowledge systems. Long before the development of modern science, indigenous peoples have developed their ways of knowing how to survive and also developed ideas about meaning, purpose and values. It has become customary to refer to this kind of knowledge variously as "indigenous knowledge", "traditional knowledge", "local knowledge", "traditional ecological knowledge", "ethno ecology" etcetera. This is often seen as a contrast to, or at least as very different from, western ways of generating, recording and transmitting knowledge. From the perspective of western science, indigenous knowledge and cultural elements have been considered to be "primitive", "prelogical", "illogical", "irrational" and incoherent.

However, this view is incorrect, as Indigenous Knowledge Systems (IKS) are human experiences, organized and ordered into accumulated knowledge with the objective to utilize it to achieve quality of life and to create a liveable environment for both human and other forms

of life (Serote; 2001). Indigenous knowledge can be defined as a set of perceptions, information, and behaviours that guide local community members' uses of land and natural resources. Indigenous knowledge is created and sustained by local community members as a means to meet their needs for food, shelter, health, spirituality, and savings. Indigenous knowledge is usually adapted and specific to local ecological conditions and to community members' social and economic situations and cultural beliefs. This knowledge can be simple or complex. It is not static, but evolves in response to changing ecological, economic, and socio-political circumstances, based on the creativity and innovation of community members and as a result of the influence of other cultures and outside technologies.

1.2. BACKGROUND

The rapid environmental changes with disastrous consequences in many parts of the world, such as droughts and floods, have led to a greater public awareness of the need to conserve the environment for human welfare. The recent global environmental disasters, including the tsunami in East Asia, the earthquake in Haiti, the floods in various regions of the world (including South Africa), to name a few, have been a matter of great concern worldwide. This is even more so since a lot of the environmental disasters, e.g. global warming, acid rain, desertification, environmental pollution, loss of biodiversity in many parts of the world, have resulted largely from scientific and industrial activities. An important goal of environmental education is to help learners develop valid understanding of the environment as well as to nurture responsible attitudes towards that environment. It seems that for learners to develop the right attitudes towards the environment, they need to be introduced to environmental issues (environmental awareness) early in life, otherwise learners' will for ever loose the interest in geography education.

In the South African Geographical Journal, Le Grange (2008) explains that:

> *the past decade has witnessed several changes to school Geography in South Africa. In the General Education and Training (GET) Band, for example, the changes have occurred in three phases: the introduction of the interim syllabus in 1996; the introduction of Curriculum 2005 in 1997; and the introduction of the Revised National Curriculum Statement (RNCS) in 2002.* (Le Grange, 2008:68)

Furthermore, Le Grange (2008) argues that the 'changes have ostensibly been introduced to strengthen social sciences education in South Africa generally, and geography education more specifically'.

The Revised National Curriculum Statement Grades R-9 schools policy (RNCS) of 2002 for Social Science promotes a learner that can "develop an awareness of how to influence our future environment by confronting and challenging" environmental inequalities (RNCS, 2002). The features and scope of the RNCS for Social Science are focused on producing learning outcomes that promote more-or-less the same values that this research study seeks to determine, which is to promote:

- "enquiry skills to investigate **key concepts and processes in Geography**";
- "knowledge and understanding of the interrelationships between **people, resources and the environment**"; and
- "critical analysis of development issues on a **local, national and global** scale" (Department of Education, 2002).

The Revised National Curriculum Statement (RNCS) (2002) also requests and describes *the kind of teacher it envisages* to be able to achieve its goal of the transformation of education with the new curriculum. The South African Department of Education (2002) stipulates the following:

> *All teachers and other educators are key contributors to the transformation of education in South Africa. This Revised National Curriculum Statement Grades R-9 (Schools) envisions teachers who are qualified, competent, dedicated and caring. They will be able to fulfill the various roles outlined in the Norms and Standards for Educators. These include being mediators of learning, interpreters and designers of Learning Programmes and materials, leaders, administrators and managers, scholars, researchers and lifelong learners, community members, citizens and pastors, assessors and Learning Area or Phase specialists.* (Department of Education, 2002 :9)

This type of teacher also fits the profile of a capable professional that will be able to demonstrate the values that are being set out in this research study, namely through "dialogical argumentation"-based instruction that will allow learners to develop meaningful dialogue and group interaction that can foster and create new knowledge in learners.

An in-depth understanding of science means students should not only be aware of 'what we know' but also of 'how we know what we know and why we choose to believe it over alternatives' (Duschl, 2008, p.163). Thus, science teachers need to address the epistemic practices that characterise the scientific endeavour. Kelly (2008) defines epistemic practices as 'the specific ways members of a community propose, justify, evaluate, and legitimise knowledge claims within a disciplinary framework' (p.99). This study argues that one way to

foreground the epistemic practices of science within science education is to view the teaching of science as argument. Argumentation is an integral practice of science which explores the construction and critique of scientific knowledge fostering not only the critical scepticism that is the hallmark of the scientist but also enhancing learners conceptual understanding (Kuhn, 1993, Osborne, 2010). During argumentation-based instruction, learners' use evidence to support their claims and evaluate other individuals' claims and, in this manner, are enculturated into the discursive practices of scientists (Erduran & Jiménez-Alexaindre, 2008). Consequently, argumentation constitutes a form of epistemic discourse (Sandoval & Morrison, 2003); a way of talking that can help learners' develop a more informed view of the nature of science and its epistemic practices. Epistemic discourse could include instances of asking for evidence to support and justify a claim; making learners consider opposing views and critically evaluate which one is better and why; explicit mention of the nature of evidence that students need to be using in their explanations and of the role of this evidence for their arguments; and providing or creating counter-arguments.

The function of epistemic discourse is to help learners' acquire scientific knowledge whilst at the same time, engage learners to the discursive and reasoning process necessary for that knowledge to be acquired.
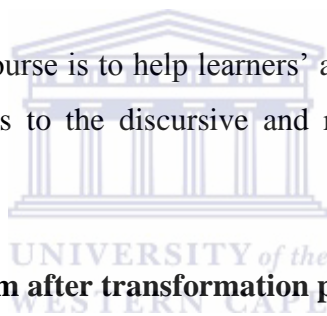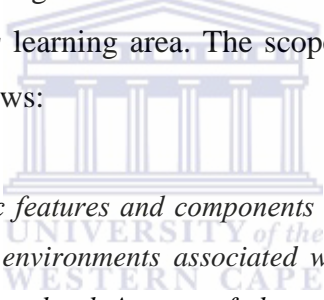
Geography and the curriculum after transformation process

When Curriculum 2005 was launched in 1997 there was concern among geographers and geography teachers that the distinctive character of Geography could be lost since aspects of Human Geography were located in the *Human and Social Sciences* learning area and Physical Geography was located in the *Natural Sciences* learning area (Le Grange, 2008; Binns, 1999). This concern was based on the fact that the discipline is made up of many fields of knowledge, such as economics, conservation, hydrology, politics, demography, development studies, regional studies, spatial literacy, environmental studies, energy studies, pedology, biogeography, meteorology, climatology, geophysics, geology and astronomy (Earle and Keats, 1996; Van der Merwe, 1996). These sub-disciplines of the subject could become lost or diluted if not integrated into a separate Geography learning area (Mosidi, 1998).

Since the Geography community's request to have a Geography learning area was not acceded to by the national Department of Education (DoE), Geography remained split, with Physical Geography located in the *Natural Sciences* learning area and Human Geography

in the *Human and Social Sciences* learning area. This left unaddressed the concern expressed by Pemberton (1990: 5) that '…attempting to solve many important geographic problems without geography's physical component or its social component leads to unsatisfactory

solutions'. The consequence of this is that the possibility of school Geography (as a subject in the GET) effectively addressing the Critical Outcomes (COs) and the subjectspecific Learning Outcomes (LOs), was significantly reduced.

Moreover, the position of Human Geography in the *Human and Social Sciences* was tenuous at the time because the first Curriculum 2005 document did not prescribe specific content for each grade (Le Grange, 2008). Implementation of Curriculum 2005 was based on the premise that teachers had the competence to design learning programmes that would help learners achieve nationally defined critical and specific outcomes (SOs). Theoretically, teachers could use any relevant content in designing learning programme activities as long as they enabled learners to achieve the appropriate outcomes. In October 1997, however, broad content guidelines were provided in the form of what was termed assessment criteria, range statements and performance indicators (for details, see Department of Education, 1997). The publication of the latter document reinforced the location of Physical Geography within the Natural Sciences learning area by defining the theme *The Planet Earth and Beyond* as one of four themes of the *Natural Sciences* learning area. The scope statement of the theme *The Planet Earth and Beyond* reads as follows:

> *Earth's structure, dynamic features and components – from core to upper atmosphere – and the delicacy of the many environments associated with the Earth must be appreciated and understood at an appropriate level. A grasp of planet Earth's place in the universe can instil a sense of wonder and stimulate the imaginations of learners. Within this theme, learning contexts should be drawn from* **under the Earth's surface; on the Earth's surface; above the Earth's surface; and beyond the Earth**. (Department of Education 1997: NS-7)

Geography teaching and learning under the RNCS

Based on the review of Curriculum 2005, a final Revised National Curriculum Statement (RNCS) was published in 2002. In short, OBE remained the foundation of the RNCS, the critical outcomes remained unaltered, but the specific outcomes were replaced by fewer curriculum-linked outcomes called learning outcomes, and some of the sophisticated design features were simplified or removed. In both the RNCS and FET Geography activities such as fieldwork, the integration of Information and Communication Technology (ICT), problem-solving, debating, composing proposals and authentic learning are promoted. Apart from working individually, learners throughout the two bands are also encouraged to engage in pair

or group contexts during different learning and assessment activities using a dialogical argumentation model of instruction.

Relationship between IKS conceptions and understanding of meteorological concepts

Research shows, that only if argumentation is specifically and explicitly addressed in the curriculum will students have the opportunity to explore its use in social science (Kuhn, 1991). Because science education mainly focuses on learners' understanding of science concepts and adopting using different ways in achieving this, like transmission learning and not drawing on reasoning only the delivery of science facts. Using teaching methods that uses argumentation through the use of appropriate activities and teaching strategies in the social science class can provide a means of promoting a wider range of goals, including social skills, reasoning skills and the skills required to construct argument using evidence (Osborne, Erduran, & Simon 2004a). So, in order to emphasise that teachers need argumentation during teaching social science, they (teachers) need to adapt their teaching styles to a more dialogic approaches (Alexander, 2005) that will involve students in class and lesson discussions, and using teaching methods to interact with students to foster argumentation skills. And then the role of 'such dialogical space' is to enhance and promote the 'process of re-articulation, appropriation and/or negotiation of meaning of the different world-views' (Ogunniyi, 2007).

Below is a conventional classroom statement advocating dialogical argumentation-based instruction of the differences between *weather* and *climate:*

> ***Climate helps you decide what clothes to buy, and weather helps you decide what clothes to wear each day.***

Teachers can use this type of argumentation benchmark to start dialogical argumentation instruction amongst learners in a classroom setting, they can debate and deliberate their differences until they rich a common view for departure into the science (geography) lesson at hand.

Teachers in South African school are faced with the new formulated CAPS (2011) policy statement that was introduced to assess indigenous knowledge systems (IKS) as a specific outcome (SO 3.2) in the curriculum. Many teachers are not informed how to implement and formulate a pedagogy that can assess IKS/Science in the class room.

1.3 RATIONALE FOR THE STUDY

The rationale for introducing children to meteorological literacy and environmental education during foundation phase training at school cannot be overstated. According to Schreuder & Le Grange (2002) the majority of the environmental problems in South Africa are related to the educational crisis caused by the previous apartheid policies of the South African government. During this time, educational resources were not equally distributed and only benefited a minority of the population, whereas the majority received a poor education. This resulted in environmental illiteracy, lack of environmental sensitivity and over-exploitation of natural resources. With the adoption of South Africa's new constitution, human rights and social responsibilities are finally linked to environmental issues. The 1995 White Paper on Education saw the need for environmental education processes that involve an active approach to learning (Department of Education 2001b:3-7). The NCS promotes the same values that this research study wants to determine, which is to promote: enquiry skills to investigate key concepts and processes; knowledge and understanding of the interrelationships between people, resources and the environment and critical analysis of development issues on a local, national and global scale (Department of Education, 2002).

Despite the improvements to policy, the majority of children in the Western Cape are not achieving their academic potential. This may be attributed to (a) inadequate time and attention paid to reading, writing and counting in the first three grades of school, (b) poor levels of accountability for performance from education officials and educators, (c) weak school management and leadership, (d) slow rate of response and support from the education department, (e) the low morale of teachers, (f) inadequate quality textbooks and other learning materials, and (g) lack of learners' interest in key subjects. The combination of these factors has led to poor learner development and understanding. The grade 12 pass rate has dropped, as shown by the following statistics: 2004 boasted an 85% pass rate, which dropped over the proceeding five years to 75,7% in 2009. The number of under-performing schools (schools with less than 60% matriculation pass rate) in the Western Cape has increased from 36 in 2006 to 85 at the end of 2009 (Department of Education, 2009). The following table indicates in detail the year-on-year changes from 2008 to 2009 in the matric pass rate, and results in the key literacy subject of mathematics (table 1.1 is used to illustrate the overall 2008/ 2009 pass rate only).

The Minister of Education in the Western Cape, Donald Grant, also noted in a statement made to the media (2010) on "Easter holiday programmes", that for grade 12 learners it is essential

to improve their results. The office of the minister identified a number of subjects that "deserve special attention" after analyzing the 2009 results of grade 12, which are Geography, Physical Science, Mathematics, Life Sciences Accounting and Economics (Department of Education, Office of the Minister of Education, Media release, 26 March 2010).

Another factor explaining the worsening matric results is inadequate school and curriculum systems, especially in the General Education and Training (GET) phase, which lasts until the end of grade 9. In teacher hearings across the Western Cape Province about promotion and progression in the Further Education and Training (FET) and GET phase, many teachers mentioned "the lack of focus" and "measuring the progress" of learners in the GET phase (Department of Education, 2009).

Table 1.1: Western Cape Department of Education National Senior Certificate Examination Results and Pass Rate for 2008 and 2009

DESCRIPTION		2008	2009
		Full-time TOTAL	Full-time TOTAL
Number of candidates who passed **Mathematics**	Number wrote	19 957	19 210
	Number passed	**13 003 (65,2%)**	**12 467 (64,9%)**
Number of candidates who passed **Mathematical Literacy**	Number wrote	24 550	26 367
	Number passed	**22 406 (91,3%)**	**23 318 (88,4%)**
Mathematics **TOTAL**	Number passed	**35 409**	**35 785**
Number of candidates who passed **Physical Sciences**	Number wrote	13 611	13 349
	Number passed	**9 690 (71,2%)**	**7 064 (52,92%)**

DESCRIPTION / BESKRYWING	2008	2009

8

	Full-time TOTAL	Full-time TOTAL
Number of candidates who correctly wrote full examination /	43 957	44 931
Number of National Senior Certificate (NSC) passes without access to Higher Education /	22	28
National Senior Certificate with **access to Higher Education**	**Bachelors Degree** Number : % of total candidates:	14 512 33.0%	14 324 31,9%
	Diploma	12 842	12 677
	Certificate	7 180	6 988
Total number of passes		**34 556**	**34 017**
Percentage pass rate		**78.6%**	**75,7%**

The teachers made strong calls for "proper examinations" and "meaningful terminology", and noted the missing of proper concepts (Geography) in the GET phase. "Many submissions noted that the transition to the FET phase from grade 9 is problematic" and most of the learners are unprepared to take on the workload in grade 10 (Department of Education, 2009:36).

A key factor explaining the poor results in specific subjects is learners' interest in the subject. In a survey (Table 1.2 below) done by Statistics South Africa (2009) on learners' favorite subjects by gender shows that learners between grade 8 and 12 showed little interest in Natural Science and Technology subjects. Only a 2,5% interest in Natural Science both for male and female grade 8-12 learners was recorded for 2009. In the Technology subject the statistics were even lower for female learners with only a 1,6% interest and for male learners a slightly higher percentage was recorded of 3,6%. The overall low interest in these important subjects can directly be linked to the decreasing results and pass percentages that were recorded by the Western Cape Department of Education (2009) in the National Senior Certificate Examination Results for 2009, as shown in Table 1.1 above. The pattern of interest is clear. For grade 8-12, Language was chosen as the most favorite subject of male and female learners, followed by Mathematics (7,2% of male learners and 6,3% female learners chose this subject as their favorite)

Table 1.2: Favorite subject by gender, Grades 8-12

	Languages	Maths	Life Orientation	Technology	Arts & Culture	Maths Literacy	Natural Science
Male	11,4	7,2	3,8	3,6	3,3	2,8	2,5
Female	15,3	6,3	5,4	1,6	4,0	2,4	2,5
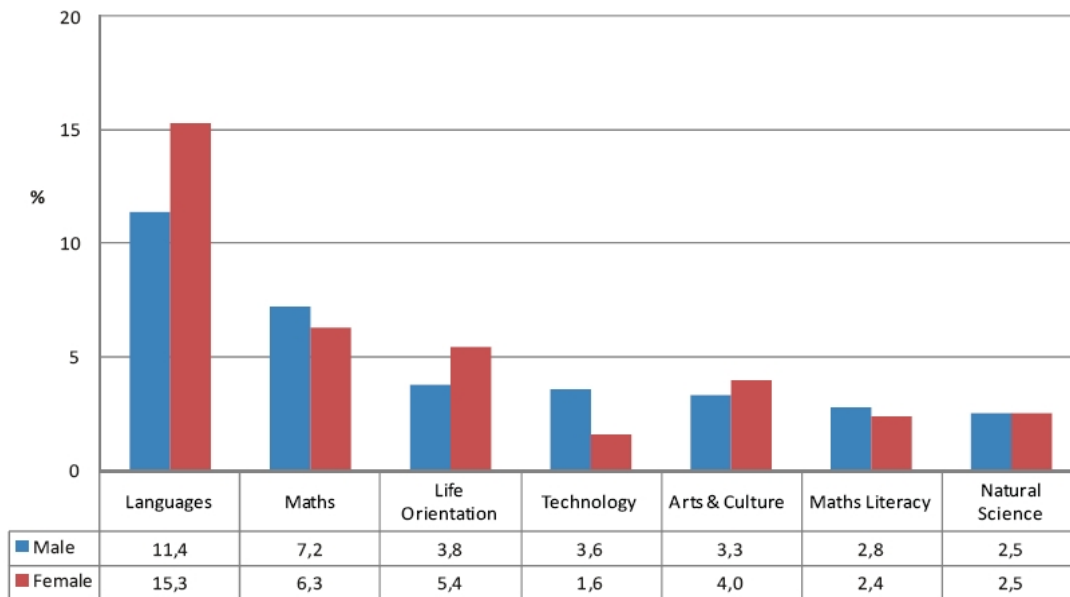
1.4 PROBLEM STATEMENT FOR THE STUDY

Considering the rationale for supporting natural science education at schools, due to the growing urgency and importance of natural science in the world and the link between natural science and social rights and responsibilities, and in light of the worsening matric results in the Western Cape and general lack of interest in natural science, the problem of how and when to develop learners' environmental literacy is of great importance. Opinions vary at which grade learners should be introduced to environmental (meteorological) literacy and what kind of pedagogy or teaching method (strategies) need to be followed in teaching environmental education. While some argue for the pre-school or the first grade, others point to the third grade or later (Stapp, 1978). Whatever the case, it seems reasonable that children should be introduced to meteorological concepts very early in life. Early exposure to meteorological literacy (Natural Science) will enhance environmental education (Social Science) that is likely to foster lifelong learning in these young minds. Such experiences play a vital role in shaping the norms, values and behavior towards the natural world.

It could be that environmental education based on life experiences should begin during the very early years of life as such experiences play a critical role in shaping life-long attitudes, values and patterns of behavior towards natural environments. It is perhaps the late introduction of environmental education in learners' syllabuses that has brought about the poor attitudes that many show to their environment. To explore these issues, the present study will undertake to explore the literacy of meteorological concepts among grade 9 learners in a

selected school in the Western Cape. This is based on the premise that early exposure to environmental concepts would provide learners opportunities to learn the various ways by which their environment can be conserved and used to improve their quality of life. By the same token it is expected that such an early exposure would enable them to appreciate and develop desirable attitudes to their environment. In other words, "children must develop a sense of respect and caring for their natural environments during their first few years of school life or be at risk of never developing such attitudes" (RNCS, 2002).

The new Revised South African curriculum published by the Department of Education (DOE) in 2002 aims at ensuring that learners acquire and apply knowledge and skills in ways that are meaningful and relevant to their life worlds. In this regard the curriculum puts emphasis on acquainting learners with local or indigenous knowledge (IK) because such knowledge has sustained the people living in the area for thousands of years. At the same time the curriculum stresses the need for learners to be fully aware of existing current knowledge in global contexts as presented to them formally at school (DOE, 2002).

The Revised National Curriculum Statement (RNCS) (DOE, 2002) and the Curriculum and Assessment Policy Statement (CAPS) (2011) suggest the need to relate knowledge in the natural and social sciences to IK as a way for them to close the gap between the knowledge they develop at home and what they learn at school as well as to develop a holistic understanding of their bio-physical and socio-cultural environment. In this regard the Curriculum Statement and the CAPS expect learners be able to develop certain process skills process skills that they need to solve the problems they encounter in their daily lives such as the ability to:

(1) **access** relevant information from appropriate sources;

(2) i**nterprete** and **summarize** information in a variey of ways and thus creating patterns, meanings and structures as well as drawing valid inferences;

(3) **think** critically **raise** or pose relevant questions about a situation

(4) **select** key ideas, **describe** and **construct** the history of specific discoveries from the past and their relevance to present ideas or worlviews;

(5) **evaluate** the relevance/importance of specific discoveries for society;

(6) **identify** and **solve problems** and make decisions using critical and creative thinking skills;

(7) **work effectively** as individuals and with others as members of a team;

(8) organize and **manage** themselves and their activities responsibly and effectively

(9) **communicate effectively** using visual, symbolic and/ or language skills in various modes; etc. (Department of Education, 2011; CAPS, 2011).

The process skills above call for the mobilization of critical thinking skills in classroom discourse. But this presupposes that learners have the freedom and the opportunity for self-expression. This form of classroom interactions where learners are able to express their views without feeling intimidated comes under the general umbrella of argumentation instruction an approach that has been receiving increased attention in the literature since the turn of the 21st century. This means that using a dialogical argumentation instructional model (DAIM) approach could *probably* assist the teaching and learning of meteorological concepts in geography.

1.4.1 Argumentation

In the International Journal of Environmental & Science Education, Ogunniyi & Hewson (2008) support the use of argumentation as an instructional tool in the following manner:

Within the last decade there has been an increased interest in determining the effectiveness or otherwise of argumentation in enhancing teachers' and students' understanding of the NOS (e.g., Driver et al, 2000; Ebenezer, 1996; Erduran et al, 2004; Jimenez-Aleixandre et al, 2000; Kelly & Bazeman, 2003; Kelly & Takao, 2002; Niaz et al, 2002; Osborne et al, 2004; Ogunniyi, 2004, 2006, 2007 a & b; Simon et al, 2006; Zohar & Nemet, 2002). Many of these studies have shown the importance of argumentation and dialogue as useful tools for enhancing teachers' and students' conceptual understanding as well as increasing their awareness of the tentative and material-discursive nature of scientific practices (Barad, 2000). (Ogunniyi & Hewson, 2008)

Argumentation is a form of conversation involving two people or members of a group with the sole purpose of reaching some consensus. In the same vein argumentation instruction is a method of teaching in which the teacher creates opportunities in class for learners to argue and discuss freely particularly on a particular topic where learners possess a variety of viewpoints or worldviews (Ogunniyi, 2004). Meteorological concepts provide ample opportunities for learners to argue from various scientific, religious or cultural perspectives. For example, learners from various cultural groups hold different views about the causes of various natural phenomena e.g. lightning, thunder, and changes in the seasons, cold front a major source of rainfall in South Africa, and so on.

To achieve the outcomes of the new curriculum, the study has adopted the method of dialogical argumentation. Numerous studies have indicated the significance of dialogic argumentation as a valuable instrument for finding out teachers' and learners' conceptual understanding as well as making them aware of the tentative and material-discursive nature of the natural sciences (Ogunniyi & Hewson, 2008). By extension the use of dialogical argumentation in the class room should help teachers and learners in other learning areas to understand the cultural side of hidden indigenous knowledge. This would not only allow the teacher the time to build on school and home knowledge but to get acquainted with the indigenous knowledge that has been lost to many in indigenous community or culture due to the pervading impact of school science.

The use of argumentation allows learners the time to express and argue with fellow learners on various important topics. This is vitally important in a society that is becoming used to electronic communication – that make IK seems boring. Teachers would be able to create a platform for learners to understand the science and metaphysical world and how these two worlds relate to each other.

1.5 AIM OF STUDY

The aim of the study has been to encourage learners to acquire knowledge about local weather patterns, their causes, and how they affect people's everyday lives. A corollary to this is that their understanding would enable learners to evaluate the importance of meteorological literacy for society hopefully would become an integral part of the school curriculum. The hope is that this in turn would have an overall positive impact on learners' attitudes in the way they attempt to contribute to environmental conservation matters.

1.6 PURPOSE OF STUDY

The purpose of the study is to investigate the effectiveness of an Argumentation-based (A-B) instruction in enhancing grade 9 learners' understanding and awareness of weather patterns and selected meteorological concepts.

A related aim is to determine the learners' understanding of weather and climatic phenomena and how human beings interact with these phenomena on a daily basis. More specifically, the study attempts to determine the effectiveness of an A-B instruction on grade 9 learners' understanding of weather and climate related issues. The emphasis is placed on how learners relate to selected meteorological concepts and interpret them in the current school curriculum.

The study also aims in creating an awareness among the learners about the importance of certain weather concepts, especially their interpretation of such concepts.

1.7 INDIGENOUS KNOWLEDGE

Our beliefs, knowledge, arts and other forms of cultural expression have been handed down through the generations. Integrated in these elements is indigenous knowledge, which can be defined as a set of perceptions, information, and behaviours that guide local community members' use of land and natural resources. Indigenous knowledge (IK) is created and sustained by members of a community as a means to meet their needs for food, shelter, health, spirituality, savings and environmental education. Indigenous knowledge is usually adapted and specific to local ecological conditions and to community members' social and economic situations and cultural beliefs (Hunn, 1993).

Since the turn of the 21st century there has been concerted effort in many developing countries including South Africa inclusive to include IK within the mainstream school curriculum. But other than the usual rhetoric on the subject, not much has been done to know or create teachers' or learners' of what IK stands for and how to integrate introduce it into the school curriculum. Although most of the recent science and physical geography textbooks acknowledge the fact that learners do bring their own ideas about how the world works into the classroom and that school learning science should relate to the context of real life worlds of learners not much progress has been made in this regard. The extant literature has revealed that in countries where attempts have been made to integrate science and indigenous knowledge all that has been done was to sprinkle or flavour the standard account of science with certain extraneous accounts of IK e.g. the curriculum programmes designed for the North American Indians or the Aboriginals of Australia. While many of these programmes have been useful in addressing the issue of the learning styles, social patterns, the commonality of knowledge, the communal life styles and the mode of inquiry of indigenous peoples and how these enrich instructional practices have hardly been considered. This is because of the the general assumption that learners from indigenous cultures come into the classroom like a blank slate so to speak (Ogunniyi, 2004, 2007a & b). It was against this setting that the study was embarked upon.

1.8 RESEARCH QUESTIONS

- What existing meteorological concepts do grade 9 learners currently hold?

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- Are grade 9 learners' meteorological conceptions related to their age, class or gender?
- What are grade 9 learners' ideas and attitudes towards their environment?
- What differences exist between the learners' conceptions of weather before and after they have been exposed to DAIM?

1.9 SIGNIFICANCE OF THE STUDY

In a study done by Hewson et al. (2009) on 'South Africa's new revised National Curriculum , especially the aspect which deals with the inclusion of IK in the curriculum Hewson et al found that teachers are not generally aware about the various indigenous knowledge systems existging in South Africa. They further noted that the learners involved in their study were also lacking adequate knowledge on IKS values in their respective indigenous communities. They emphasize the importance of learning about health and freedom from disease, particularly HIV/AIDS conclude that: (1) both science and IK are important in the education of learners; and (2) that science teachers could co-teach their IK in conjunction with science topics (Hewson et al., 2009).

Two other studies conducted by the NEETF (National Environmental Education Training Foundation) in 1990, claim that meteorological theory-based literature do help in promoting a difference in environmental education, and that learners do benefit from these illustrations. These two studies reported that Environmental Education develops certain skills that help with understanding science content, e.g. meteorological concepts, and promotes global warming awareness among learners (Leidermann & Hoody 1998).

A number of studies have indicated that, by linking school curriculum activities, worksheets, and outdoor classroom activities to local environmental conditions, the learners make real-world connections, allowing the material to be made more meaningful, tangible and relevant in terms of increasing their interest as well as decreasing discipline problems (Battersby, 1999; Glynn, 2000; Krynock & Robb, 1999). The gains in learners' achievements and motivation are attributed to the nature of environmental literacy, which utilizes discipline integration, problem solving and hands-on activities (Glynn, 2000).

It is hoped that findings from the study would help the researcher to identify a number of major outcomes:

- That meteorological education promotes an important public discourse concerning vital issues involving science and technology.
- That all learners involved in the study would become more aware of both scientific and IK-based knowledge about weather or environmental conditions critical to human welfare.

- That the IK about environmental or weather phenomena held by the learners but which are incompatible with the scientific viewpoint are moderated but respected. Knowing about the indigenous knowledge that the learners hold should be of great benefit to this study because it will give the researcher the opportunity to clarify how and why such IK is considered important to the learners involved in the study.

- It is also hoped that the findings would prove informative and useful to future studies in the area.

1.10 LIMITATIONS AND DELIMITATIONS OF STUDY

The researcher recognizes a number of limitations to this study. These limitations include that the subject matter used in the empirical component of the study, while under the broad banner of Social Science under the RNCS (Revised National Curriculum Statement R-9), differs for grade 9 learners from the normal Geography subject and meteorological concepts dealt with in the old curriculum. Teacher implementation styles and pedagogy of the new curriculum approach (C2005) vary across different teachers. Such limitations may influence end results and findings within the study. As with any classroom-based research, the inability to control the teacher factor without interfering with his professional belief and practice is also a source of limitation for the study.

Language is a second factor which also limited the research process; the participating school in the research study had Afrikaans as the first language of instruction, and all the research materials were printed in English. The questionnaires and MLT-test were conducted in Afrikaans. All data collected had to be transcribed, translated and interpreted into English before it could be coded and sent for statistical analysis. This placed a considerable amount of time pressure on the study itself.

1.11 CHAPTERS LAYOUT

Chapter Two

This chapter reviews the relevant literature that supports the theoretical framework of this research. The study is underpinned by TAP (Toulmin's Argumentation Pattern) and CAT (Contiguity Argumentation Theory). This chapter explains the use of argumentation as an instructional method of classroom teaching, which has attracted attention in the fields of mathematics, (meteorology) science and technology. In this study dialogical argumentation,

combined with IKS (Indigenous Knowledge Systems), was viewed to be a powerful tool both in enhancing learners' views and positively identifying indigenous knowledge systems within their own cultures and communities as tool that facilitate the learning of (meteorological) science concepts. The literature helps to form a cognitive basis to statistically analyse the relevant data collected for the study. It not only supports the views presented in the study, but also helps to establish certain claims made in this study.

Chapter Three

This chapter engages with the research design chosen for this study. The relevant research design, a *quasi-experimental pre-test-post-test design*, supports the conceptual and theoretical frameworks and allows the use of both qualitative and quantitative research methods relevant to the study.

The use of qualitative inquiry is 'mainly to understand the meaning of human action in a given context' (Ogunniyi, 1992). In this case the study focuses on the effects of dialogical argumentation on learners' conceptual understanding of a selected meteorological concept, namely *cold fronts* in the Western Cape, South Africa. Therefore, this research study will use both quantitative and qualitative methods of inquiry. The two types of inquiry can embrace one another and vice versa. The chapter describes how the data collected from the research instruments, high school survey (HSS) questionnaire, conceptions of weather (CoW) questionnaire and meteorological literacy test (MLT), will be summarized and manipulated qualitatively and quantitatively to show their interchangeable use which closely relate to aspects of this research design.

This research method also helps to explain the use of TAP and CAT as argumentation models for this study. This chapter also guides the researcher through the research journey and relates to the view of Henning (2004) on 'the role of writing in the whole research process as a tool for *reflection* and a tool of *composition*.

Chapter Four

This chapter presents and interrogates the data and findings of the study. This chapter first provides the background of the study and why certain data were collected. This chapter then proceeds to present the findings of learners' perception towards meteorological science education in a South African classroom, focusing on the key issues of ideas and attitudes of

learners towards their environment and, whether a dialogical argumentation instructional method has any effect on learners' perceptions and attitudes towards their environment. It then summarises the research methods used to conduct the study.

Chapter Five

This chapter draws the thesis together by summarising the methodology employed in chapter three and the main findings of chapter four, before it proceeds to implications and recommendations emanating from the study. The limitations of the study and proposals for further research are also presented in this final chapter.

CHAPTER TWO: LITERATURE REVIEW

This chapter focuses on theoretical and practical issues issues regarding grade 9 learners'
conceptions of selected meteorological concepts. Theoretical issues here refers to the literature
based on the views expressed by well-informed scholars while the practical issues deal with
actual studies done in the area. This study investigates grade 9 high school learners'
conceptions of meterelogical concepts. Such conceptions of course consist of both
scientifically valid ideas about such concepts as well as what is regarded in the study as
indigenous knowledge systems (IKS) based conceptions about weather conditions or
environmental factors.

Amidst the diverse environmental challenges resulting largely from increased human
activities, particularly scientific and industrial activities, several developing countries have
implemented policies and action programmes to address such challenges. In this regard calls
are being made by government and non-government organization to find ways and means to
integrate relevant local, traditional or indigenous knowledge with science and technology so
as to achieve a more comprehensive goal than has been the case while relying solely on the
scientific view of the environment. The argument has been that: indigenous knowledge reflects
the wisdom and experience that have been used successfully to sustain the environment for
thousands of years; a substantial part of this knowledge and wisdom has been lost as a result of
colonialism and the western form of industrial activities and needs to be rediscovered; the
scientific and technological choices that people make reflect their values; values are moulded
early in life particularly though formal and informal education, the former being more
dominant; teachers have a critical role to play in shaping learners' attitudes towards the
environment and life in general; learners in traditional societies live essentially in two separate
worlds namely, the one at school and the other in their communities; and that the integration of
both worlds is urgently needed if a long-term solution to the current environmental crisis is to
be addressed comprehensively (e.g. DOE, 2002, 2011; Ogunniyi, 2004, 2005, 2007a & b;
20011a & b).

The focus of this chapter is not to question the validity or otherwise of this argument as doing so
would require a more extensive analysis beyond the scope of the study. Rather the aim has been
to explore the feasibility of the proposition by grounding the whole argument within the
dialogical argumentation framework, a scheme that has been found very effective for tapping
into the views and opinions of learners than the usual traditional chalk-and talk approach
(Erduran et al, 2004; Simon et al, 2004; Ogunniyi, 2004, 2007a & b).

2.1 INDIGENOUS KNOWLEDGE SYSTEMS

As indicated in chapter 1 indigenous knowledge is regarded as local knowledge that shapes the worldview of a people group (Odora-Hopper, 2002). Much of IK is preserved in the memories of elders and thus, this knowledge is gradually disappearing due to memory lapses and death. The oral tradition and empirical learning are the principal ways of transmitting knowledge. Nevertheless, access to IK (indigenous knowledge) is fragmented in the local communities due to various factors, including social dimensions such as age, gender, status, wealth and political influence (Walker, 2004) and attitudes, perceptions, norms, values and belief systems inherent to indigenous people (Meyer 2008). Other factors are related to the safety mechanisms used by local people to protect their own intellectual property, and to formal education which has excluded IK.

There is need for developing countries to recognise the importance of managing IK, as much of the knowledge required for agricultural development and environmental management already exists with farmers and traditional practitioners. Most of this knowledge was not written down or even archived in any form of literature, books, memo's or novels for future engagement. Thus, it could be lost forever if not protected, preserved or archived for future generations – it was seen as taboo to publicly engage in any form (written or general talk) with the traditional knowledge (that are normally used at traditional ceremonies and cultural gatherings) - which is kept away or kept sacred from the young members in the fear that they would leave the community, join other cultures and share these guarded secrets with non-members.

In the indigenous communities particularly in the pre-colonial days (and perhaps now particularly rural areas) young members often were not allowed to question or challenge any form of cultural sayings, dances, or rituals within the culture. They were only allowed performance and engagement with it (dances, songs, rituals, etc.) on request and at special events within the cultural group on instruction by the elders. These traditional ways of doing/knowing are not allowed to be performed or staged anywhere outside the boundaries of the culture. They include a variety of traditional ways of doing/knowing: rain dances, prayer meetings, initiation ceremonies that go on for weeks or even months when requested to do so. It was seen as disrespectful to the ancestors to act against the request from the elders, and to thus, keep traditional knowledge safe. The fear of losing their cultural identity grew when Western cultures came with colonialism to African countries, the community leaders felt that all their existing knowledge should be kept alive in the minds of the elders, as a token of respect towards

their ancestors. As a result of this kind of behaviour between 300- 400 years of the cultural knowledge was lost and buried with the elders of those earlier communities (DOE, 2002; Riffel, 2011).

According to Vygotsky, the main aim of education is to generate and develop, which is the result of social learning through internalization of cultural and social relationships. Vygotsky stressed that a society is the carrier of the cultural heritage without which the "development of mind" is difficult. The Vygotskian social-cultural theory (Scott, 2004) brings together community and personal perspectives, sharing "ground with constructive perspectives that a learner cannot be a passive recipient of knowledge and instruction" (p.92) (Govender, 2012).

Many high school learners do not recognise the value of cultural or indigenous knowledge. They do not understand the concept of IK and how it relates to their everyday knowledge. Everyday knowledge is important in the classroom setting, as it allows learners to make certain connections to the outside or real world. Many teachers seldom use IKS argumentation-based instruction in classroom situations to enhance a positive connection between concepts and their practical application. The learner never gets a chance to explore what is indigenous knowledge and what is scientific knowledge. They never experience the value of cultural knowledge inheritance, where knowledge is passed on from elders to the modern generation. Nowadays, the pervasiveness of modern technology such as the internet, video games, cellular phones and other advanced informational gadgets, have tended to make IK unpopular with learners. They place so much value on these digital gadgets that they lose interest in making a connection with IKS and its cultural values.

Some characteristics of IKS according to Hunn (1993 :13) are:
1. IK is local: it is rooted to a particular set of experiences related to geographical place, and generated by people living in those places. The corollary of this is that transferring that knowledge to other places runs the risk of dislocating it from its context.
2. IK is orally-transmitted, or transmitted through imitation and demonstration. The corollary is that writing it down changes some of its fundamental properties. Writing, of course, also makes it more portable, reinforcing the dislocation referred to above.
3. IK is the consequence of practical engagement in everyday life, and is constantly reinforced by experience and trial and error. This experience is characteristically the product of many generations of intelligent reasoning, and since its failure has immediate consequences for the lives of its practitioners its success is very often a good measure of Darwinian fitness. It is, as Hunn (1993: 13) neatly puts it, `tested in the rigorous laboratory of survival' (Hunn, 1993).

So the question that comes to mind is: What is scientific reasoning? It is the type of reasoning a learner uses by means of scientific knowledge gathered throughout any school science curriculum and traditional engagement in their culture of origin. This will include scientific knowledge that derives from IKS (Indigenous Knowledge Systems) and Western science.

The Curriculum Corporation is cited by Fleer (1999) in Diwu (2010 :18) to assert that: *Scientific knowledge has been expanded by cumulative efforts of generations of scientists from all over the world. It has been enriched by the pooling of understanding from different cultures – western, eastern and indigenous cultures including those of Aboriginal peoples and Torres Strait Islands – and has become a truly international activity.* (p. 128)

Furthermore, Fleer (1999) raises a concern that, there seems to be an implicit assumption namely, that all other knowledge systems had come to support the one worldview which is 'Western science' (Diwu, 2010). According to Ogunniyi (2011) it is worthy to note that despite attempts that have been made to unravel the nature of IK the use of euro-centric lenses have not enabled scholars to appreciate its full potential. Even with the most charitable assumptions about the good intentions of these efforts, the use of western science as the only authentic way of knowing and interpreting human experiences with nature have made such efforts to be unfruitful.

The fact is that it is difficult to fully capture the cultural ethos nuances and meanings associated with a form of knowledge in which one has little or no direct experience. For instance, how does one make a clear demarcation between a set of symbols from their cultural roots? Or how does one separate symbolism from the cultural values of a people group? It is a well known fact that the same words or statements in the same language may convey completely different meanings depending on the cultural context in which they are used. The same symbolisms used in science may easily convey different meanings or signification in different cultures despite and our avowal of their universality.

In many traditional cultures, numbers are not mere neutral entities but signify various meanings. For example the word "snake" or "serpent" has different symbolic significations in different religions or cultures. For the same reason a snake which is classified only as a reptile in science could connote different meanings to different learners depending on their cultural or religious beliefs. The challenging question is, how can we help learners to know in which

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context a particular meaning of a term is more appropriate than another? In my view the most appropriate way to answer this question is to create an environment where dialogues and arguments and critical discussions form part of the cultural dialectics of the classroom (Ogunniyi, 2011).

2.2 DIALOGICAL ARGUMENTATION

Dialogical argumentation occurs when different perspectives are expressed on a subject with the hope of reaching consensus in the end. The purpose is to persuade others of the validity of the claim through well-reasoned or well-grounded arguments. Through dialogical argumentation learners articulate their "reasons for supporting a particular claim and then strive to persuade or convince" others about the truthfulness of such a claim (Ogunniyi & Hewson, 2008). Dialogical argumentation provides the critical "environment for learners to externalize their doubts, clear their misgivings or misconceptions, reflect on their own ideas and those of their peers in order to arrive at clearer and more robust understanding of a given topic than would have otherwise been the case" (Ogunniyi & Hewson, 2008).

Classroom talk can also take the format of argumentation. There is argumentation in a classroom setting, mostly between students, if a viewpoint is tabled and justified or if others demand a justification (Qhobela & Moru, 2011). This means learners in a science classroom setting need to use the available data to make sense of a specific claim. To complete the process, *warrants* and *backings* are given to support the original claim and *rebuttals* are given as counter-claim in showing non-compliances to the original claim. The use of argumentation as a way of learning science derives its strength from the nature of science and the nature of scientific enquiry. As stated by Qhobela and Moru (2011) that 'scientific knowledge' is a product of intense and robust discussion within the community of scientists. A scientist must convince other members of the community that a finding amounts to a new, acceptable and important contribution to knowledge (Ford & Forman, 2006).

Research shows that only if argumentation is specifically and explicitly addressed in the curriculum will students have the opportunity to explore its use in social science (Kuhn, 1991). Since science education focuses on learners' understanding of science concepts, it often adopts methods like transmission learning, which do not draw on reasoning, only the delivery of science facts. Deploying teaching methods that use argumentation through the use of appropriate activities and teaching strategies in the social science class can provide a means of achieving a wider range of goals, including social skills, reasoning skills and the skills required to construct argument using evidence (Osborne, Erduran, & Simon 2004a). So, in

order to emphasise that teachers need argumentation while teaching social science, they (teachers) need to adapt their teaching styles to more dialogical approaches (Alexander, 2005) that will involve students in class and lesson discussions, and use teaching methods to interact with students to foster argumentation skills. Then the role of 'such dialogical space' is to enhance and promote the 'process of re-articulation, appropriation and/or negotiation of meaning of the different world-views' (Ogunniyi, 2007).

The constitution of the Republic of South Africa (Act 108 of 1996) provides the basis for curriculum transformation and development in South Africa (Department of Education, 2002). The constitution emphasises the following aims:

- "heal the divisions of the past and establish a society based on democratic values, social justice and fundamental human rights";
- "improve the quality of life of all citizens and free the potential of each person;
- "lay the foundations for a democratic and open society in which government is based on the will of the people and every citizen is equally protected by law"; and
- "build a united and democratic South Africa able to take its rightful place as a sovereign state in the family of nations".

Education and training plays a vital role in realizing these aims of the constitution. The Revised National Curriculum Statements (RNCS) (2002) seeks to incorporate these values in the *kind of learner that is envisaged*:

> *The promotion of values is important not only for the sake of personal development, but also to ensure that a national South African identity is built on values very different from those that underpinned apartheid education. The kind of learner that is envisaged is one who will be inspired by these values, and who will act in the interests of a society based on respect for democracy, equality, human dignity, life and social justice. The curriculum seeks to create a lifelong learner who is confident and independent, literate, numerate, multi-skilled, compassionate, **with a respect for the environment** and the ability to participate in society as a critical and active citizen.* (Department of Education, 2002, :8)

Le Grange (2007) also argues that in "Africa, schools are the sites where most learners first experience the interaction between African and Western worldviews", and teachers working in these contexts need to be alert, especially in a South African science teaching context, of "this type of interaction and understand the way it could complicate the learning process". Much literature has been produced over the years (see Ogawa 1986; Ogunniyi 1987, 1988; Jegede 1989; Jegede and Okebukola 1989; Jegede and Fraser 1990) about the experiences of African

and South African learners with learning science in the classroom. Despite much literature being produced, and the "fact that indigenous knowledge systems reside among the majority of South Africans", the topic has not been given the attention in educational curriculum development policies "it deserves", resulting in a lack of attention to indigenous knowledge in "the discursive terrains of all learning areas/subjects" (Le Grange 2007).

According to Schreuder & Le Grange (2002) the majority of environmental problems in South Africa are related to the educational crisis caused by the previous apartheid policies. Educational resources were not equally distributed and only benefited the minority of the population, whereas the majority received a poor education. This resulted in environmental illiteracy, lack of environmental sensitivity and over-exploitation of natural resources. With the adoption of South Africa's new constitution, human rights and social accountability were linked to environmental issues. The 1995 White Paper on Education saw the need for environmental education processes that involve an active approach to learning (Department of Education 2001b:3-7). The Revised National Curriculum Statement Grades R-9 (Schools) Policy of 2002 for Social Science promotes the kind of learner that is envisaged and that can "develop an awareness of how to influence our future environment by confronting and challenging" environmental inequalities (RNCS, 2002).

The unique feature and scope of the National Curriculum Statements is that learning outcomes promote the same values that this research study wants to determine, which is to promote enquiry skills to investigate key concepts and processes; knowledge and understanding of the interrelationships between people, resources and the environment and critical analysis of development issues on a local, national and global scale (Department of Education, 2002).

2.3 THEORETICAL FRAMEWORK USED IN THE STUDY

The study is underpinned by an Argumentation Framework based on Toulmin's (1958) Argumentation Pattern (TAP) and Ogunniyi's (1997) Contiguity Argumentation Theory (CAT). The two theories accord with Vygotsky's notion of constructivism whereby an individual learns or acquires new experiences from his/her interactions with his/her physical or socio-cultural environment. The TAP construes learning in terms of the ability to support one's claim with valid evidence or reasoning while the CAT construes learning as a product of self- or cross-conversation and reflection. This study explores the application of both TAP and CAT in the context of classroom discourse dealing with selected meteorological concepts.

The two theoretical frameworks TAP and CAT are chosen because of their amenability to classroom discourse dealing with phenomena on which learners might be holding conflicting worldviews. These frameworks provide the necessary context for inductive, deductive and analogical reasoning. They also accord with the Piagetian and Vygotskian notion of constructivism namely, that knowledge is constructed as one makes sense of the world around him/her. This type of reasoning can be used as an instructional tool for learners who constantly interact with their environments and surroundings. Interactions with the environment and surroundings result in experiences gained whereby individuals relate to that environment in a sensible and responsible manner. The context of a given discourse plays an important role in the amount or intensity of emotional arousal experienced by the participants in such a discourse. (Ogunniyi, 2007 a & b, 2008).

The TAP and CAT frameworks have two strands drawn from the Vygotskian socio-cultural perspective of learning. The first strand is that learning science occurs within a social setting (Leach & Scott, 2003). The primary understanding is that a learner makes meaning of a concept that already exists on the social plane. Vygotsky (1978:57) argues that "Every function in the child's cultural development appears twice: first, on the social level and later, on the individual level; first, between people (interpsychological), and then inside the child (intrapsychological)."

Vygotsky describes a complex and yet important process of transformation of mental functions from the social plane to the individual plane. The second strand is that learning science is a discursive and cultural process (Duran, Dugan & Weffer, 1998). This perspective emphasises the centrality of dialogical argumentation or classroom talk among learners. Classroom settings informed by this perspective give learners opportunities to practice the social language of the aspired to community. Classroom talk (dialogical argumentation) is not restricted to responding to questions asked by the teacher or giving learners opportunities to ask questions, these argumentations allow learners the space to learn from others and report on their very own cultural views and conceptions on questions asked. Maloney and Simon (2006:1822) mention that "... if we are to encourage children to develop their scientific thinking, we need to teach them how to argue *about* their ideas in order to clarify what they think and then how to argue *for* their ideas when they try to convince others of their merits." They underline the need for encouraging argumentation as a way of developing scientific thinking.

2.3.1 Toulmin's Argumentation Pattern (TAP)

In order to participate in a scientific community, students and novices need to know "how to construct substantive arguments to support their" position. Toulmin (1958) develop the Toulmin's Argumentation Pattern, that can be used "as a basis for characterizing argumentations in science lessons" (Pedemonte 2005). Toulmin (1958) also suggested that a substantive argument requires providing supporting data to a claim. In this research study this model will be used to compare and analyse the understanding of grade 9 learners' conceptions of selected meteorological concepts from a cognitive point of view.

Three elements make up the Toulmin's basic model of an argument, which are:

C (claim): the statement of the speaker,

D (data): data justifying the claim C,

W (warrant): the inference rule, which allows data to be connected to the claim.

In any argument, the first step is expressed by a standpoint (an assertion, an opinion), or in Toulmin's terminology, a claim. The second step consists of the production of data supporting the claim. The warrant provides the justification for using the data conceived as a support for the data–claim relationships. The warrant, which can be expressed by a principle or a rule, acts as a bridge between the data and the claim.

The basic structure of an argument is presented in Figure 1 below.
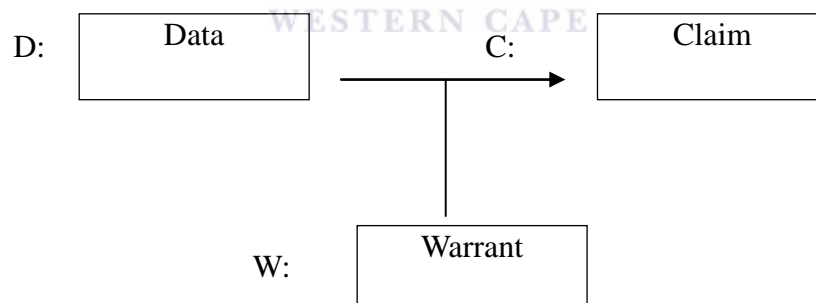
Figure 1: Toulmin's basic model (Toulmin, 1958)

Toulmin's argumentation model (Figure 2 below) can be used to compare and analyse the understanding of grade 9 learners' conceptions of selected meteorological concepts in this study. In Figure 2, the three elements to describe an argument are displayed as a qualifier, a rebuttal, and a backing (Toulmin 1993).
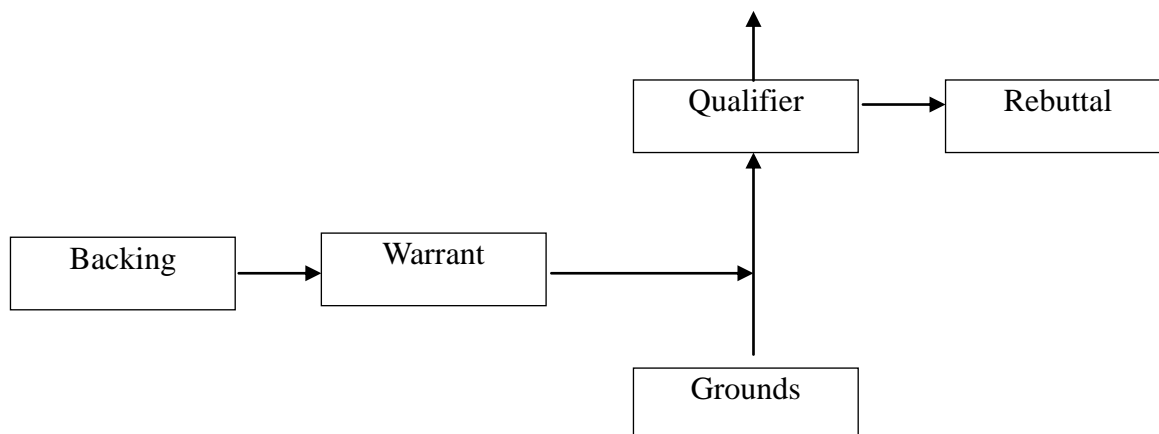
Figure 2: Toulmin's model (Toulmin, 1958)

Features of Toulmin's (1958) analysis of argumentation include: the extent to which learners and teachers make use of data, claims, warrants, backings, qualifiers and rebuttals, and the extent to which they engage in claiming, justifying and opposing the arguments of each other. The Toulmin (1958) framework can therefore be used by teachers to conceptualise and evaluate argumentation. To provide learners with tasks that require discussion and debate, teachers can support learners in the construction of arguments through the process of argumentation, as represented in Table 3 below.
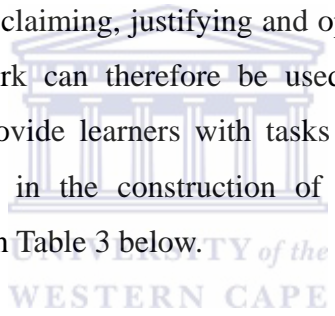
Table 2 Tabulated representation of TAP (Stone, 2009).

Components	*Code*	Definition	Example	Scaffold
Claim	C	**Statement or belief** about a phenomenon whose merits are in question **Statement** whose validity is in question **Conclusion** whose merits are sought to establish **Hypothesis** based on available evidence **Premise** based on deductions	…there is a battery in the box	I think/ believe that…

		Belief based on dogma		
Counter-claim	CC	**A challenge:** a specific type of claim, one which question the validity of another claim	…there could be something else in the box	No I think/ believe that…
Data	D	**The facts** (observed or believed) used as evidence to support a claim. **Evidence** appealed to as foundations for the claim	…the bulb is lit	…because
Warrant	W	**Statements** used to establish or justify the relationship between the data and the claim. Statements that act to show that the move from data to claim is valid. The warrant links the data to the claim and indicates the relevance of the claim to data.	…a circuit must be complete for the bulb to light up	…since
Backing	B	**Facts or assumption** which establishes a warrant. Backings for warrants may be expressed as categorical statements of facts, just as data are appealed to in direct support of a claim/ A backing may be the implicit assumptions underpinning the claim. Underlying assumptions that are not often made explicit.	…because adding bulbs to the circuit slows the electricity down	…on account of/ because
Qualifier	Q	**Special conditions** under which the claim holds true i.e. the conditioning governing the claim	…and so there must be a battery in the box – a battery provides the power in the circuit	…and so
Rebuttal	R	**Statements** which show that the claim is invalid. Statements that contradict either the data, warrants, backing or qualifier of an argument	There is no battery in the box	…because

2.3.2 THE CONTIGUITY ARGUMENTATION THEORY

But useful as Toulmin Argumentation Paattern is in assessing the quality of arguments it does not address metaphysical IK-rated beliefs that impinge on learners' understanding of diverse phenomena. It was because of this limitation that Ogunniyi (2004) proposed the Contiguity Argumentation Theory. The effectiveness of argumentation instruction in enhancing learners' understanding of school of science is well supported by a plethora of studies (e.g. Erduran, et al, 2004; Ogunniyi, 2004, 2005, 2007a & b, 20011; Osborne et al, 2004; Simon et al, 2006). In an attempt to mediate between science and IK that learners hold Ogunniyi (2007a) has proposed the Contiguity Argumentation Theory (CAT) in order to capture learners' experiences beyond the scope of school science. CAT is rooted in the Aristotelian contiguity notion of resolving conflicting ideas. CAT suggests that, "two distinct co-existing thought systems" such as science and IK "tend to readily couple with, or recall each other to create an optimum cognitive state. Unlike TAP which only deals with logical substantive arguments (Toulmin, 1958), "CAT deals with both logical or scientifically valid arguments as well as non-logical metaphysical discourses embraced by IKS" (Ogunniyi & Hewson, 2008: 146).

The five levels of the CAT that been used to analyze teachers' cognitive shifts between science and IK or vice versa are as follows:

- **Dominant**: a powerful worldview that explains a subject matter more effectively or convincingly than a rival worldview e.g. science or IK.

- **Suppressed:** a worldview that is suppressed by a dominant one e.g. science or IK.

- **Assimilated:** a worldview that is assimilated or subsumed by a more dominant worldview e.g. science or IK.

- **Emergent:** a new worldview that is formed as a result of an individual encountering additional information, insight or experience e.g. a previously unknown idea in science or IK.

- **Equipollent:** when two competing worldviews (e.g. science and IK) have comparably equal intellectual force, they tend to co-exist without necessarily resulting in conflict (Ogunniyi, 2007a).

Although the underlying mechanisms for cognitive elaboration in moving from one level of logical argument to another in terms of TAP or in shifting from one worldview to another in terms of CAT are not well known, there is consensus among scholars in the field of neural science, psychology, psycholinguistics and anthropology that it is an adaptive process probably triggered off by the arousal context in which an individual finds him/herself. As the context changes so does the worldview an individual holds change in response to the dynamics of change to maintain so to speak a sort of homeostasis, or more correctly allostasis (Ogunniyi, 2007a; Ogunniyi & Hewson, 2008; Sapolsky, 1994).

CAT contends that as the context changes a once dominant idea can become suppressed. For instance, in a religious context faith or a cultural belief might be more appropriate for dealing with the issue at stake than empirical evidence. An assimilated idea is an idea, which becomes subsumed to a more dominant one. An emergent idea is a newly acquired idea that has no rival or opposing idea, as would be the case for most science concepts first encountered at school. Equipollent ideas are those competing ideas that exert comparably equal intellectual and emotional force on the learners' cognitive structure. These ideas are a state of flux and may change from one form to the other depending on the context a learner finds him/herself (Ogunniyi, 2007a).

One of the questions often asked by science educators is, "How feasible is it for teachers to integrate science with IK in their classrooms?" The issue in my view is not whether or not the two knowledge corpuses are compatible but rather how justifiable is the segmentation of knowledge when in fact according to (Le Grange 2007) knowledge is knowledge. Other than for pragmatic consideration it is hard to justify the fragmentation of knowledge as is commonly the practice in the school curriculum. Besides, as one ascends the educational ladder knowledge which becomes separated after the primary school level becomes multi- and in-displinary in nature.

The issue being addressed here is not not to state that all knowledges are necessarily good or bad for that matter per say. Indeed, there are areas of IK that one would not recommend for inclusion in the school curriculum e.g. the belief in witches and associated practices. Of course not aspects of modern science are necessarily good either. For instance aspects of science (and technology) that have devastating and irreversible consequences for individuals, societies or the biophysical environments. The abuses of drugs today have had devastating consequences among a vast number school going learners. The thrust of the chapter is thus the need to develop curricula and instructional practices that provide learners the opportunity to dialogue and to see the relevance of what they learn at school and what they learn at home.

While there are many places where learners can acquire environmental literacy, the most effective locations perhaps are schools. The school plays a vital role in the process of helping children to acquire environmental literacy and awareness. But to develop a robust knowledge of the environment learners need to see the relevance of what they learn in class with their daily experiences. Otherwise, they might regard the former as no more than an activity to pass examinations.

A study done by Barraza (2004) shows that the school is the place where children most commonly report they learn environmental literacy. School science classes are the contexts in which learners are exposed to activities that enhance their knowledge and awareness of their environment. According to Ogunniyi (2001) the CAT assumes that when different ideas interact they tend (through a sort of dialogical process) to find areas of commonality i.e. areas where their subsumed elements are compatible and this ultimately may result in a higher form of meaning than was previously possible (Ogunniyi, 2001; as stated by Ogunniyi in Book 2 SIKSP, 2009). He cites Sapolsky as stating that learning as a dynamic processentails a delicate balance between reason and emotion, body and mind and nature and nurture – all interacting in diverse ways to attain some level of equilibrium or allostasis.

The principles of the CAT model are clearly seen in the Learning Outcome 3 of the RNCS Grades R-9 (2002) science curriculum which expects learners to be able "to demonstrate an understanding of the interrelationship between science and technology, society and the environment" (Department of Education, 2002:10). Research further shows that only if argumentation is specifically and explicitly addressed in the curriculum will learners have the opportunity to explore its use in social science (Kuhn, 1991). Because science education mainly focuses on learners' understanding of science concepts and adopting using different ways in achieving this, like transmission learning and not drawing on reasoning only the delivery of science facts.

Using teaching methods that uses argumentation through the use of appropriate activities and teaching strategies in the social science class can provide a means of promoting a wider range of goals, including social skills, reasoning skills and the skills required to construct argument using evidence (Osborne, Erduran, & Simon 2004a). So, in order to emphasis that teachers need argumentation during teaching social science, they (teachers) need to adapt their teaching styles to a more dialogic approaches (Alexander, 2005) that will involve students in class and lesson discussions, and using teaching methods to interact with students to foster argumentation skills.

Vygotsky used the term (mediator) to convey the role of the teacher who actively and thoughtfully mediates the culture (knowledge, skills and values) to learners in such a way as to enable them to appropriate the culture for themselves, assimilating it into their own systems of meaning, adapting it as they adapt those systems, and developing competence in the process. According to Vygotsky, 'learning awakens a variety of internal developmental processes that are able to operate only when the child is interacting – with people in his environment and in co-operation with his peers' (Vygotsky, 1978).

Vygotsky's (1978) central notion of the ZPD refers to the gap between a learners' actual level of development (what he/she can do on his/her own without assistance) and his/her simultaneous potential level of development (what he/she is able to do under adult guidance or in collaboration with more capable peers). Jerome Bruner, the American educationist who was strongly influenced by Vygotsky's theories, used the metaphor of "scaffolding" to interpret the ZPD concept. This refers to various forms of assistance which the teacher gives to learners, and which are gradually withdrawn as the learners become able to function independently.

2.4 How children learn

The most influential sources of constructivist ideas have been Piaget and Vygotsky. Both of these theorists reject the notion of simple maturation as well as the direct impact of the environment and the transmission of knowledge as sufficient to explain learning. Both see learning not as a passive activity as an construction of knowledge. Development through transmission from outside the learner. Here teaching is a matter of transmission or operant conditioning, and learning is essentially a passive process. The best advocates of such behaviourist notion is Skinner (1975). B.F Skinner sees learning only in terms of visible change in behaviour, and psychological development as an accumulation of such changes. Here teaching is a matter of providing a 'nourishing' environment to allow this essentially natural growth to flourish and to avoid stunting it. Advocates of such view are Jean-Jacques Rousseau and Maria Montessori (see 1986 & 1989).

Stapp's definition of meteorological literacy in the Journal of Environmental Education in 1969, outlined EE "as a means of producing an environmentally literate citizenry, empowered and motivated to solve environmental problems" (Stapp, 1978).

However, over the past decade and a half, research has begun to reveal broad academic benefits of using the environment as a foundation for instruction. Multiple studies indicate a positive correlation between meteorological literacy and students achievements (Stapp, 1978).

As stated earlier, this study is underpinned by an argumentation framework as espoused by Toulmin's (1958) Argumentation Pattern (TAP) and Ogunniyi's (1997) Contiguity Argumentation Theory (CAT). The two theoretical frameworks are chosen because of their amenability to classroom discourse dealing with phenomena on which learners might be holding conflicting worldviews. These frameworks provide the necessary context for inductive, deductive and analogical reasoning. They also accord with the Piagetian and Vygotskian notion of constructivism namely, that knowledge is constructed as one makes sense of the world around him/her. This type of reasoning can be use as an instructional tool

to learners who constantly interacts with their environments and surroundings. Interacting with the environment and your surroundings great experience are gained where individuals relate to that the environment in a sensible and responsible manner.

While there are many places where learners can learn about environmental literacy, the most effective locations perhaps is the schools. The school plays a vital role in the process of helping children to acquire environmental literacy and awareness. A study done by Barraza (2004) shows that the school is the place where children most commonly report as the place where they learn environmental literacy. School science classes are the contexts in which learners are exposed to activities, which enhance their knowledge and awareness of their environment.

According to Ogunniyi (2001) the CAT assumes that when different ideas interact they tend (through a sort of dialogical process) to find areas of commonality i.e. areas where their subsumed elements are compatible and this ultimately may result into a higher form of meaning than was previously possible (Ogunniyi, 2001; as stated by Ogunniyi in Book2 SIKSP, 2009). Furthermore Learning Outcome 3 of the Revised National Curriculum Statement Grades R-9 (2002) science curriculum expects learners to be able "to demonstrate an understanding of the interrelationship between science and technology, society and the environment" (Department of Education, 2002:10). This outcome serves as a good departure to consider the central concern of the study namely, grade 9 learners' conceptions of selected meteorological concepts.

Looking at The National Curriculum Statement

The constitution of the Republic of South Africa (Act 108 of 1996) provides the basis for curriculum transformation and development in South Africa (Department of Education, 2002). The constitution amplifies the following aims:

- "heal the divisions of the past and establish a society based on democratic values, social justice and fundamental human rights" (Department of Education, 2002);
- "improve the quality of life of all citizens and free the potential of each person (Department of Education, 2002);
- "lay the foundations for a democratic and open society in which government is based on the will of the people and every citizen is equally protected by law" (Department of Education, 2002); and

- "build a united and democratic South Africa able to take its rightful place as a sovereign state in the family of nations" (Department of Education, 2002).

Education and training plays a vital role in realizing these aims of the constitution. On the other hand the curriculum trends to develop a kind of learner that is envisaged. As quoted in the Revised National Curriculum Statement R-9 (Schools) RNCS(2002):

The promotion of values is important not only for the sake of personal development, but also to ensure that a national South African identity is built on values very different from those that underpinned apartheid education. The kind of learner that is envisaged is one who will be inspired by these values, and who will act in the interests of a society based on respect for democracy, equality, human dignity, life and social justice. The curriculum seeks to create a lifelong learner who is confident and independent, literate, numerate, multi-skilled, compassionate, **with a respect for the environment** *and the ability to participate in society as a critical and active citizen.* (RNCS, Department of Education, 2002 :8)

Research on Culture and Learning for Indigenous Learners' in Science Education

One of the difficulties that learners experience with learning science is communication. Yet a plethora of studies have shown that classroom discourses involving the use of argumentation do enhance learning. This should not be surprising considering that when people sre given the opportunity for free expression they are likely to externalize their thought, clear their doubts and even change their minds in the light of the arguments posed by others (Erduran et al, 2004).

This section examines a number of research studies that have used dialogical argumentation to enhance learning in science education classrooms. Until the very recent past, there has been little debate about a likely connection between argumentation and science education. The scenario is now changing as more and more attention is being paid to the science exposure of learners' who live in communities in which traditional practices and beliefs guide daily actions. The interest has been fuelled, in part, by the global thrust towards school science programs that are intended, not for a select few, but for all students. The "science for all" movement is intended to equip all students to use their knowledge of science in their daily lives. "Science for all" and "science for daily living" take on new meaning when indigenous communities' needs are considered in cultural context.

Currently, there are three approaches dominating the IK field that are all derived from anthropology. These are worldviews (Cobern, 1991), collateral learning (Jegede, 1995), and border crossing (Costa, 1995; Aikenhead, 1996). Cultural anthropology (Maddock, 1981) and postcolonial scholarship (McKinley, 1996) both influenced the direction of indigenous science education research toward humanistic school science. In 1981, Maddock focused on theory building through a review of literature in science education and anthropology. He argued against the deficit model that focused on bring Western modern science into developing nations. His viewpoint was that science and science education are cultural enterprises, which form part of the cultural matrix of society, and that educational considerations concerning science must be made in light of that wider perspective. He considered the science curriculum projects of many nations and emphasizes that they were greatly influenced by Western scientists. Many of the science curricula developed by Western scientists were simply transplanted from one culture to another, with no cultural dialogue, often for little regard to resources or place. Typically, it had been assumed that 'primitive' cultures had no science, yet there had been little research in these cultures to confirm that assumption. Finally, Maddock concludes with the argument that to continue to progress, science education, both in its practice and research, needs to adopt an anthropological point of view.

Several scholars have incorporated Maddock's viewpoint of including an anthropological approach, particularly the localized and a humanistic framework to science education research (e.g. Ogunniyi, 1982; Henry, 1987; Ogunniyi, 1987). The purposes of the studies carried out by these scholars were to study specific curricula in a specific location. These new curricula focused on science learning that is relevant to everyday life of students. A local example in South Africa are the studies Of Ogunniyi and associates which use a dialogical argumentation instructional model (DAIM), the same as in this study, to determine how students or teachers have attempted to negotiate their indigenous or alternative viewpoints with the scientific worldview. Most of the findings have shown that no matter what intervention teachers and learners tend to retain their IK-based conceptions alongside those of science (Aikenhead & Jegede, 1999).

Sevearal studies have also shown the need for curricula to be made relevant to to the specific cultures. They also suggest that learners or teachers should not be forced to abandon their traditional beliefs as that might prove counterproductive on the long run. However a distinction still remains between indigenous and the scientific worldviews. It was with this use of anthropological definition of culture that a framework for worldview was brought into science education (Cobern, 1991). Within this framework, George (1988 :818) sought to explore the role of practical and culturally relevant curricula in a Caribbean context, which

added a new dimension to the argument for indigenous knowledge in school science. She argued that, "Children in developing countries therefore need to learn that technological innovation does not always have to originate in the developed world but that they too have the ability to create" (p. 818). She proposed that in addressing this idea through science curriculum, students would have pride of their heritage and would drive to continue to innovate.

Indigenous Language through Argumentation-Based Instruction

Historically, little research has been done to address student learning and indigenous languages. Because of the paucity of research in this area, there is no consistency among researchers about how or if indigenous language should be included in science instruction. There is aheated debate about how much indigenous language can be include in the science classroom. Clerk and Rutherford (2000) carried out a study of English language learners in South Africa and found that the use of vernacular hindered student learning in a science classroom. They argued that there should be more English language usage to avoid confusion. However, this study did show clearly how the supposed local languages interrupted the students' conceptions or or contributed their misconceptions in science.

McKinley (2005) has argued that one of the main ways in which indigenous knowledge systems will survive and thrive is through the establishment of programmes taught through indigenous languages so that a dialectal relationship between language and science knowledge is established that continues to act as the wellspring. However, the critical issue is not only what happens in the science classrooms but also what happens in the teacher education institutes. Indigenous languages in science education face many barriers including the danger of extinction. Therefore, the focus needs to move away from what makes teaching and learning effective for indigenous peoples to what indigenous language effective for learning and teaching science?

The multicultural debates are linked to other debates in science education aimed at inclusion, such as the constructist approach of 'science for all', and SSI initiatives, which can improve the learning and achievement in science of a wider range of students. Buit according to McKinley, "... the failure of science education research during these times was in not taking culture, language, 'race' or colonization as major factors in any of the projects" (McKinley, 2005 :230). This is despite that fact that a number of indigenous writers have argued the importance of connecting school science education to the students' cultural background

(Cajete 1995, Kawagley 1995, Kawagley and Barnhardt 1999, McKinley, 1997). Making the connection to the cultural background can be done in two different ways, both of which are the foundations for place-based curriculum: 1) making science 'relevant' to the student, which usually involves teaching in culturally relevant contexts or everyday science, 2) using culturally responsive teaching or culturally based pedagogy (see Bishop and Glynn 1994, Ladson-Billings 1995).

Another study on discourse and argumentation which I have examined is one by Zeynab Badreddine (2009) "Building context and continuity in classroom discourse; a case study at the high school level." That study presents a case study which focuses on the importance of temporal links in teachers' discourse in particular how these links participate in the drawing of classroom content from the beginning of the school year. From a socio-cultural perspective and by taking the teaching learning process as a dynamic process, it was built on three theoretical concepts:

(1) the definition of *context and continuity* developed by the works of Mercer (1987& 2008) argues the following:.

> *…context "refers to everything that the participants in a conversation know and understand, over and above that which is explicit in what they say, that contributes to how they make sense of what is said". Thus, "continuity is the development of such contexts through time".* (Eduards & Mercer, 1987 : 63)

The term *continuity* refers to and puts a stress on the evolutionary construction of meanings throughdiscourse interaction, establishing thus coherence between the meanings developed andpresented in a past context and the present context. It involves the idea that the meaningsattributed to a taught content in a particular moment evolve during the sequence. (Eduards & Mercer, 1987)

(2) The definition of macroscopic, *mesoscopic*, and *microscopic* scale defined in the work of physics education for studying the progression of knowledge in time, its coherence and continuity. These authors define three scales in order to describe and to organize class phenomena through time. In their study, define three different time scales for an analysis of phenomena related to the teaching and learning process:

> *the macroscopic scale that corresponds to the academic time (weeks and months), the mesoscopic scale that corresponds to the didactic time (minutes and hours), and finally the microscopic scale that represents a smaller granularity, around minutes and seconds. This microscopic scale is at the level of utterances and gestures of actors [...], the level of interactions.* (Eduards & Mercer, 1987 :63)

(3) and finally the concepts of *themes* and *episodes* in order to organize the taught knowledge respectively at the mesoscopic scale and microscopic one.

> *A **theme** is defined as the "central topic of a discussion during a given time interval in the classroom. These units have a structure, with boundaries and a thematic coherence. They include most of the time an introduction and a conclusion, the majority of utterances is connected to the same theme" As for the notion of **episode**, it represents "a coherent set of actions and meanings produced by the participants in interaction.* (Eduards & Mercer, 1987 :63)

The episodes provide access to the rhythm of the classroom life, the dynamics of the classroom interaction and progression of taught content, at the microscopic level.

The main focus in the above case study that has been reviewed, is on two episodes situated on the same theme ("the representation of the solar system as an almost empty (lacunar system"), and extracted from a video-recorded sequence at the beginning of the school year. The teacher in question is an experienced teacher. These two episodes describe how the teacher draws the *knowledge context* and ensure continuity of the class with regard to knowledge on a short scale and on a longer one. It is a study in progress that aims: (1) to understand how different teachers from different disciplines and different profiles manage from the beginning of the school year the construction and managing of knowledge in the classroom discourse, (2) to provide teachers with tools related to the managing of knowledge through time. The study showed that by studying the practices of experienced teachers, one is able to see how their performances and the tools tools they utilize help them relate and manage knowledge through time, particularly, in the way they make explicit to students the links between the past, the present, and the future of the taught content. Badreddine (2009) believes that teacher education programmes that make explicit links between the contents and the daily experiences of learners would assist pre-service teachers to use such strategies efficiently in there teaching practice activities. Furthermore, when links are made in the classroom discourses the progression of the lesson of the lesson becomes more evident.

Another study that was reviewed out of interest in dialogical argumentation instructional model (DAIM), was that of Evagorou, Papanastasiou & Osborne (2009) on "The case of designing and validating a tool to assess 11-14 year old students written argumentation." The purpose of the study was to present the process of designing and validating a tool to assess 11-14 year old learners' written argumentation in science. Given the emphasis on argumentation in science education in recent years, methodologically the assessment of argumentation has become one of the dominant issues in the field. In the study the researchers present two written argumentation tools that were designed for 11-14 year old learners, the validation process, and the main outcomes from testing the argumentation tools with 246 learners (students) in the UK. The analysis of the data from two versions of the questionnaire (Test A and Test B)

shows that both tests are reliable for evaluating written argumentation when the first item is removed (Cronbach's alpha .674 for Test A and .705 for Test B). Additionally, the analysis of the data implies that choosing a convincing argument is more difficult for the students than any of the other three aspects of argumentation that were evaluated in the tests (choosing a convincing counterargument, writing an argument, writing a counter-argument). Finally, the results from the questionnaire suggest that argumentation might be content specific. Implications for research include the design of a new tool combining the questions from both tests, using aspects of the questionnaire to explore whether argumentation is context specific, and exploring whether deciding on a convincing argument is a higher sub-skill compared to writing an argument.

In sum, the above study implies that choosing a convincing argument is more difficult for the learners than any of the other three aspects of argumentation that were evaluated in these tests (choosing a convincing counterargument, writing an argument, writing a counter-argument). Also, the results from the questionnaire imply that argumentation might be content specific since for the same structure of the two tests, Test A had a lower Cronbach's alpha, and that was higher when Question 1 (which was heavily relying on students' knowledge on electric circuits) was removed. The hypothesis that argumentation is context specific is also supported from findings in previous studies. Some implications here include the fact that the design of a new tool combining the questions from both tests to see if this provides a higher internal consistency measure, and also using aspects of the questionnaire to explore: (a) whether argumentation is context specific, and (b) that deciding which is a convincing argument is a higher sub-skill.

Since the findings from this study suggest that choosing a convincing argument from a list of given arguments is more difficult that constructing an argument, implications for practice include finding ways to support students when deciding upon convincing arguments, since this is a skill useful in their everyday life.

According to Hanife Hakyolu (2010) argumentation research is still relatively young field and more research needs to be carried out on students' argumentation quality (Hakyolu & Ogan-Bekiroglu, 2010). The purpose of the study was to examine the quality of students' argumentation and to find out how their argumentation quality changed as their involvement in scientific argumentation increased. A case study design guided the research. The participants of the study were 13 senior pre-service physics teachers, four of whom were females. Argumentation sequences were implemented in the methods course and lasted six weeks

including two subjects, i.e. kinematics, and heat and temperature. Data were collected via learners' worksheets and video recordings made during the argumentations.

The study then concludes that learners' argumentation quality does not increase as the number of argumentation and their involvement in argumentation increase. Second, if students have familiarity with the concepts that are argued on, they can reach the highest quality level of argumentation although they do not have any experience with argumentation process in their previous instructions. Third, changing of subjects in argumentation may get learners' interest and thus affect their quality of argumentation. Fourth, concepts that argumentation is founded on can influence argumentation quality. Finally, there is no consistency in learners' argumentation quality through argumentation sequences when content as well as context of argumentation change in each sequence. This study has implications for presenting the changes in learners' argumentation quality in scientific argumentation sequences.

Konstantinidou, Castells & Mª Cerveró (2010) examined the inter-class relationship among learners' within an argumentation instructional setting. From their review of previous studies we they identified types of arguments that learners use when they solve problem-tasks in a science class. Focussing on the way the features of the tasks determine the type of argument that learners use. They identified how learners interrelate their ideas with the types of arguments they use in a science class situation involving dialogues in small groups. Using an analytical framework based on the Theory of the Argumentation of Perelman, and the schemes for presumptive reasoning of Walton they were able to recognize the the type of arguments and premises that learners use in their arguments. They also found that tasks tend to influence the argumentative schemes and the premises used by learners in a different, and sometimes unexpected, way. This depends on specific features of the tasks, but also on the personal interpretation that leraners make, which could be related to their ideas and misconceptions.

In view of the above findings in terms of the interrelationship between the four elements identified by means of the analysis (features of the problems-tasks, previous scientific ideas students have, personal interpretation of the tasks' situations and the argumentative schemes used by the learners performing the tasks in small groups) further studies are needed to determine how the argument schemes that learners use in science classes enhance or hinder their conceptions in science. An implication of this research could be to include not only learners' misconceptions in teachers' training programmes but also the most common argumentative schemes that learners use to improve their thinking and learning skills in science. This is important because the teachers will be able to use these argument schemes in their dialogical argumentation instructional lessons as a "tool" to favour the process of

learning science and to provide "clues" to help them to choose appropriated activities in science education.

2.5 CONCLUSION

As stated earlier, this study is underpinned by an argumentation framework as espoused by Toulmin's (1958) Argumentation Pattern (TAP) and Ogunniyi's (1997) Contiguity Argumentation Theory (CAT). The two theoretical frameworks are chosen because of their amenability to classroom discourse dealing with phenomena on which learners might be holding conflicting worldviews. These frameworks provide the necessary context for inductive, deductive and analogical reasoning. They also accord with the Piagetian and Vygotskian notion of constructivism, namely, that knowledge is constructed as one makes sense of the world around him/her. This type of reasoning can be used as an instructional tool for learners who constantly interact with their environments and surroundings in a sensible and more meaningful way.

The focus in this study is on environmental education, specifically of scientific meteorological literacy. Stapp's (1978 :87) definition of meteorological literacy in the Journal of Environmental Education in 1969, outlined environmental education "as a means of producing an environmentally literate citizenry, empowered and motivated to solve environmental problems". However, over the past two decades and a half, research has begun to reveal broad academic benefits of using the environment as a foundation for instruction. Multiple studies indicate a positive correlation between meteorological literacy and students achievements overall (Stapp, 1978).

One of the reasons for the focus on indigenous knowledge systems (IKS) in this study is that the latest Curriculum and Assessment Policy Statement (CAPS) (2011) document for Natural Science of the Department of Basic Education indicates a change in the curriculum plan, effective from January 2011, that incorporates "indigenous knowledge". It vaguely indicates the assessment strategies towards IKS in the classroom in *Specific Outcome 3.2* that state:

> *3.2 RELATIONSHIP OF INDIGENOUS KNOWLEDGE TO NATURAL SCIENCES*
> *Examples that are selected (and that should, as far as possible, reflect different South African cultural groupings) **will** also link directly to specific areas in the Natural Sciences subject content.* (CAPS, 2011 :39)

Implementing these aims will have direct implications for the Natural Science curriculum in South African schools – with no space, framework or resources to develop IKS properly. So,

the provision for IKS in the national curriculum has opened debate amongst IKS-researchers, curriculum developers, academics and education specialists, because IKS is part of any culture or society and can't be ignored for the purpose of creating a smoother assessment curriculum policy statement in education. IKS forms the basis of every learning area, whether in science, life and living skills, or social science, and should be seen at school as a point of departure to learn and create new knowledge and healthy argumentation in class amongst learners of all ages.

CHAPTER THREE: METHODOLOGY

The main aim of the present study is to investigate grade 9 learners' conceptual understanding of selected meteorological concepts by using a dialogical argumentation-based instructional model (DIAM). This chapter will detail the research design and methodology used to determine the effectiveness of the DIAM-model on the learners' conceptual understanding. The research instruments used to collect data employ qualitative and quantitative methods, or 'mix-methods', and are derived from the theoretical framework that underpins this study. This chapter also details the procedure that was followed to formulate the findings and results according to the research problem.

3.1 Design of the Study

The research design (figure 3 below) was based on the pre-test-post-test control group design. The subjects' conceptions of weather were evaluated in a pre- test followed by a series of argumentative learning intervention sessions and a post-test evaluation. The control group was also pre- and post-tested but was not exposed to TAP and CAT intervention but to the conventional talk-and-talk approach. Blow is an illustration of the research design:

$$O_1 \quad X \quad O_2 \quad \text{(Experimental group) = (E)}$$

$$O_3 \qquad O_4 \quad \text{(Control or Comparison Group) = (C)}$$

$$O_1 \quad X \quad O_2 \ = \text{Pre-observations}$$

$$O_3 \qquad O_4 \ = \text{Post-observations}$$
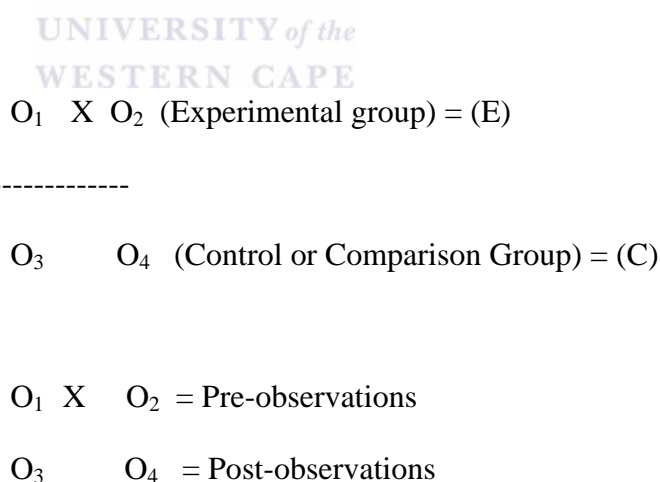
Figure 3 : Illustration of research design

This researcher was responsible for the intervention strategy with the experimental group and a science educator at the control school was responsible for the data collection from the subjects at that school.

3.2 PRACTICAL CONSIDERATIONS

Why experimental research design?

The study is based on a case study design with two main components, namely, a quasi-experimental design with qualitative and quantitative research design components – also known as a mixed-method approach. This approach attempts to establish a 'relationship between variables by exercising very tight control over key aspects of the setting in which the research is conducted. In the experimental design form, the approach entails manipulating one variable (known as the independent variable) to observe the effects this has on another variable (the dependent variable).'

In the case of evaluating a teaching strategy, according to Dowling and Brown (2010 :44) the "teaching strategy" will act as the "independent variable" and the learners' "scientific reasoning" will be the "dependent variable". As they stand, neither variable is sufficiently well defined, so Dowling and Brown (2010) suggest that "in order to construct an experiment, the teaching strategy in which you are interested has to be translated into an explicit procedure, which can be repeated with a high degree of consistency" (Dowling & Brown, 2010 :44). This will constitute the experimental treatment of the DAIM-model that will be carried out in the study. According to Ogunniyi (1992:81) the purpose of experimental research is described as "the consequences of a direct intervention into the status quo". This status quo can also be seen as an indicator of the quality of reasoning in order for us to present or render this (scientific reasoning) as visible and measurable in this study.

It is important to remain aware of the fact that the strict demand made by experimental designs can create a number of problems for educational research. In this study, the groups of learners chosen for the study are from a group of grade 9 learners at the research site. Therefore, randomly assigning learners to groups is disruptive and likely, in many if not most circumstances, to be impractical to deal with as a researcher. As the researcher, I am also aware that only with sufficient precision and tightly controlled experimental settings will one be able to apply the prescribed treatment, in this case the DAIM (dialogical argumentation model) without raising concerns about the *ecological validity* of experimental research in which phenomena are explored in a context other than those in which they naturally occur (Dowling & Brown, 2010 :46). This normally happens when groups that have been constructed in this way need to be taken away from the ideal classroom situation to manipulate the treatment they will receive to get the desired results.

Dowling and Brown (2010) raise the questions of the *typicality of behavior* within an experimental context, and the *transferability of treatments* from an experimental setting to the classroom. The awareness of being part of a research study according to Dowling and Brown (2010 :46) might itself influence the research by what is known as the *Hawthorne effect*. In this case the effects of being researched outweigh the influences of any of the factors being researched. This phenomenon clearly has implications for all forms of observational research. With the experimental research approach there is also potential for ethical problems when it comes to the circumstances in which school children are taught. The experimental researcher should never embark on a journey where the process is harmful to the educational progress of any group of school pupils. Similarly, one must be careful that the research design does not lead to beneficial forms of action being withheld from groups for an extended period of time.

To overcome the possibility that the study could end up producing the *Hawthorne effect* or encountering other risks to credibility of findings a *quasi-experimental* type of design was adopted. This design deals with a more complex socio-cultural and economic context that allows for the use of both quantitative and qualitative research methods.

3.3 RESEARCH SETTING.

This research was conducted in a previously disadvantaged community in Cape Town, Western Cape, South Africa. This area formally hosted the oldest informal community in Western Cape called '*Blik Dorp*' (pseudonym name) with a 57 year old history dating back to 1948 under the previous ruling government in South Africa. With its tin roof and shack-like informal housing structures, it gave permanent residence to more than 750 families in the southern suburbs of the Western Cape. The first primary school of the area was erected as a temporary structure (wooden walls on concrete slabs) adjacent to *Blik Dorp* in the early 1950's. In 1989 the area got a new high school together with the two existing primary schools, all servicing a community consisting of more than 6 000 citizens.

Blik Dorp was rebuilt to proper brick and cement houses under the RDP (Reconstruction and Development Policy) Act of 1996, under the then new ANC ruling government, and for the past 16 years has been home to proud families. When this study was conducted in mid 2011 it had two high schools and two primary schools (one primary school still has the same semi-temporary structure at the same location). The high school where the study was conducted is located in the same area described above in the Western Cape, using learners from the same socio-economic and educational backgrounds. The school had 1 headmaster, 2 deputy

principals, 28 teachers (educators) and 980 learners from grades 8-12 at the time, with an average 1:35 teacher-learner ratio.

3.4 SAMPLING

Two intact class groups from a public high school (called school "X" for now) in Strand. The school is situated in a distinct socio-cultural and economic background area in the Helderberg Basin. The sampling involved two grade 9 classes from the same school. Participants ranged from 14-16 years of age. Classes were positively selected on the basis of **comparability** with respect to:

- Classes doing the same subject and taught by the same teacher
- Formal class test and reports
- Learners within comparable socio-cultural and economic backgrounds

The choice of the grade 9 was based on the following ctiretia that serves as the sampling techniques:

- The NCS syllabus covering the topic in more detail begins in Grade 9 and the learning outcomes are explicitly addressed (see CAPS (2011) Specific Outcome 3.2) .

- Grade 9 was more suitable for research in that the learners had left the junior secondary school level and had become more enculturated to the school and free from the demands of the matric examinations. Grade 10, 11 and 12 generally are not easy grades to do research in particularly in an examination-driven education system like that of South Africa.

- The learners have ideas of weather instruments from their Social- and Natural Science and Technology classes in Grades 6 and 7 as well as from their local communities.

- I had taught grade 9 geography (Social Science) for a number years in the same school before taking my new appointment and hence was more familiar with the culture of the school than would have been the case if I had chosen another school.

- The school was not far from where I currently work.

A brief profile of the sample of the study:

1. Both groups E1 and C1 (boys and girls) were all in grade 9 (senior intermediate phase) at the time of the study.

2. The E1 group had 17 learners (8 boys and 9 girls), and the C1 group had 12 learners (8 boys and 4 girls) in each group.

3. Learners' ages in the E group varied from 15-17 years, with the C group ages ranging from 15-19 years of age.

4. All subjects were bilingual in Afrikaans and had a fairly good command of English.

5. 17 E group members were born in an urban environment as were two of the 11 members in C group, and only 2 members in the E group relocated from a rural area in the Eastern Cape, and 9 members of the C group came from rural parts of the Western Cape.

6. 1 E group learner visited their rural home once a year as compared to 3 in the C group while there were 2 learners who visited their rural homes twice a year in both groups.

7. The majority of the learners (80%) in the study subscribed to the Christian faith whilst the remaining (20%) subscribed to the Muslim faith.

A full tabulation and description of the demographic profiles of the learners is presented in the following section.

In line with the two argumentation models underpinning the study as discussed in the chapter however, it is apposite to first examine the biographical data of the learners involved in the study.

Why the two groups of learners came from the same school

The two groups were two intact grade 9 classes taught by the same educator who was assigned in the study to teach C group. The educator was trained to use the IKS/Science based approach and was made aware to keep all content close to the meteorological topics as set out in the geography curriculum. The training of the educator involved in the research study commenced 6 months before the actual study took place. Training was given two days per week (Tuesday and Wednesday respectively) after school for 3 months covering teaching methods and strategies for intergrating between IKS and Science. These teaching methods and strategies include how to plan and employ a dialogical argumentation instructional method (DAIM) lesson in a science classroom using an IKS based knowledge (see Appendix E &H).

For example, in class learners will have the opportunity, either in small groups or through a teacher-directed discussion (dialogical argumentation), to share their information and to ask for clarification. When learners are satisfied they have a complete list of cultural knowledge (IK) on weather sayings they have researched, learners can complete the summary activity as planned. This activity is an opportunity for learners to apply the cultural knowledge weather sayings (IK) they have researched. Learners are given possible scenarios for a typical summer situation. Each learner is asked to choose a course of action for the upcoming day's activity. He/she must choose and then explain his/her choice, including what cultural knowledge has been used to make the decision. When learners have presented their choices individually, they may form small groups to discuss their choices.

The C group was chosen purposefully after the plan to use a group in another school did not materialize. No doubt, this crisis created an anomalous setting for me and hence constitutes part of the limitations of this study. But as Ogunniyi (1992) has argued, research in the social sciences (including education) is fraught with extraneous variables such as history, maturation, high mortality rate, unpredictability of humans who often act and react to contextual changes, lack of universal theories about human behaviours, problems associated with formulating terms or variables with precise operational definitions, etc. Additional limitations were the experience connected to the above C group receiving their intervention before the E group, meaning that data contamination was possible. This issue was likely resolved by the June school holiday break, over which time most of the learners would have forgotten the intervention.

3.5 QUANTITATIVE AND QUALITATIVE RESEARCH METHODS

For the purpose of this study both quantitative and qualitative "mixed methods" were used to complete the data collection process. The qualitative data were derived from learners written responses in the Conceptions of Weather Test (CoW), Attitudes towards Geography (ATG) survey questionnaire, Meteorological Literacy Test (MLT), as well as Classroom observation schedules (COS) and Focus Group Interviews (FGI). The quantitative data were derived from learners' performance scores in the Meteorological Literacy Test (MLT), as well as Attitudes towards Geography (ATG) survey questionnaire.

The research setting is a public secondary school and the participants sampled were two groups of grade 9 learners from the same school. Two groups were sampled, the experimental (E) and control (C) groups on the basis of grade representation, class performances, test results, socio-economic backgrounds and being taught by the same teacher to make them

comparable. A set of three different instruments were designed and verified through the process of variability and reliability, these being: a high school survey (HSS) questionnaire, conceptions of weather (CoW) questionnaire and a meteorological literacy test (MLT).

The HSS questionnaire was used to determine attitude levels of the learners towards the subject of geography at their school and reasons why they show interest in the subject. This information collected was used to determine the level of questions that should be set out in the MLT test for both the E and C groups and the level of DAIM (dialogical argumentation model) for the E-group intervention only. The CoW questionnaire was used to determine the learners' conceptions and understanding of weather-related concepts, the information was also used to determine their attitudes towards their immediate environment. The MLT test was used to measure and determine the effect of the DAIM intervention in both the E and C groups respectively. The data gathered were statistically analysed by the Statistics Department, University of the Western Cape and University of Missouri under supervision of Professor Richard Madsen with the use of the SAS software programs.

In addition to the additional teacher who undertook the Comparison (C) group intervention, myself as the researcher took charge of the Experimental (E) group Dialogical Argumentation Instructional Model (DAIM) intervention. The teacher who handled the (C) group used traditional teaching methods, discussions and resources to complete the research process. The teacher was also asked to use normal teaching methods according to the National Curriculum Statement (NCS) (DoE,2002) and the Curriculum Assessment Policy Statement (CAPS) (DoE, 2011) that encourage the implementation of IKS into a school Science Curriculum. I used the Dialogical Argumentation Instructional Model (DAIM) with the experimental (E) group. Both the comparison (C) group and experimental (E) groups were exposed to the same Meteorological Literacy Test (MLT) assessment. I observed the (C) group teacher to conclude if he understood the method of teaching IKS as an integrated science curriculum that was agreed upon. A voice recording and video was taken of the (E) group session – both footages were later carefully reviewed to help with analyses of the research process and to determine if the proposed intervention was effective and successful.

3.5.1 Qualitative Research Design

The qualitative data collection occurred at the research site with classroom observations. It was of great importance for me as the researcher to observe the process of the current teachers of both the E (experimental) and C (control) groups. The experimental (E) group had more

structured argumentation lessons planned and tasks to complete which included group work and feedback sessions.

I noted in the classroom observation how the learners of both groups were divided into different groups for their classroom discussions and group work activities. Various positions were given to each group member to deliver and report his/her tasks at the end of each group work activity. The positions vary from group leader, gate/or time keeper, reporter and scriber (secretary). The group leader had an important position within the group to ensure that all members of the group successfully carried out their tasks. As a result of this observation, learners who became group leaders in each class were selected to be my sample for qualitative analysis.

The rationale for this decision was that group leaders were required to transmit the voices of the group, and consequently had themselves made more detailed observations of the whole group's activities, members' socio-cultural and socio-economic status that enable the leader to voice a collective opinion towards the group they represent. This decision was also influenced by the fact that the theoretical framework sought to exploit the benefits of structured dialogical argumentation whose outcomes would largely be influenced by group consensus on the topical issue at hand. All views presented were important for the purpose of this study, and because individual members of a group may have felt reserved when presenting a viewpoint, I decided on focus group interviews as a method to be more appropriate for this study. This view is also supported by Fleer (1999:128) who asserts that ... 'the common practice of interviewing children on a one-to-one basis has also been shown to yield very little indigenous data. However, when children are interviewed as a group, children's responses are much richer and more readily given.

Qualitative data collection instruments

A quantitative research method seeks to establish a causal relationship between the independent and the dependent variable (Ogunniyi, 1996) such as the DAIM and the achievement or attitude or awareness demonstrated by the learners. The instruments used were as follows:

- A Conceptions of Weather (CoW) questionnaire that contained the learners' personal details' section, an attitudes to science section and a meteorological conceptions section.

- A pre- and post-test Meteorological Literacy Test (MLT) that was administered at the beginning and at the end of the intervention in both groups.

According to Ogunniyi (2009), qualitative research involves the collection of experiential data or reflective data rather than data based on empirical testability or numerical values. While this study was to be largely based on a quantitative design, i.e. a quasi-experimental design, the setback I referred to earlier prevented me from using the other group as previously planned. This prompted attention of the qualitative aspect of the study, which enhanced the findings of this study by allowing one to explore aspects of the study that were not easily amenable to quantification, as well as providing the space to make meaningful interpretations which otherwise might be impossible if sticking to a strictly quantitative method. Henning *et al.* (2004:34-41) support this kind of research approach where "the researcher has to develop a taste for seeing the possible systematic ordering of social life in such a way that it can be portrayed to the community of scholars and practitioners who are interested in the topic".

Qualitative data instruments from both the high school survey (HSS) and the conceptions of weather (CoW) questionnaire were in written format. These responses were analysed and categorised according to the five categories of the Contiguity Argumentation Theory (CAT) framework model to determine learners' understanding and conceptions of weather on the basis of the responses given towards a science world view (SWV) and IKS view (IKSV) belief. Some of the verbal excerpts and diarized summaries from the focus group interviews will be displayed in chapter 4 to give a formal and collective analysis of the views involved in this study. Henning *et al.* (2004) also relate that qualitative studies usually aim for depth rather than "quantity of understanding". They further argue that "studies are conducted in settings that are bound by the theme of the inquiry and these cannot usually be extensive unless there is a large team of investigators" (Henning *et al.* 2004 :42-49).

The meteorological literacy test (MLT) and conceptions of weather (CoW) questionnaire were administered to determine class performance and achievements towards meteorological concepts. Included in the MLT test was a qualitative activity to test learners ability for indigenous (IKS) weather forecasting. This application was a five day scenario application (as in APPENDIX D) to predict weather based on the learners decisions and on indigenous weather knowledge they are familiar with. The responses of the learners were analysed and categorised according to the theoretical framework patterns that guided this study. The pre-test and post-test questionnaire sought to find out what conceptions of weather grade 9 learners held prior to and after the intervention. The items expected learners to give explanations or

reasons for their answers. These reasons were then analysed in terms of quantitative or qualitative descriptions depending on whichever was deemed appropriate.

3.5.2 Quantitative Research Design

Why a Quasi-experimental Control Group Design?

Rather than making a comparison between two groups constructed for the purpose of research, comparison can be made between two classes within the same school – one receiving a particular treatment, the other acting as a control group. The quantitative aspect of the study in the form of quasi-experimental pre-test-post-test control group design is as shown below:

The research design can be both quantitative and qualitative in nature e.g.

$$O_1 \quad X \quad O_2 \quad \text{(Experimental group)} = \text{(E)}$$

$$\text{--------------}$$

$$O_3 \qquad O_4 \quad \text{(Control or Comparison Group)} = \text{(C)}$$

$$O_1 \quad X \qquad O_2 = \text{Pre-observations}$$

$$O_3 \qquad O_4 \ = \text{Post-observations}$$
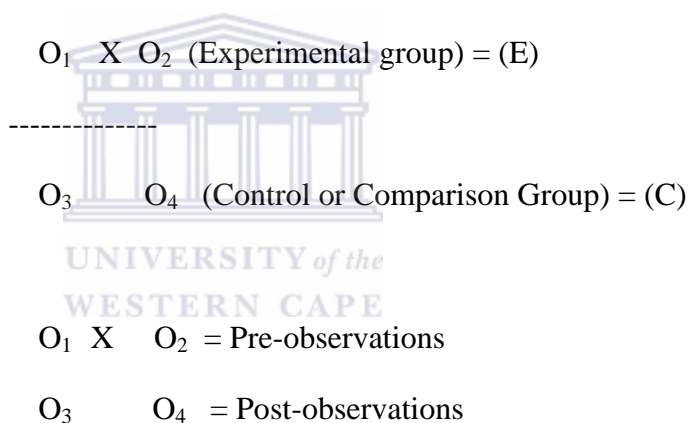
Figure 4: Quasi-experimental control group design

In the figure, **O_1** and **O_2** represent the pre-and post-test observations for the experimental group (E) whereas **O_3** and **O_4** stand for the pre-and post-test observations for the control group (C). **X** stands for the treatment, namely the (DAIM) dialogical instructional method. The dotted line indicates that intact rather than randomized groups were used (Ogunniyi, 1992).

In order to investigate the relationship between the dependent variable and independent variable, the *pre-test-post-test design* was chosen for this study. This research design allows for testing the subjects (learners) in the study before and after the treatment or intervention. This design will also allow the researcher to establish that the use of a particular teaching strategy (in this case dialogical argumentation) causes the observed changes in the dialogical

argumentation or scientific reasoning in the learners, and has some control over the effects presented through this type of experiment. To support this type of research design Paul Dowling and Andrew Brown (2010) argue the following,

> *There are, however, a number of possible influences on the performance of the children that you would be unable to control. This is particularly acute if your treatment takes place over an extended period of time, say over a series of science lessons covering a school term or semester. In this case you would not know whether the observed changes were due to the treatment or to activities that were taking place outside the experimental session. Even the general maturation of the children over the period of time may be important. Although these factors cannot be directly manipulated, an attempt can be made to **control** for their effects through the design of the experiment.* (Dowling & Brown, 2010:44)

Therefore, a second group (control group) of learners were sampled and introduced into the design, this group did not receive any form of treatment or intervention −and is now referred to as a *pre-test-post-test control group design,* with an *experimental group (E)* and a *control group (C)* members. Only members of the (E) group, but not those of the (C) group, received the DAIM treatment. Both groups were tested before and after the treatment was given to the (E) group only. By means of pre-post-tests it enables the researcher to compare changes in the performances of the subjects who received the treatment with those who did not.

3.6 INSTRUMENTATION

As a teacher previously employed in the service of the Western Cape Education Department (WCED), I have noticed the lack of proper English communication in many public schools. This made me decide to design all the instruments in both Afrikaans and English, and for the purpose of the study to only use the English version for ease of discussions. Most of the subjects sampled in both the (E) and (C) groups indicated a good command of the English language. All subjects were fluent in English and could read, write and speak both Afrikaans and English.

As a former staff member of the selected school I am also aware of the work load and extended working hours most teachers have to deal with in the current curriculum including extra-curricular activity involvement. This knowledge also made me decide to streamline all research instruments and intervention workshops to speed up and ease the research process.

Table 3.1 below provides a summary of the instrument structure used in the study.

TABLE 3.1: Instruments and analytic categories of the CAT (adapted from Diwu, 2010)

INSTRUMENTS USED IN BOTH STUDY GROUPS	MEASUREMENT SCALES USED AND OPERATION SEQUENCE FOR EACH ANALYSIS.	ANALYTICAL INTERPRETATION METHOD	REACH QUESTION ANSWERED
Pre/Post-test Conceptions of Weather (CoW) scale	1. 5-point Strength of Argumentation scale 2. 5-point World View Response classification	1. Quantitative with 2. Qualitative	Research Question 2 & 4
Pre/Post-test Attitude toward Natural Science (Geography/IKS scale	5-point CAT categories' sub-scale	Qualitative	Research Question 3
Post-intervention Meteorological Literacy Test (MLT) scale	1. 5-point Strength of Argumentation scale Items' levels of skill classification	1. Quantitative 2. Qualitative	Research Question 1 & 4
Classroom observations	Learner responses and excerpts	Qualitative	Research Question 1, 2 & 3
Focus group interviews	learner responses and excerpts	Qualitative	Research Question 2 & 3

The design of the instruments has largely been influenced by my industrial experience as a meteorological scientist as well as previous teaching experience in Natural Science (Geography) at secondary school level. I have in this regard attempted as much as possible to incorporate this experience into the instrumentation design.

All questionnaires provided three sections to complete: demographic detail, attitudes towards science, and conceptions of weather. The purpose of the questionnaires was to elicit information regarding the learners' views about meteorological science in geography and processes with specific reference to cold fronts in the Western Cape, South Africa. Section one are for the learners' personal data, two and three are for the learners' responses, attitudes about science and traditional weather forecasting content knowledge respectively.

Demographic Profile of Learners

Section A of the learners' questionnaire collected information relating to their demographic profile. The information was gathered under the assumption that such pieces of information might elucidate the learners' responses to the various instruments. For qualitative analysis, the personal data of learners helped in tracking down the subjects for purposes of interviews and to obtain correlations between their responses and their bio-data.

Table 3.4 below compares the profile of the learners in both groups. This was to further corroborate my assumptions about their comparability of backgrounds. The table shows that both groups have Afrikaans as the language spoken at home. In the experimental group (E group), 17 learners are comfortable in speaking English compared to a total of 12 learners in the control group (C group). The birth place of the majority of learners in both E (16 learners) and C (10 learners) was urban areas, whilst 1 and 2 learners in each group respectively were born in rural areas. In the E group (13 learners) and in the C group (11 learners) indicated that their parents' place of birth were urban compared to the 7 learners in the E group and the 1 learner in the C group. Both groups have a high representation of family living in an urban location. Table 3.4 shows that the demographic patterns of the two groups are very similar in all respects.

An examination of Table 3.4 below shows that, apart from where learners lived at the time of the study, the demographic profiles and the mobility of the E and C learners were similar. The demographic profiles of the learners showed that 16 (94.11%) learners from the E group were born in urban areas as opposed to 8 learners in the C group. Learners born in urban areas would probably be less exposed to activities practiced in rural areas. Again, it is seen that 2 (11.76%) learners in the E group have permanent homes in the urban areas as opposed to just 3 (25%) in the C group. This implies that, these learners would hardly have reasons to visit the rural areas. For this reason, learners in the control group will probably have an upper hand with regard to traditional information. This claim will be investigated in chapter 4.

TABLE 3.4: DEMOGRAPHIC INFORMATION OF GROUPS (E) and (C)

Demographic Data	URBAN		RURAL	
	E (17)	C (12)	E (17)	C (12)
Place of birth	16	8	1	4
Parents' place of birth	13	11	4	1
Immediate Family in rural areas	15	9	2	3
Home Language	AFR		ENG	
	E (17)	C (12)	E (17)	C (12)
	17	12	0	1
First Additional Language	XHOZA		ENG	
	0	1	17	12

Note: One learner is capable of speaking three (3) languages: Afrikaans, English and Xhosa

Conceptions of Weather (CoW) Questionnaire

The questionnaire was administered in the first week of school, after the 2011 June school holidays. This sought to extract learners' conceptual understanding of weather from mainly a Science – IKS perspective. It was hoped that the information gleaned from this section would help in identifying the science knowledge which might be embedded in IKS. The key questions dealt with the following:

Attitude toward Natural Science

Part 1 of the survey focussed on the learners' perceptions on the **importance of geography** as a subject. This questionnaire consisted of 20 questions or items on what the learner's opinion was on the importance of Geography. Possible answers to an item were on a five point Likert Scale as in table 3.2 below. The learner was asked to read the statement of belief about geography and then tick a relevant box which matched his/her belief. Each item was scaled as in table 3.2 below:
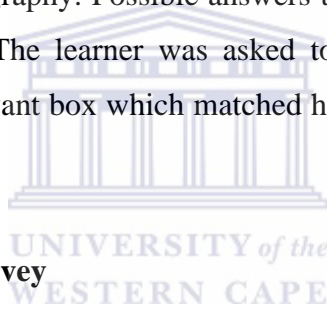
Table 3.2: Likert scale for survey

Level	1 =	2 =	3 =	4 =	5 =
Like-it Scale	Strongly disagree	Agree	Uncertain	Disagree	Strongly disagree

The survey questionnaire had five scales with acceptable reliability: Learning geography as a science (Item 2: Learners are encouraged to participate in classroom activities); Active learning (Item 5: I would like to visit places where I can learn more about the weather and the environment e.g. Weather Stations); Lesson structure (Item 8: Geography lessons are worth the time and effort I put in); Geography knowledge (Item 9: Cold fronts bring much of the rain that South Africa needs'); Importance of geography (Item 13: Knowledge of the environment is important for our survival on earth).

Table 3.3: Learners belief and Assessment scale

Learners Answer	Assessment scale
Strongly agree	The learner's view matches perfectly with the statement given.
Disagree	The learner's view tends to disagree with the statement given.
Agree	The learner's view tends to side with the statement given.
Strongly disagree	The learner strongly opposes the view expressed.

Geography Classroom Environment

Part 2 of the questionnaire looked at learners' perception of their **geography classroom environment**. This section measured the learners' attitudes towards a technology-rich learning environment and how they perceived geography needed to be instructed as a school subject.

This section was administered at the same time as part 1 and consisted of 10 items along the same five point Likert scale: Investigation (Item 2: There are sufficient textbooks and instructional materials for the learning of geography); Organization (Item 4: The geography classroom has a lot of useful charts, maps and many useful learning materials); Satisfaction (Item 6: The geography class is very lively because learners have opportunities to discuss topics about our environment); Open-endedness (Item 9: 'I like working alone while doing my assignments in geography) and Material environment (Item 10: We have no sufficient equipment, tools, maps, atlas, computers, etc. in the geography classroom).

Meteorological Literacy Test (MLT)

Part 3 of the survey questionnaire addressed topics to inform the suitability of learner's **geography knowledge** and the benefits to learning and opinions of weather phenomena. This section also measured the learners attitude towards geography and consisted of 10 items on a Yes, No or Uncertain scale: Global weather knowledge (Item 1: Geography subject can explain Climate Change); Environmental knowledge (Item 4: Geography makes me understand the environment and nature better); Practical knowledge (Item 6: I like the practical part of the geography subject); Geography classroom knowledge (Item 9: I can express my own ideas and opinions in the geography classroom).

3.7 Validation, Reliability and Piloting of instruments

The instruments designed were subjected to validity and reliability tests. The validity and reliability was tested among a group of 26 science experts in the (Science and Indigenous Knowledge Project (SIKSP) at the University of the Western Cape (UWC), South Africa. Rating of all the instruments was also done through the same panel of experts in the SIKSP group. Other colleagues, teachers and experts were asked to provide comments. The instruments were piloted in a neighbouring school, given the pseudonym, "Xample Secondary School". As mentioned earlier, this school was initially planned for the comparison group (C group), but because the principal could not appoint an assisting teacher in due time to administer the intervention, it was used for piloting of the instruments. *Triangulation* was also employed as part of the piloting process. This was used as a means to obtain multiple perceptions on specific questions or issues to clarify meaning and verify the repeatability of the observation or interpretation of the research instruments.

Prior to obtaining parametric statistics that would address the research questions, issues of internal consistency and normality of samples had to be ascertained first. It is good practice to first make sure the instruments that are used for collecting data are valid, otherwise statistical results obtained will be unreliable (Diwu, 2010). With regard to normality of a sample, some statistical techniques were based on certain assumptions. These assumptions dictate that prior to the use of that particular statistics, the appropriate assumptions be borne in mind. All parametric statistics are sensitive to how scores of a particular sample are distributed around the sample mean. When low and high scores are equally distributed around the sample mean, then that sample is said to be normal. The Kolmogorov-Smirnov normality test is used to give a measure of how much significant the normality of a particular sample is. In terms of the Kolmogorov-Smirnov statistics, when significance values than are greater than 95% or p values less than 0.05, the sample scores are said to be normal. Where the sample scores were not normal, non-parametric statistics were employed (Pallant, 2001; Dawson & Trap, 2004; Ogunniyi, 1992).

Statistical techniques that are not sensitive to how data is spread around the mean are termed, "non-parametric". As in the case of the reliability of an instrument, if the wrong statistical techniques are used, the results elicited from that particular statistical method will also be invalid. The following tests were done to ensure that any statistical claims made are valid. While no one instrument is reliable under all circumstances or conditions, the Cronbach alpha values tells how reliable a particular instrument is for general conditions. Likewise, it is very seldom or impossible to get a perfectly normal sample in social science studies. The tests give

tolerance values so that the underlying assumptions stipulated by the statistics intended to be used for the quantitative aspect are not significantly violated (Diwu, 2010: 84).

According to Pallant (2001), the Cronbach Alpha coefficient is the most common used indicator of internal consistency or how each item in a scale correlates with each other in terms of the construct that the scale intends to measure. He therefore, recommends that the Cronbach alpha coefficient should be above 0.7. In the above case, 0.7 represents that the instrument concerned should be reliable 7 times out of 10 or 70% reliable. He also adds that the Cronbach alpha coefficient is very sensitive to the number of items within a scale and cited Briggs and Cheek as recommending a mean of the inter-item correlation of 0.2 - 0.4 in the event that the scale items are under 10 (Pallant, 2001: 11).

Pilot test results

After a careful critique of the instruments and proposals at the Friday seminars, the instruments were given the go ahead to be piloted. After the piloting stage, all learner responses were categorized according to ordinal scales and captured into the SPSS Statistics programme. The reliability tests were obtained by using the Cronbach alpha reliability values as indicated in the above section. The Conceptions of Weather Questionnaire (CoW) obtained an initial reliability value of less than 0.7 for the original 14 items and through an elimination process provided by Statistical Program for Social Science (SPSS) programme, the number of items achieving a reliability of 0.733 became 8. The items selected for analysis were items, 1 – 6, and 8 – 11. All the 25 items in the Meteorological Literacy Test (MLT) achieved the Cronbach reliability alpha value of 0.719 and hence were all eligible for analysis.

Preliminary data of the main study

The survey conducted in the two schools in the area acted as a form of preliminary data gathering to guide the main research study in the right direction. The type of questions that were asked in the survey were aimed to provide the researcher with the possible knowledge on how learners' perceived their immediate school environment as well as their perceptions of the geography classroom setting. These questions ranged from the availability of resources in the geography classroom to their understanding of various terminology and concepts in the geography subject. This information gave the researcher baseline data in setting the level and type of questionnaires for the formal research that followed. All information gathered from the survey was treated as highly confidential and only used for the purpose of this research.

3.8 INTERVENTION: Dialogical Argumentation Instructional Model (DAIM)

Dialogical argumentation, also referred to in this study as the dialogical argumentation instructional model (DAIM), occurs when different perspectives are expressed on a subject with the hope of reaching consensus in the end. The purpose is to persuade others of the validity of the claim through well-reasoned or well-grounded arguments. Through dialogical argumentation learners articulate their "reasons for supporting a particular claim and then strive to persuade or convince" (Ogunniyi & Hewson, 2008) others about the truthfulness of such a claim. Dialogical argumentation provides the critical "environment for learners to externalize their doubts, clear their misgivings or misconceptions, reflect on their own ideas and those of their peers in order to arrive at clearer and more robust understanding of a given topic than would have otherwise been the case" (Ogunniyi 2008).

Outline of intervention lesson content

The intervention took place after school hours to allow the learner the space and time to have their normal contact session with teachers. All the lesson plans and content were designed around the grade 9 syllabus and based on the current CAPS (Curriculum and Assessment Policy Statement) standards. The following were included in the lesson plans and learners were assessed accordingly:

1. Tools for predicting weather the IKS way
2. Know your weather instruments: like rain gauges, barometer, compass, thermometers
3. Record weather data information from various instruments
4. Measuring of weather conditions (temperature, relative humidity, barometric pressure) using various weather instruments.
5. Cultural Weather research
6. Weather sayings: What sayings are still being used or active in the community?

number of periods = 10 (45min sessions)

Lesson Outline

Lesson 1: Introduction

This lesson is an introduction to the weather. Learners will learn the basic difference between weather and climate. Learners will help derive the need for weather forecasting. Learners will learn the historical need for weather prediction. All cultures have developed methods of

translating weather. Locally, the indigenous people have passed down this information through oral history. Learners will make notes based on the oral history document provided in **Appendix H**. Learners will be given other cultural sayings related to weather. Once they have this background, they are ready to start conducting their own weather sayings (sayings about weather perdictions) research.

Lesson 2: Cultural Weather Sayings Research

This lesson directs learners to conduct their own weather sayings research. Learners are guided to look to their family, friends, or other sources to find out cultural weather sayings. Learners will look for specific weather indicators from animals, wind, clouds, and other signs. Learners are encouraged to find and to record their own resources.

Lesson 3: Cultural Weather Sayings Sharing

This lesson is designed to share the learners' research. It will allow learners to share their sources, their knowledge, and to fill in gaps. After the sharing is done, learners will work on a performance task for testing their comprehension of the cultural teachings. Learners will complete the five-day scenario, choose an option, and explain their choice based on what cultural saying they used to make their choice. When they are finished, learners can work in small groups to compare and to share their choices and reasons.
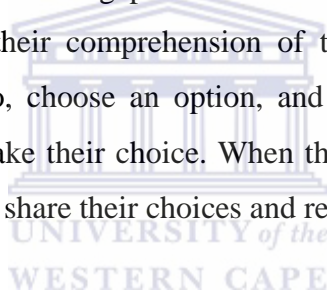
Lesson 4: Weather Forecasting Journal

This activity is to be completed as a performance task to show learners' understanding and application of cultural sayings. This journal assignment can be completed immediately after the introduction activities or it can wait until learners have learned more about modern forecasting techniques. This task takes place over the course of five days as a homework project. It involves the learners in weather observation and data collection. Learners will collect personal weather data (temperatures, wind, clouds, animals, etc.), as well as the meteorological forecast for the day. Learners are encouraged to add weather observations as the day progresses. They are also required to write a summary at the end of the day, discussing how the predictions worked, did not work, and what observations may have been omitted.

Classroom Activities

This series of lessons incorporates **Earth and Beyond** of the foundational objectives from the unit entitled: Core Knowledge and Content of Natural Science: *Earth and Beyond - Intermediate* and Senior Phases – for the CAPS Policy document *Statement*. These lessons examine Indigenous Knowledge Systems (IKS) and cultural perspectives on weather and weather predictions, and are designed to be an introduction to the topic of weather.

Senior Phase – Earth and Beyond (Area 3) / Term 3
Topic - Earth: solar system to fossils

Climate varies in different parts of the globe. It tends to be cold in the Polar Regions and hot in the tropics. Different types of plants and animals are adapted to living in different climatic regions.

Curriculum and Assessment Policy Statement (CAPS) 2011 – Alignment
The following CAPS (2011 :9-13) specific aims where used as guidelines to align and design IKS lesson plans.

Specific Aim 1: Acquiring Knowledge of Natural Sciences
Specific Aim 2: Investigating phenomena in Natural Sciences

Specific Aim 3: Appreciating and understanding the importance and applications of Natural Sciences in society

3.1. Understanding the history and relevance of some scientific discoveries
3.2 Relationship of **indigenous knowledge** to Natural Sciences (Curriculum and Assessment Policy Statement, 2011 :9-13)

IKS Classroom Activities (see APPENDIX E)

For all activities a limit timeframe was introduced to keep the research on track: (Approximately 4 in-class hours, plus an ongoing journal for 5 days)

Indigenous Knowledge and Cultural Weather Perspectives

A few key understandings were taught as indicated below:

- Knowing what the weather would bring was important to those who lived off the land, and is important to a variety of people today.
- All cultures had ways of determining what the weather would be prior to technology.
- Weather patterns can be identified using cultural knowledge as well as by using technology.

Below are some essential questions that were asked to stimulate the learner argumentation on the topic of weather.

1. Why is it important to predict weather?
2. How do we predict weather?
3. How does weather dictate outdoor activities?
4. What is the impact of weather forecasts on various segments of society?
5. What are the essential characteristics of your local weather patterns?

3.9 DATA ANALYSIS

All data was analyzed in terms of statistical correlations between the measured variables. The SPSS and SAS (social sciences statistical computer software) were used to analyse and plot the data statistically. SPSS (originally, Statistical Package for the Social Sciences, later modified to read Statistical Product and Service Solutions) is among the most widely used programs for statistical analysis in social science. The SPPS statistical software program is used by market researchers, health researchers, survey companies, government, education researchers, and others to analyzed research data. The original SPSS manual has been described by Dowling et al. (2010) as 'one of sociology's most influential books'. In addition to statistical analysis, data management (case selection, file reshaping, creating derived data) and data documentation features of the base software and therefore the researcher has chosen SPSS as the preferred statistical analysis program for this study because of its credibility in the social science research.

The data collection for the qualitative design consists of the following:

- Observation of the daily school population, with scheduled visits to classrooms where teachers teach Geography, Natural Science and Life science, to get a background perspective on what it is like to be at the school and inside where learning takes place.

- Learner and teacher views in relation to concepts dealing with meteorological literacy.

- Other techniques such as; questionnaires, interviews, tests, and observations, etc. were also part of the data collection.

3.10 ETHICAL CONSIDERATIONS

A research application letter was issued to the WCED (Western Cape Educational Department) to ask for permission to perform the research study at the selected schools.

A letter of consent was also addressed to the (SGB) School's Governing Body informing them of the research process and obligations of the study where the survey and research will be conducted. A meeting with senior school management of the participating school was held to inform them of all pre-post intervention sessions to be conducted. A detailed timetable with schedules for classroom observation and group intervention sessions was submitted to the principal's office.

All participating schools are entitled to a summary of the research study that was conducted for future organizational and curriculum planning. All participating learners will also be informed of the implications of the study and how the data was analyzed and interpreted, and for which purposes. A Letter of consent was signed by parents of all underage participants in the research study. All students were also informed of their rights and obligations within the research process.

Ethical checklist

The following ethical checklist was followed to ensure that the study conformed to the ethical standards laid down by the Senate Research Committee of the University of the Western Cape:

- The principals' permission letters from the two schools was sought (APPENDIX A1).

- Permission to conduct the study was sought from the research department of the Western Cape Education Department (WCED) - (letter is attached as APPENDIX A2)

- The purpose of the study was explained orally and in writing to all participants involved in the study.

- Teachers and learners consent was also sought after.

- All interviews were strictly confidential and a confidentiality letter was written to the schools concerned.

- Learner questionnaires are anonymous.

- Names of schools will be kept anonymous and no information about the schools or learners will be divulged to any person.

- At the end of the study the school principal concerned received a summary report of the findings of the study conducted in his/her school.

- Consent Letter - A copy of the consent letter (APPENDIX F) is attached.

The ethical issue of accessing traditional knowledge from religious groups

Of the 17 members in the experimental group, 3 belonged to the Moslem faith and the rest, 14, were of the Christian faith. It was explained to them in the interest of the research that both religious faiths would have equal rights and opportunities to share their ideas and to give input to support the study in accessing traditional knowledge. It was explained that each religious faith has its own cultural ways of looking at weather phenomenon and predictions.

The following example was given to explain different cultural perceptions and inheritance on the weather phenomenon: Moslem religious members look for a 'new moon' occurrence to start off the celebrations of the Moslem New Year "Eid Mubarak" which normally happens after the long fast period known as 'pwasa' (a month long religious engagement with little or no food during the day). On the other hand, fishermen and members of the Christian faith use the 'position and size of the moon' to judge high and low sea tides for perfect fishing weather and conditions. Both religious group members felt at ease with the examples given and agreed to willingly participate and share in the interest of the research process.

CHAPTER FOUR: RESULTS AND DISCUSSION

The purpose of this chapter is to present and discuss the results from the empirical study. The reports and analysis of the results are formulated around the research questions of study. The structure for the analysis is to first give the qualitative data followed by the quantitative data, and a brief summary. As mentioned earlier the main purpose of the study is to investigate the effectiveness of an Argumentation-based (A-B) instruction in enhancing grade 9 learners' understanding and awareness of weather patterns and selected meteorological concepts. This chapter will focus on and investigate the importance of meteorological literacy and how it affects the learners' performances in (1) meteorological literacy (MLT) science achievement test, and (2) the conceptions on weather (Cow) attitudes test, towards the current CAPS (2011) policy statement of the Department of Education in South Africa.

A related focus point of this study is to determine the learners' understanding of weather and climate phenomena and how they interact with these phenomena. A further emphasis is placed on how learners perceived and interpreted these selected meteorological conceptions towards the current natural science school curriculum. The study also envisage to make learners aware of the importance of indigenous knowledge for weather predictions and how it could help them in understanding the immediate weather conditions or patterns around them.

4.1 RESEARCH QUESTION 1 (RSQ1): What meteorological concepts do grade 9 learners hold?

In order to address the above research questions, the results of the learners' pre-test and post-test conceptions of weather were tabulated. The results in table 4.1 below were obtained by using the Wilcoxon Signed Rank test for comparison of pre-test and post-test results for each group.

What meteorological concepts do grade 9 learners hold before and after the DAIM.

An examination Table 4.1 shows that in the pre-test the E-group scored a mean value of **18.88** and the C-group scored a mean value of **14.33** respectively. The mean rank scores of **18.88** and **14.33** had standard deviation scores of **3.3** for the E group and **4.39** for the C group which was more than the **t-critical** value of **2.052** for all 4 items in question. A non-significance results of **t = -7.62** and a **p = 0.09** was obtained. This result also confirms that the two groups were indeed comparable. For item 1 (Q1) both groups scored the almost the same scores, the E group scored a mean value of **6.5882** with a standard deviation value of **2.3468** and the C group scored a mean value of **5.7500** with a standard deviation value of **2.8324** at the end.

TABLE 4.1   Learners' pre-test and post-test means scores on conceptions of weather

ITEMS	GP	PRE	POST	Median	Std Dev
All 4 ITEMS	E	**18.88**	29.87	19.00 (30.50)	**3.3** (4.28)
	C	**14.33**	15.45	15.50 (17.00)	**4.39** (3.72)
BTWN GRPS SIG. **t-ratios (df=29)** **T-crit = 2.045**		0.09 -7.62	0.9257 1.7665	**2-tailed Test, critical value =2.052 at df = 27** **(Both pre-post –test analysis for both groups)**	
ITEM	GP	PRE	POST	Median	Std Dev
1. Weather Instruments	E	6.58	7.50	6.0 (8)	2.34 (1.7)
	C	5.75	6.36	6.50(6)	2.83(2.50)
2. Geography science concepts	E	4.88	5.06	5.0 (5.0)	1.21 (1.06)
	C	3.91	3.45	4.0 (4.0)	0.99 (1.36)
3. Cold Fronts patterns	E	2.35	3.18	2.0 (2.5)	1.11 (2.07)
	C	1.83	2.18	2.0 (2.0)	1.26 (1.47)
4. Indigenous Knowledge on weather	E	5.05	14.12	6.0 (13.0)	3.32 (3.22)
	C	2.83	3.45	2.0 (3.0)	3.12 (2.42)
N = 27, t-ratios (df=25) , T-critical value = 2.052, Alpha value is 0.05					

Conceptions of weather from high school attitudes survey

The results from the high school survey were used to give the study some background information and some indication on learners' attitudes towards meteorological science. The results from this survey indicated that both boys and girls that completed the survey had different perceptions and attitudes towards weather, especially when it came to the understanding of how cold fronts in the Western Cape relate to and affect the weather of this area.

Table 4.2: Learners' pre-test mean scores on items categorized according to geography reasoning

KNOWLEDGE OF GEOGRAPHY INSTRUMENTS	MEAN RANK	IKS WEATHER FORECASTING KNOWLEDGE	MEAN RANK
1. Weather Instruments	**E = 6.58** C = 5.75	4.Indigenous Knowledge on weather	**E= 5.05** C= 2.83
t-ratio at alpha = 0.05	**-0.763**	t-ratio at alpha = 0.05	**0.282**
2. Geography science concepts	**E= 4.88** C= 3.91	3. Cold Front patterns	**E=2.35** C= 1.83
t-ratio	**-1.693**	t-ratio	**-6.291**
Alpha value is 0.05, t critical = 2.052 with df =27			

The items in table 4.2 require a good understanding of weather related geography knowledge as well as what type of instruments can be used to determine certain weather conditions. Items 1 (Weather instruments), 2 (Geography science concepts) 3 (Cold fronts patterns) and item 4 (Indigenous Knowledge on weather) were of importance here to evaluate if learners' understand the current geography curriculum knowledge of the grade 9 school curriculum syllabus. Sections 1 and 2 required that the learners show that they can relate to what type and kind of instruments can be used to determine immediate weather conditions although they had not been exposed to home use of weather instruments before. Learners also indicated that their only knowledge of such weather instruments came from text books and pictures and that they had never had the opportunity before to view them in real life situations and discussed their proper functions.

In research question two (RSQ2) a more detailed analysis will follow on some of the excerpts from learners' responses to item 1. However, not being exposed to weather instruments before did not seem to influence their knowledge of how these instruments relate to weather observations in and around the home environment (Table 4.2). Some learners gave meaningful answers as in the following excerpts below:

Item 1: Which of the instruments shown above would best measure each of the following conditions. Give reasons for your answer:

_____ a) 20mm rain fall on a specific day.

Give reasons: _____ (see Appendix D)

Written responses of learners:

Learner E 012: Answer to item 1 (a) : *"Rain gauge"*

Reason: *"It show how many rain will fall on that day"* (direct translation)

Although learner E 012 does not go into much detail about measuring rain on a specific day, the main thing is that, the learner understands which instrument is best used when it comes to measuring rain fall. Most of the learners in the E group gave such vague and partial answers. Below are two excerpts from C group learners to the same item: (direct translation)

Learner C 006: Answer to item 1 (a): *"Rain Gauge"*

Reason: *"because a rain gauge is for the measure of the rain"*

Learner C 008: Answer to item 1 (a): *"Rain Gauge"*

Reason: *"Many people say it like – my elbow is full pain. It massure the water"* (direct translation from learner script)

(Somehow the learner unknowingly brings in a little bit of **IKS** knowledge)

In addition to what Learner E 012 indicated, learner C 006 highlighted the fact that a rain gauge is used to measure rain fall, showing a clear understanding of what is being asked in item 1. On the other hand learner C 008 gives an indigenous knowledge (IK) view/way of how "an elderly person with joint pain" would know if it will rain soon during winter time. Without knowing learner C008 presented an answer that links up with indigenous knowledge (IK) on how to predict weather (see APPENDIX D, activity 2). The general observation after analysing learner C008's reason to item 1 indicated that somehow the learner had an already existed form of indigenous knowledge (IK) before the pre-test was administered. With a follow up interview with learner C 008 it was concluded that he "overheard some elder family member mention it" in a conversation at home. This specific answer from learner C 008 alerted the researcher of the possible indigenous knowledge systems (IKS) that are somehow still alive in the community where the research was conducted and could easily be tapped into

if approached positively. The initial plan of the research was however to promote the use of IKS knowledge in understanding meteorological science concepts in the geography classroom.

If we look at the respective mean rank scores of both groups, a **6.58** mean rank for the E group and a **5.75** mean rank score for the C group on item 1 was obtained, putting the two groups in close proximity on weather instrument knowledge levels. Although 4 learners in the C group and 2 learners in the E group left blank spaces in response to their answers, the mean rank differences of **0.83** for item 1 was a minor difference in terms of their significance. Furthermore, both groups gave positive answers indicating that their current knowledge on weather instruments is in line with the National School Curriculum (NSC), Natural Science syllabus, grade and age.

In item 2 (Geography science concepts) a good geography understanding in concepts is required to complete statements as true. The mean rank score of **4.88** for the E group and **3.91** for the C group were the second lowest of all 4 items with a mean difference of **0.97** between the two groups. In this section it is required of learners in both groups to select a word from a given list that will make each of the eight sentences a true geography statement. In a general observation of learners' pre-test scripts it was noticed that the learners do not read and understand the questions correctly, resulting in them giving wrong answers. This was picked up in the focus group interviews (FGI) held with the E group learners. Most of the learners in this group could relate to or give correct answers when asked the same question in verbal or dialogue format, showing a lack of understanding when reading the same question. Learner E 005 replies: (direct translation) *"ek weet nie altyd wat ek lees nie"* (meaning: I do not always understand what I'm reading), when asked if they understood all the pre-test questions of the MLT test.

For item 3 (Cold fronts patterns) and item 4 (Indigenous Knowledge towards weather) the focus shifted in the pre-intervention stage, on how much home knowledge the learner has currently acquired in order to complete the task at hand. The items in 3 and 4 had focused on the learner home knowledge that they bring to school or to the classroom.

Summary on research question 1 (RSQ1)

After the pre-test quantitative data were statistically analysed (table 4.2) it was evident that the two groups were indeed similar in terms of their conceptions of weather instruments and geography concepts. Also, the quantitative data showed that the two groups had a conceptual degree of understanding on the usage of various different weather instruments. These also indicate that learners were exposed to science/IKS knowledge without realising it. According

to Jegede (1996) these every day experiences can be termed indigenous knowledge systems (IKS) (Jegede, 1996). Another interesting finding has been the low performance level of both the E and C groups on item 4 (Cold front patterns). This could be the result of very little exposure to weather related phenomena in their own surroundings. Although cold fronts with their associated weather patterns are a natural and familiar occurrence in the Western Cape region during winter months, some learners still struggle to grasp this concept.

A variety of weather measurement instruments such as: barometers, temperature meters (Minimum and maximum), hygrometers, oil damped compass, plastic garden rain gauge (see Appendix D) were taken to class and used in conjunction with the DAIM lessons. These instruments were put on display at the beginning of the session and each group had to identify a chosen item, give a brief description and explain to other groups their common usage. This engagement stimulated the intervention process amongst the groups. Although learners indicated that they were never introduced to IKS at school level their inputs and comments during the intervention period were valid and striking. Some groups responded that IKS knowledge is only present in the minds of the elders in the community and that they as youngsters would like to learn more about IKS. Some learners even indicated that their grandparents still talk about some of the 'old ways' of doing things without the use of current technology. This laid the basis for further engagement with the experimental group. They were also made aware that IKS is not widely documented or very little literature is available on the local IKS in this specific area.

In conclusion, since indigenous knowledge systems (IKS) form part of the new Curriculum and Assessment Policy Statement (CAPS) for Grade R-12 and according to specific outcome 3.2, it is imperative to address the inclusion of IKS orientated materials, resources and instructional methods. Thus, the DAIM method can only benefit and assist the teaching strategy to enhance learner's current understanding of meteorological science concepts.

4.2 RESEARCH QUESTION 2: Are grade 9 learners' meteorological conceptions related to their age, class or gender?

Not much analysis can be drawn from the limited amount of subjects with very little variety in class, race and language differences. All the subjects mostly came from the same community and had an almost even gender representation in both groups. Table 4.3 represents statistics that compare the various differences in both (E) + (C) groups according to their gender, religion, race and language.

TABLE 4.3: Overall Chi-square results for comparing groups

Chi-Square STATISTIC	DF	VALUE	P-VALUE
Gender	1	2.6729	0.1021
Age	1	0.2246	0.6356
Religion	1	0.1134	0.7363
Race	1	0.1037	0.7475
Language	1	0.1037	0.7475
N=29, Critical t-value = 2.045, Alpha = 0,05			

Based on the Chi-square test, the two (E) and (C) groups do not differ significantly on gender, age, religion, race or language according to the p-values.

The researcher also notice in this case that using an analysis of covariance and including 'gender' as a factor, 'gender' is not a significant predictor of post-scores (p=0.56)

Learners' interrogation on the COW questionnaire.

In the first week of the third term after the June school holidays the learner survey and CoW (Conceptions of Weather) instruments were administered to twenty (20) grade 9 high school learners. An even gender ratio of 10 males and 10 females were present when the survey was administered. These learners were randomly selected and under no obligation to take part in the survey, it was a voluntary decision to be part of the study that was conducted during two separate first interval school breaks with no disturbances caused to the school academic time table.

The survey was the first to be administered because it was set up to test the perceptions of learners towards geography. The second to be completed was the COW which tested the learner's conceptions of weather. The two instruments were administered one week apart from each other.

- For the purpose of the COW the same grade 9 group of learners from the same public high school (called school "X" for now) was selected. The school is situated in a socio-cultural and economic disadvantaged area. Participants range from 13-18 years of age.

The group was selected on the basis of comparability with respect to: Learners doing the same subject and taught by the same geography teacher

- Formal class test and reports
- And learners from within the same socio-cultural and economic background

Table 4.4: Boys and Girls MLT Mean score per group

Experimental Group	Variable	N	Mean	Median	Std Dev	Minimum	Maximum
Girls	Pre-test	10	19.4000	19.5000	4.0879	11.0000	25.0000
	Post-test	9	30.0000	31.0000	4.6797	20.0000	35.0000
Pre-post differences		*9*	*10.3333*	*10.0000*	*3.2787*	*6.0000*	*16.0000*
Boys	Pre-test	7	18.1429	18.0000	1.7728	16.0000	21.0000
	Post-test	7	29.7143	29.0000	3.9461	26.0000	36.0000
Pre-post differences		*7*	*11.5714*	*10.0000*	*4.4668*	*8.0000*	*18.0000*
t-value = <.0001 Alpha = 0.05	Pre-post scores: Girls & Boys combined	16	10.8750	10.0000	3.7572	6.0000	18.0000

Control Group	Variable	N	Mean	Median	Std Dev	Minimum	Maximum
Girls	Pre-test	3	12.0000	9.0000	6.0828	8.0000	19.0000
	Post-test	3	17.6667	17.0000	1.1547	17.0000	19.0000
Pre-post differences		*3*	*5.6667*	*8.0000*	*6.8069*	*-2.0000*	*11.0000*
Boys	Pre-test	8	15.5000	16.5000	3.8914	7.0000	20.0000
	Post-test	7	135714	13.0000	2.9921	10.0000	18.0000
Pre-post differences		*7*	*-1.7143*	*-2.0000*	*4.3480*	*-7.0000*	*4.0000*
t-value = <.0001 Alpha = 0.05	Pre-post scores: Girls & Boys combined	11	1.3636	-2.0000	6.3446	-7.0000	11.0000

Table 4.5 below gives a summarised overview of the background information of participants

Table 4.5 Biographical summary of the participants.

	Girls	Boys
Participant s (N)	10	10
Grade	9	9
Age range (years)	13-15 yrs. (7)/ 70%	13-15 yrs. (8)/ 80%
	16-18 yrs. (3)/ 30%	16-18 yrs. (2)/ 20%
Home Language	Afrikaans (10)	Afrikaans (10)
Moslem religion	20% (2)	20% (2)
Christian religion	80% (8)	80% (8)

All the learners' that participated in the survey and COW-test came from the same community. The learners belonged to two different religious faiths namely the Christian religion and Moslem religion. I have noted that the Christian faith has a bigger representation than the Moslem faith in the selected school where the study was conducted. This religious representation also filters through within the community itself. The most commonly used language is Afrikaans for those who have participated in this study. English is a second language school subject and all participants had a good command of English when the survey and COW-test was administered for the research. Both male and female subjects represented a wide age range between 13 and 18 years old. The age range of 13-15 years was represented by 70% and 16-18 years was represented by 30% of the female participants. On the other hand the age range for the male participants was almost a similar number, and 80% represented the 13-15 years age range, while 20% represented 16-18 years of age.

Conceptions of Weather (CoW) Questionnaire

Quantitative research methods were introduced in the form of a Conceptions of Weather (COW) questionnaire consisting of concepts dealing with meteorological literacy and IKS aspects for learners.

Table 4.6: Likert-scale with reason for answers

Strongly Agree   Agree   Disagree   Strongly Disagree

Reason: ....

Source of information: Science, Religion, Personal View and Cultural View

Table 4.7: Sample questions used in COW-test

Order of Questions	Conception of Weather (COW) questions
1.	Learning geography through school science is interesting..
2.	Using my indigenous knowledge to learn geography helps me to understand weather better.
3.	I can use what I learn in a geography class at home and in my community.
4.	I believe more in my indigenous knowledge than geography knowledge to understand the weather.
5.	I am only interested in geography to pass my exams.
6.	There is a relationship between what I learn in geography and weather patterns.
7.	Cold fronts and bad weather (like heavy rain and strong winds) are caused by witches and traditional.
8.	It is not necessary to protect yourself from bad weather, because it cannot kill you.
9.	Geography explains the effects of cold fronts better than what I learn from home.
10.	When cold fronts appear in the Western Cape we should be aware of bad weather patterns and heavy rain.
11.	Without cold fronts Western Cape will be dry like the Kalahari Desert.
12.	Cold fronts show that the sea gods are happy with us.
13.	Unless we stop cutting down the trees and burning the veldt the rainfall received will fall drastically.
14.	There is a relationship between global warming and increased flooding and too much carbon dioxide from the industries.

Results and Findings of COW

The report of results is in the context of the original questions, and combines the descriptive data with survey data. Where survey and descriptive data (pre-test) were noted, the CAT was applied to describe the type of findings.

This questionnaire was administered two weeks after the survey questionnaire was completed. The same group that completed the survey completed the COW-test.

Note: (1) Each question asked contained a liket scale with a reason for answer as indicated below (2) Questions 6-10 did include a source of information choice (see below). This source of information was used to analyse and code learners' responses either into a Science World View (SWV) or the Indigenous Knowledge Science World (IKSW) view on their beliefs.

During the COW-test the following was noted: learners have little knowledge about IKS and the impact that it has on the global community. Very little indigenous knowledge was used at home by parents and other family members. If any IKS knowledge was used in daily traditions it was never noted by the elders and others that it belonged to a cultural system of IKS. This made it very difficult or even impossible for learners to get acquainted with what is cultural knowledge or IKS when answering the COW-test.

Much of the traditional/cultural knowledge is derived from elders in the communities. Some of the traditional knowledge made its way to present day situations through stories and folk-lore that was passed on through traditional dances, song, rituals and other cultural engagements like community festivals, weddings, prayer meetings and seminars.

A total of 20 subjects from the E and C group completed the COW (Conceptions of Weather) questionnaire.

Non-Parametric presentation of COW results

In this study it is important to note the performances of learners based on their conceptions and beliefs towards weather related issues. Although table 4.8 presents data in a *nominal* and non-parametric test way it is important in terms of educational value to test and measure the findings of how well learners perform in terms of their conceptions in the COW test. Other forms of non-parametric testing like sign test, median test, chi-square, Wilcoxon Scores (Ranks Sums) for variables in pre-post test and Mann Whitney U test are used throughout this chapter to illustrate and present various stages of findings in the study.

Table 4.8: Non-Parametric 'Like-it' scale overall results of COW questionnaire

Nominal scale	1	2	3	4	Total
Like-it Scale	Strongly disagree	Agree	Disagree	Strongly disagree	
Boys Beliefs (%)	15.71	40.71	34.29	9.29	= 100 %
Girls Beliefs (%)	28.57	42.15	17.14	12.14	= 100 %
Total %	44.28	82.86	51.43	21.43	(200) / 2 = 100%

Table 4.8 above presents a *Nominal* type (Ogunniyi, 1984) of measuring scale to illustrate the different beliefs of the learners towards their conceptions of weather. The numeric number is used as a class label with a qualitative property attached. This nominal measuring amount is also used to assign a number to present the *amount of a property* possessed by the belief or views of learners'. The term property simply means the characteristic of the...event in question (Ogunniyi, 1984). In this case the event is 'like it' choices of answer towards the questions in the COW test questionnaire.

In examination the overall results of the conceptions of weather (COW) test questionnaire in table 4.3 one can draw the conclusion that the answers from learners display a more positive and inspired view on the nominal scale 1= Strongly Agree (44.28%) and nominal scale 2 = Agree (82.86%) then disagree, nominal scale 3 = (51.43%) and nominal scale 4 = (21.43%) respectively on the original questions that were administered to them in the CoW test. On item 1 'Learning geography through school science is interesting.' the response count between boys and girls were surprisingly low. Only two boys (20%) and two girls (20%) agreed with the statement that they find 'geography interesting'. This claim can be supported by reasons given by learners' why they chose to agree or disagree in the following excerpts:

On item 1: some boys (2) responded (direct translation used)

> L1: Because there is a lot of stuff to do and to learn about.
> L3: Because I don't like it and I don't no what to do when the teacher give
>   the class to me.

Learner L1 is saying that the geography subject has too many complicated sections to deal with, and alert that it is difficult to deal with subjective learning material that you do not

understand. He also finds it complicated to handle all the various concepts within the geography subject. For L3 being in the geography classroom and in the presence of other learners, besides his subject teacher, is in itself just too much for him to deal with cause he does not like geography as a school subject at all.

On item 1: some girls (2) responded (direct translation used)

L10: The teacher doesn't make it interesting but I make it myself, sometimes he makes it interesting.

L12: The children in class makes it not easy to understand the teacher.

The excerpts below are representative of the learner's responses (direct translation) to certain items in the CoW questionnaire:

No connection between IKS and weather related geography, although 80% (16) agree that using IKS to learn geography can help understand the weather better. Out of the 20 participants only 6, three girls and three boys responded to their choice of answers.

On Item 2: some girls (3) responded:

L8: I don't always know what the weather would be.

L9: To know everything about the weather is better than to understand that.

L10: Sometimes I'm wrong but it help a little with geography.

On Item 2, some boys responded:

L15: No, if you don't know geography how can you understand the weather.

L16: Yes, it show all the countries and show the weather.

L18: To know what is going on with the weather.

On Item 4 the girls (2) responses were:

L18: It's not the same every time.

L10: I don't believe in both.

On Item 4 boys (3) responses were:

L16: It shows on the news what is the weather going to be.

L18: Their knowledge is better than ours.

L20: Because indigenous knowledge will not show you about the weather.

Findings on COW questionnaire

Among others, the excerpts above suggest that most learners were never exposed to IKS in the field of geography and that there is no connection or relation between IKS and their understanding of weather phenomena.

Not all learners completed the response section, and this resulted in less than half of the total questionnaires that were administered being fully completed. This also reflected that the learners did not show interest in reading and making time to answer questions properly. The lack of interest shown in many of the completed questionnaires leads to the impression that most of the learners are not geared up with geography and the impact it has on their daily lives.

Out of the 14 items that were presented in the questionnaire only 2 were fully answered by all participants. Most of the reasons given to the items do not relate to the choice of answer from the Likert scale. For example, answer given by L01, such as "I don't like the stuff" to the item 1 question, which was: "Learning geography through school science is interesting.". Such answers clearly indicate the lack of exposure towards IKS. Distorted perceptions and conceptions towards geography as a subject can be picked up in many of the remarks that were given by the learners. This indicates that our education system needs to expose IKS to learners otherwise we will lose valuable cultural information. There is no connection between IKS and weather amongst both girls and boys. One can clearly see that IKS is viewed as adding little value to their social science knowledge.

Summary for research question 2 findings

Geography is not a favourite subject at their school, because of the lack of resources. Most of the learner's current knowledge on weather and the environment are derived from school knowledge with very little knowledge gleaned from an indigenous knowledge perspective. In fact some learners have never heard of IKS. Some even mentioned that they had never encountered the term IKS. Teaching strategies should be initiated that showcase the importance of tapping into indigenous knowledge for easier and more relevant consumption of geography concepts.

4.3 RESEARCH QUESTION 3: What are grade 9 learners' ideas and attitudes towards their environment?

To answer research question four (RSQ4) the high school survey (HSS) questionnaire data (APPENDIX B), conceptions of weather (CoW) questionnaire (APPENDIX C) and the

meteorological literacy (MLT) test (APPENDIX D) pre-post test results were used. Both the high school survey (HSS) and conceptions of weather (COW) questionnaire were administered in the beginning of the research before the intervention stage. The data MLT test was designed as a pre-post test instrument before and after the intervention stage. The high school survey supplied the researcher with valuable background information and data to compare the learners' attitudes towards their own school and home environments after the study. The MLT results assisted me to unpack the qualitative findings of the other two (HSS and CoW) instruments and also to validate the responses given by the (E) group learners. In figure 5 below is a scatter diagram illustration of the pre-post-test scores for both (E) and (C) group learners' performances before and after the dialogical argumentation instructional (DAIM) intervention model.
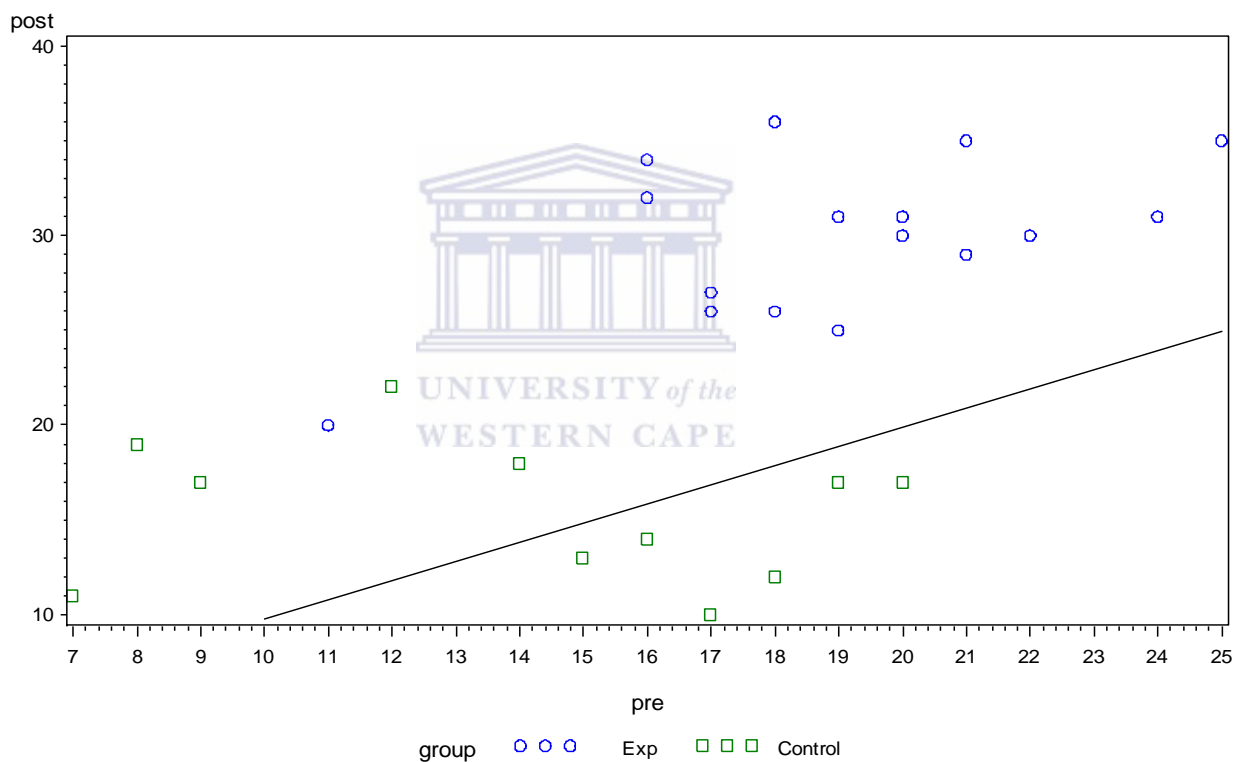
Figure 5: Scatter diagram of Pre-Post test scores for E and C group (Identity line shown for reference)

Scatter Diagram

An examination of the scatter diagram figure 5 gives us a visual impression of correlation between the two groups. The circles marked as (o) represents the experimental (E) group and the square marked as (□) represents the control (C) group in the pre-post meteorological literacy (MLT) test. The line (identity line) represents the base line scores for each pre-post test score. If the placement of either the square (□) or circles (o) appears to be on the line, we

can assume that the performance in the pre-post test scores were the same for both tests before and after the intervention took place. The pre-post test scores were plotted against each other to get the pictorial representation of the relationship between the pre-test scores (x-scores) and the post-test scores (y-scores).

Analysis of Scatter Diagram

The visual impression of the E group shows a more positive correlation as to the negative correlation of the C group between the two tests. The E groups (circles) are all plotted above the identity line (base-line) towards the far upper right-hand corner, as to the C group (squares) that are plotted, some below the identity line and some to the lower left hand side of the scatter diagram. This gives us a rough idea of the performances of learners' in both groups in relation to their pre-post test scores. We can conclude by saying that the E group has a positive correlation with a better visual representation than the C group with its scattered and negative correlation representation. Both E and C groups showing different types of correlation (figure 5) means that either groups end up with a different end results in both pre-post achievement tests, and could be as a result of the intervention that was applied only to the E group and not to the C group as such. I will discuss the pre-post test analysis (RSQ3) in the sub-headings to follow.
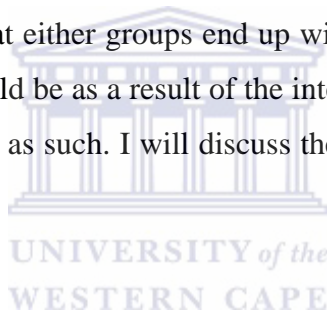
Variability and Standard Deviation:

The standard variability test was applied to show a central tendency of the (spread) variability of the scores in the above scattered diagram (figure 5). I have also made use of the most commonly used measure of variability known as the standard deviation value. The standard deviation was computed by following the steps as indicated by Ogunniyi (1992: 29).

1. *Subtracting the means from each score,*

2. *Squaring these differences,*

3. *Summing up these squared differences,*

4. *Dividing the sum obtained by the total number of scores in the distribution, and*

5. *Finding the square root of the resulting sum* (Ogunniyi, 1992).

For purpose of this research study, calculating the distribution of scores, the following computed formula was applied as shown in figure 6 below:

$$Variance \text{ or } S^2 = \frac{\sum x^2}{N-1} - \frac{N(\bar{x})2}{N-1}$$

Figure 6: Computed formula for variance (Ogunniyi, 1992)

In this case the $\sum x^2$ represents the total sum of each score squared; $\bar{x}$ is the mean, N is the total number of scores and $N-1$ is the total number of scores, minus one degree of freedom. According to Ogunniyi (1992) this "formula is easy to compute and is not biased as the definitional formula".

A computational formula was used for standard deviation as shown in figure 7 below:

$$Standard \text{ deviation or } S = \sqrt{\frac{\sum x^2}{N-1} - \frac{N(\bar{x})2}{N-1}}$$

Figure 7: Computational formula for standard deviation (Ogunniyi, 1992)

In the light of the above I have 'used the two formulas to compare a set of scores…' from my research results and found it '…quite convincingly that the standard deviation is a useful technique for determining the degree of variability (Ogunniyi, 1992). Like the mean, the standard deviation is an average of the distance between the individual scores and the mean of that distribution. The bigger the standard deviation, the more the variability and vice versa' (Ogunniyi, 1992: 30).

Analysis of pre-post-test scores using a scatter diagram

In examining the scatter diagram (figure 5) it also represents the overall pre-post test scores of both groups after the dialogical argumentation instructional model (DAIM) intervention process was completed. The right side (y-score) of the table indicates the post-test scores while the baseline (x-score) represents the pre-test scores marks out of 50 points. The straight line (identity line shown for reference) indicates an equal mark out of 50 points for both pre-post test scores. In the E group 16 learners were exposed to both pre-post test and are situated in the upper right corner of the table. This position on the table indicates that the learners from the E group obtained an mean value of 18.88 in the pre-test and a mean value of 29.8750 in the post-test with a mean value difference of 10.8750 between pre-post test with a standard deviation of 3.7572.

In the C group 11 learners were exposed to both pre-post test and are situated in the lower left corner of the table. The position on the table indicates the C group learners obtained a lower

baseline score in the pre-test, and below average scores in the post-test as well. The C group pre-test mean value was 14.333 and in the post-test a mean value of 15.4545 with mean difference of 1.3636 between pre-post test scores with a standard deviation of 6.3446. This table shows that the E group learners' performance improved with a mean 10.8750 difference. And the C group learners' performance improved with a mere mean difference of 1.3636 value. The E group difference between the two mean values indicate that after the DAIM was administered their performance improved from a pre-test mean of 18.8824 (37.76%) to a post-test mean value of 29.8750 (59.75%) with an overall increase of 21.99 % in their performance. Furthermore, the C group difference between the two mean values indicate that after the pre-post test was administered (without the DAIM intervention) their performance almost remained the same from a pre-test mean value of 14.3333 (28.66%) to a post-test mean value of 15.4545 (30.90%) with an overall improvement of 2.24% in their performances.

It would be naïve not to acknowledge that the improvement of the E group was due to the intervention that was administered to the experimental group after the pre-test. Otherwise, the effectiveness of the dialogical argumentation instructional model (DAIM) had a positive effect on the learners' overall performances after the pre-post MLT test was administered to the E group learners. In tables 4.8 and 4.9 are the respective tabulated results from both the E and C groups' pre-post-test scores.
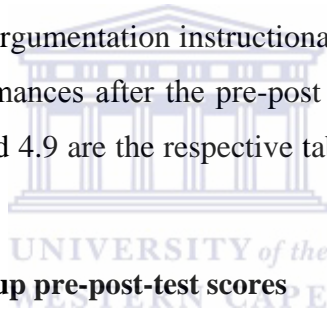
TABLE 4.9: Experimental group pre-post-test scores

E GROUP	PRE-TEST	POST-TEST	PRE & POST DIFF
MEAN	18.8824	29.8750	10.8750
SD	3.3144	4.2876	3.7572
t-TEST: N = 15, Critical t-value = 2.131, Alpha = 0.05			

TABLE 4.10: Control group pre-post-test scores

GROUP (12)	PRE-TEST	POST-TEST	PRE & POST DIFF
MEAN	14.3333	15.4545	1.3636
SD	4.3970	3.7246	6.3446
t-TEST: N = 10, Critical t-value = 2.201, Alpha = 0.05			

Quantitative analysis for research question 3 results (RSQ3).

Why use a coding structure analysis

The use of a coding structure to analyse the studies qualitative data correctly came as a suggestion from SIKSP (Science Indigenous Knowledge Systems Project) group members at University of the Western Cape and were based on the Miles and Hurberman (1994: 12) approach or framework for qualitative data analysis labelled as 'transcendental realism' (Punch, 2009). A new coding structure design emerged (as in figure 8 below) using the 'transcendental realism' approach with its three main components of data analysis. Based on the interactive model from the Miles and Hurberman (1994) framework which helped in the analysis of the qualitative data for research question three (RSQ3) in three main components, namely (1) data reduction (2) data display (3) drawing and verifying a conclusion from the data (Punch, 2009:174).
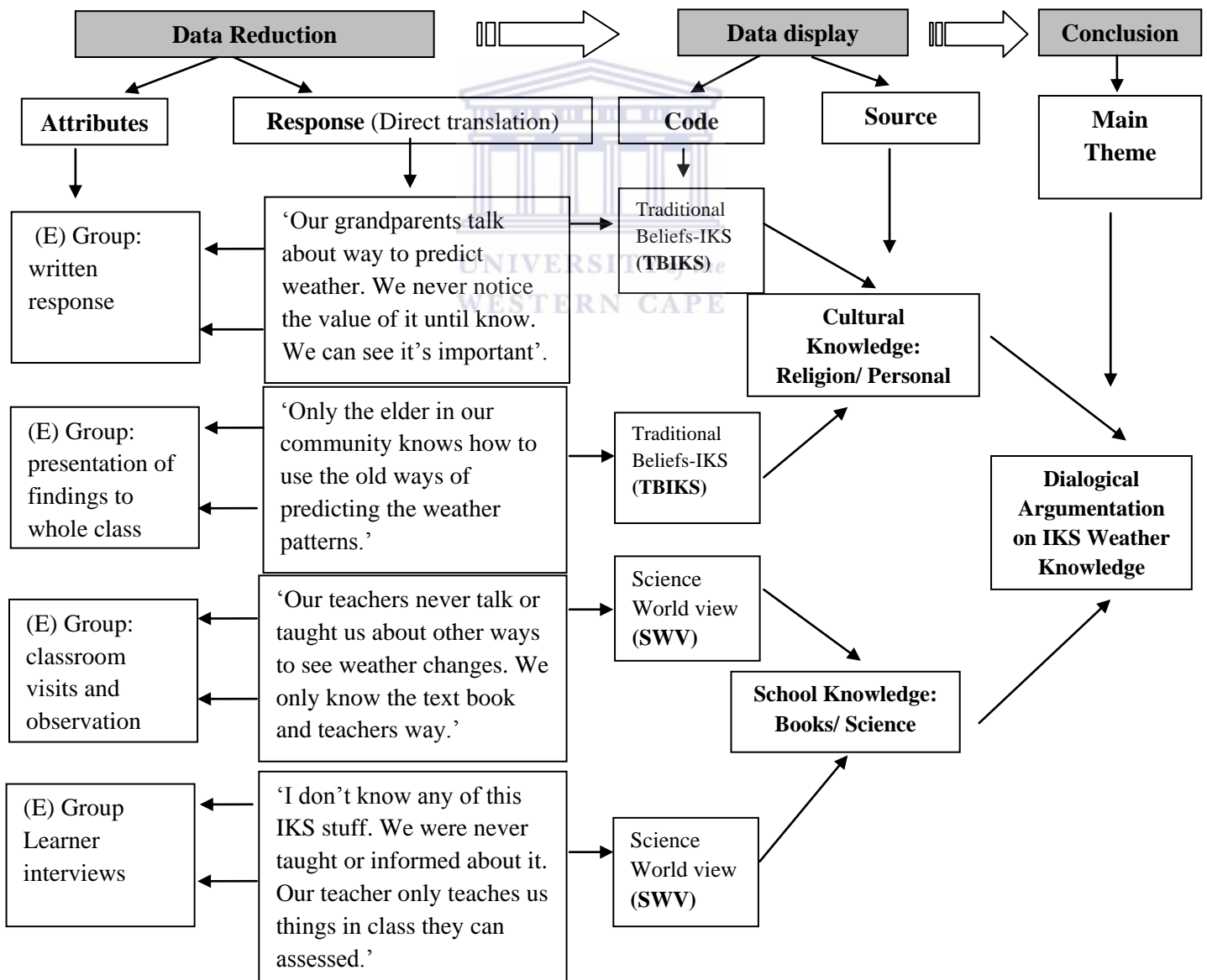
Figure 8: Illustration of the coding structure - qualitative data analysis (Riffel, 2012)

Punch (2009:175) also mentioned that 'these three overall components are interwoven and concurrent throughout the data analysis' and conclude the following:

The first two, data reduction and display, rest mainly on the operations of coding and memoing. In virtually all methods for the analysis of qualitative data, coding and memoing are the two basic operations that get the analysis going. (Punch, 2009:175)

As previously mentioned the qualitative data was collected through various types of instruments such as written responses, group feedback, observation schedules and learners' interviews to answer research question three (RSQ3).

The coding structure assisted me to (1) reduce and bring all the various forms of attributes and responses of data together (2) to formulate and verify two central data displays namely codes and themes that helped reduce and move data without any significant loss of information to (3) the dialogical argumentation on science-IKS weather knowledge central concluding theme. Two major codes were displayed and focused on, namely the traditional beliefs–IKS (TBIKS) code and the Science world view (SWV) code. From here the information provided from the data were directed into two different types of sources which were either a cultural knowledge source (KNS) that represents religion and cultural beliefs or a school knowledge source that represented the textbooks and science literature. In concluding the coding structure it gave the study a summarised view of the learners' attitudes, ideas and perceptions towards their own environment.

Illustration of coding structure

In the above illustration the qualitative data from learners' written responses were coded into cultural knowledge or school knowledge. Cultural knowledge includes views that derived from religion and personal point of views. Learners' were asked to give reasons why they chose the type of sources of information to support their answer. The following sources of information were available to choose from.

Sources of information:

1. **Science** (information that derived and influenced by a *science perception*)

2. **Religion** (information that derived and influenced by *religious beliefs*)

3. **Personal View** (information that was purely base on your own *personal view*)

4. **Cultural View** (information based on *norms* and *standards* from a *cultural belief*)

Attributes or responses from the following four qualitative data collection types were coded:

a) group work,

b) group presentations,

c) class room visits and observation schedules and

d) personal interviews with learners' from the (E) group learners.

This was taken and coded into two single codes namely, traditional beliefs that represents the indigenous knowledge system (IKS) view and a Science view that represents the science world view (SWV). Some learners' claim that they were never confronted with the topic on IKS at school level which raised some concern for this study because Natural Science is seen as a social science subject and has to deal with some sort of IKS in the curriculum. Very little evidence is also given in some of their answers that supports their claims. What came out of the coding structure was that very little of the knowledge that is currently present with the learners about IKS/weather perceptions came from a cultural belief way of knowing. Most of the knowledge about IKS/weather related issues came from text books, literature and the school in the classroom.
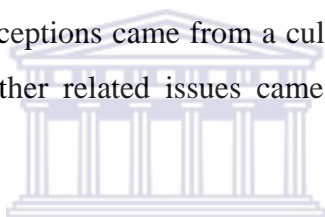
Table 4.11: EXPERIMENTAL GROUP – Pre-post –test scores

E GROUP	PRE-TEST	POST-TEST	PRE & POST DIFF
MEAN	18.8824	29.8750	10.8750
SD	3.3144	4.2876	3.7572
t-TEST: N = 15, Critical t-value = 2.131, Alpha = 0.05			

Table 4.12: CONTROL GROUP – Pre-post –test scores

C GROUP	PRE-TEST	POST-TEST	PRE & POST DIFF
MEAN	14.3333	15.4545	1.3636
SD	4.3970	3.7246	6.3446
t-TEST: N = 10, Critical t-value = 2.201, Alpha = 0.05			

Table 4.13: The means procedure of pre-post test scores (E) and (C) Group

Group	Variable	N	Mean	Median	Std Dev	Minimum	Maximum
Experimental Group	Q1	17	6.5882	6.0000	2.3468	2.0000	10.0000
	Q2	17	4.8824	5.0000	1.2187	2.0000	6.0000
	Q3	17	2.3529	2.0000	1.1147	1.0000	6.0000
	Q4	17	5.0588	6.0000	3.3255	0.0000	12.0000
	Pre-test	*17*	*18.8824*	*19.0000*	*3.3144*	*11.0000*	*25.0000*
	R1	16	7.5000	8.0000	1.7127	4.0000	10.0000
	R2	16	5.0625	5.0000	1.0626	3.0000	7.0000
	R3	16	3.1875	2.5000	2.0726	0.0000	7.0000
	R4	16	14.1250	13.0000	3.2223	10.0000	20.0000
	Post-test	*16*	*29.8750*	*30.5000*	*4.2876*	*20.0000*	*36.0000*
	Pre-post Difference	**16**	**10.8750**	**10.0000**	**3.7572**	**6.0000**	**18.0000**

Group	Variable	N	Mean	Median	Std Dev	Minimum	Maximum
Control Group	Q1	12	5.7500	6.5000	2.8324	2.0000	10.0000
	Q2	12	3.9167	4.0000	0.9962	3.0000	6.0000
	Q3	12	1.8333	2.0000	1.2673	0.0000	4.0000
	Q4	12	2.8333	2.0000	3.1286	0.0000	8.0000
	Pre-test	*12*	*14.3333*	*15.500*	*4.3970*	*7.0000*	*20.0000*
	R1	11	6.3636	6.0000	2.5009	3.0000	10.0000
	R2	11	3.4545	4.0000	1.3685	1.0000	5.0000
	R3	11	2.1818	2.0000	1.4709	1.0000	6.0000
	R4	11	3.4545	3.0000	2.4234	0.0000	8.0000
	Post-test	*11*	*15.4545*	*17.0000*	*3.7246*	*10.0000*	*22.0000*
	Pre-post Difference	**11**	**1.3636**	**-2.0000**	**6.3446**	**-7.0000**	**11.0000**

Note: Variable Q1 – Q4 = Questions in the pre-test stage, Variable R1-R4 = Questions in the post-test stage

Meteorological Literacy Test

After the completion of the MLT test the learners came forward with some improving statistics that suggest that the DAIM did improve their perception towards IKS/weather related

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concepts. This results can be seen in Chi-square statistic tables (tables 4.10 and tables 4.11) below.

4.4   RESEARCH QUESTION 4: What differences exist between the learners' meteorological conceptions of their environment before and after the have been exposed to DAIM?

In analyzing the above research question, first the quantitative data will be presented and discussed, and the findings supported by qualitative data such as interviews, questionnaire data and classroom observation.

We all know that without any proper resource materials available to any teacher in a classroom setting it is best to divert to the old "chalk and talk" method of teaching. Teachers have syllabuses, curriculum deadlines, "blue book" guidelines, grade pace setters and IQMS (individual quality management system) to adhere to at school. These administrative instruments are used as measuring tools to measure teacher-subject content knowledge and learner achievement performances in subject departments. Thus, resulting that teachers create a more shuttle and still learning environment in their classrooms to achieve the desired results. Maqutu (2003) agrees and reports that it 'relates the choice of teaching strategies to factors such as many teachers being novices and the availability of teaching materials'. The "chalk and talk" teaching strategies are dominated by minimal students' talk except when students are asked or invited to ask a question by the teacher (Qhobel & Moru, 2011).

 Lerotholi (2001) reported that there is a lack of resources such as laboratory equipment and consumables in many schools. Maqutu (2003) also acknowledges that there is significant evidence of considerable pressure on schools and teachers to have high success rates in external examinations. These problems were also acknowledged by Qhobela and Moru (2009) and they relate it to the choice of teaching strategies employed by science teachers. They claim that 'some teachers believe that chalk and talk strategies are more effective than learner centered approaches for finishing the syllabus and preparing students for external examinations' (Qhobel & Moru, 2011).

In addition to the old traditional teaching method the study suggests a new dialogical instructional model (DAIM) that can easily be adapted and implemented to cater for some of the shortcomings of the old school curriculum. The research also notices that the CAPS (2011) are an addition to the NCS (2003) curriculum policy. It adds and suggests various forms and types of assessment for grade R-12, which opens the propositions to use a classroom

argumentation-based instructional model that will draw on meaning and conceptual understanding of weather related concepts in the geography classroom.

The CAT world view analysis

In Ogunniyi (2007a), the juncture, place or area of commonality between two distinct ideas is what he calls "contiguity". It is at that symbolic location or intellectual space where ideas or worldviews overlap that cognitive processes occur resulting in conceptual conflict, elaboration, accommodation, integrative reconciliation and adaptation (Ogunniyi, 1988; Ogunniyi et al, 1995; Ogunniyi, 2004, 2007a and b). In a study done by Diwu (2010) the five symbolic categories were analysed and documented as follows:

> ***Dominant ideas*** *are those that are most favorable between rival ideas. These are dependent on the context or socio-cultural background of the learner who is exposed to the new idea. Dominance is usually dictated by overwhelming evidence in support of the new ideas or claims. In a different context the same dominant ideas can be a **Suppressed idea**, for instance, the issues of faith or cultural beliefs will dominate in a cultural context. **Assimilated ideas** are those ideas in the current cognitive structure which are influenced or modified by new ideas to create a more stable mental state. **Emergent ideas** are those ideas that are new and have no rival or opposing ideas (for example, new concepts in school science) in the learners' existing cognitive structure. **Equipollent ideas** are those competing ideas which exert comparably equal intellectual and emotional forces on the learners' cognitive structure (Ogunniyi, 2007a).* (Diwu, 2010 :60-61)

For the purpose of this study the learners' scientific and indigenous knowledge worldviews about weather were analyzed in terms of the five cognitive categories of CAT (table 4.14).

Table 4.14: Pre- and post-test of learners' attitudes to science in terms of CAT's cognitive categories.

Items	CAT Categories	E Group Frequencies		C Group Frequencies	
		PRE	POST	PRE	POST
1. Learning Geography through school science is interesting : **SSW**	Dominant	13	0	6	0
	Suppressed	2	0	0	0
	Assimilated	2	5	0	0
	Emergent	0	10	0	8
	Equipollent	0	2	6	4
2. Using my indigenous knowledge to learn geography helps me to understand weather better: **IKSW**	Dominant	14	16	16	10
	Suppressed	3	0	0	6
	Assimilated	0	0	1	1
	Emergent	0	1	0	0
	Equipollent	0	0	0	0
3. I can use what I learn in a geography class at home and in my community: **SSW**	Dominant	12	7	3	3
	Suppressed	1	7	1	3
	Assimilated	4	0	8	6
	Emergent	0	2	0	0
	Equipollent	0	1	0	0
4. I believe more in my indigenous knowledge than geography knowledge to understand the weather: **IKSW**	Dominant	3	5	0	0
	Suppressed	3	3	0	0
	Assimilated	6	1	0	0
	Emergent	5	0	0	4
	Equipollent	0	8	12	8
5. There is a relationship between what I learn in geography and weather patterns: **SSW**	Dominant	7	2	0	2
	Suppressed	0	3	0	2
	Assimilated	0	1	0	1
	Emergent	0	3	0	0
	Equipollent	10	8	12	7

SSW = School science worldview; *IKSW = Indiginous knowledge systems' worldview*

Summary for E and C groups on items 1 - 5

According to Van der Linde (2010), **,** "A conception becomes dominant when it is the most adaptable to a given situation" (Van der Linde, 2010, p. 31).

Item 1: *Learning Geography through school science is interesting*

At the pre-test 13 as against 6 of the views expressed by the E group learners on **item 1** reflected a scientific worldview while only 2 reflected suppressed or an assimilated scientific worldview. The other CAT categories were not reflected in their scientific worldviews. However, at the post-test 5, 10 and 2 respectively reflected the scientific worldview among E group learners while the other categories were not reflected at all. For the C group at the pre-test 6 views each belonged to the dominant and equipollent scientific worldview-categories compared to 8 and 4 respectively for the emergent and equipollent at the post-test.

Item 2: *Using my indigenous knowledge to learn geography helps me to understand weather better*

At **item 2** the pre-test 14 and 3 respectively views reflected a dominant and suppressed worldview compared to 16 for dominant and 1 respectively for the emergent IK worldviews

It could be the result of the DAIM intervention that changed the learners' perceptions that they can use IK to learn geography and understand the weather better.

Item 3: *I can use what I learn in a geography class at home and in my community*

For **item 3** at the scientific world view, at the post-test 12 views where recorded as dominant, 1 view as suppressed and 4 views noted as assimilated among the E group learners respectively, noted that none of the other CAT categories where reflected on at all. For the E group at the post-test level, 7 dominant, 7 suppressed, 2 emergent and 1 equippolant views were display after the DAIM intervention. For the C group learners at the pre-test level only 3 reflected a dominant view, 1   view was noted as suppressed and 8 learners reflected a assimilated science world view. At the post-test stage level after the Daim the C group displayed still 3 dominant views, 3 suppressed views and 6 assimilated views.

The above observations seem to suggest that, none of learners in the E group who displayed a emergent worldviews increased to 2 views after the intervention while none of the C group

learners displayed an emergent or equippolant worldviews in the post-test, towards item 3: *I can use what I learn in a geography class at home and in my community - (SSW)* , suggesting that something in the intervention might have caused the E group learners to change their perception on item 3

Item 4: *I believe more in my indigenous knowledge than geography knowledge to understand the weather*

For **item 4** at the IK science worldview the E group displayed only 3 views as dominant and suppressed respectively, 6 assimilated and 5 emergent at the pre-test stage level. However, apart from the 5 dominant views, 3 suppressed, 1 assimilated and 8 equippolant were recoreded at the post-test level for E group.

> *An equipollent conception occurs when two competing ideas or worldviews exert comparably equal intellectual force on an individual. In that case, the ideas or worldviews tend to co-exist in his/her mind without necessarily resulting in a conflict e.g., creation theory and evolution theory.* (Van der Linde, 2010 :31)

On the other hand for item 4, the C group display 12 views as equippolant and none of the other CAT categories in the pre-test, but at the post-test level 4 emergent and 8 equippolant views reflected, but again no other CAT categories at post-test level for item 4 were display.

Item 5: *There is a relationship between what I learn in geography and weather patterns*

Seven out of the 17 E group learners hold a dominant school science worldview and 10 hold an equippolant view at the pre-test level. Other CAT categories were not display. At the post-test level only 2 E group learners hold up such views of dominant towards a school science view after the DAIM intervention. One can probably say the the majority of the learners from the E group did not seem to display views of being dominant regarding the relationship between geography and weather patterns (item 5). In the case of the C group, zero learners hold any dominant worldviews at the pre-test. At post-test only 2 learners learners displayed views of being dominant to school science. The above shows that, while none of the C group learners in the post-test displayed dominant views, some of the E group (7) learners who formerly displayed dominant views were decreasing while the C group displayed tendencies (from zero to 2) after the intervention took place.

The E group learners also tended to develop emergent views in item 5. The number of learners in the E group seemed to increase from zero to 3 who displayed emergent views in addition to none of the learners from the C group at post-test. The above seems to suggest that, during the intervention, the E group learners must have gained new knowledge.

4.5 SUMMARY

Some major findings have emerged from analyzing both the quantitative and qualitative data and are as follows:

- For the most E group learners being exposed to argumentation in the classroom during the DAIM intervention process seemed to have enhanced their awareness of the Nature of Science (NOS) and the Nature of IKS better than those in the C group.

- Learners in both study groups held relatively good conceptions of weather processes. Their attitudes as revealed in the questionnaire indicated that both groups possessed valid scientific conceptions about weather and meteorological science.

- Both groups' pre-test responses to the attitudes questionnaire based on the framework of the Contiguity Argumentation Theory (CAT) revealed that they held largely equipollent views (i.e. Scientific and IKS-based) of weather (Geography). This means that, they held both the Scientific and the IKS-based views of weather knowledge in a co-existing manner.

- Learners that were exposed to the DAIM intervention develop better understanding and attitudes towards a science worldview and value the use of IK embedded science lessons.

From the foregoing, it seems that an argumentation-based instruction does have potential for promoting the development of a wider range social skills among learners, including social skills, reasoning skills and argumentation skills needed in dialogues and other forms of

discourses. However, to achieve this goal teachers need to adapt teaching styles that are compatible with dialogic approaches. In other words, they need involve their students in classromm discourses that warrant the use of arguments and validation of such arguments with valid reasons. These benefits are highlighted by the following findings:

- The use of dialogical argumentation instructional (DAIM) model in science education, allow learners to improve their cognitive and linguistic skills. It focuses on important learning outcomes that are often neglected in the science classroom. Learners' engagement in scientific argumentation helped them develop a better understanding of the role of argument and evidence in science. It also helped them improve their communication and writing skills, and strengthened their critical thinking skills and their ability to collaborate with others.

- The use of technological supportive resources, such as exposing learners to weather instruments during a science lesson , demonstrated a potential to successfully scaffold learners in argumentation, supporting them in the internalization of argumentative skills.

- Development of a better attitude to meteorological science among the experimental (E) group learners seemed to have enhanced their awareness and understanding of the Nature of Science (NOS) and the Nature of IKS (NOIKS) better than those in the control (C) group.

- Learners exposed to a Dialogical Argumentation Instructional Model (DAIM) tended not only to develop better attitudes to science, but also to value the science embedded in IKS more than was the case in the C group. This observation was suggested by the fact that the number of learners in this group with equipollent or dualistic views about science increased considerably after the intervention while those in the C group dwindled considerably.
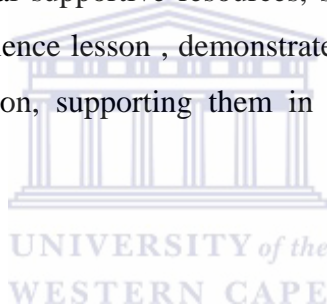
- The meteorological literacy test (MLT) scores revealed that learners who were exposed to a DAIM tended to develop skills beyond recall and conceptual understanding, but also developed higher order skills such as application and decision-making on socio-scientific issues.

Two major outcomes were identified that will contribute to building national science education standards in school-communities/organizations to promote meteorological education at any public school. These two possible major outcomes are:

(a) That meteorological education promotes an important public discourse concerning vital issues involving science and technology, and

(b) That all learners should become aware and share the excitement of caring about the natural world and respect for the environment and its related systems.

In chapter 5 I shall look into the implications of these findings for curriculum development, instructional practice and others.
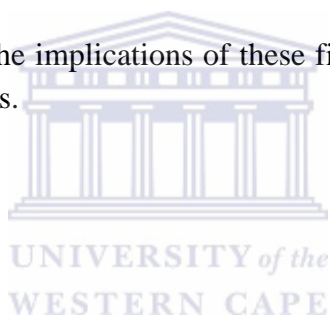
CHAPTER FIVE: CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

In this chapter I provide an overview of the study that summarises the basic research findings which will be followed by a brief discussion and recommendations that emanate from the study. I will reflect on the experience of conducting the research, some shortcomings and irregularities in the study and suggest possible solutions. In addition, I look at implications for educational policy, curriculum and instructional practices in South African generally, and specifically in the Western Cape where the study was conducted.

5.1 OVERVIEW OF FINDINGS

The Experimental (E) group learners developed a positive attitude and better understanding towards science and enhanced their awareness of the Nature of Science (NOS) and the Nature of IKS (NOIKS), as opposed to the Control (C) group

Both groups were exposed to the conceptions of weather (meteorological) science and IKS content test (MLT) and the average scores were almost the same for both groups in the pre-test. The (E) group had an average of 18.88 (37.76%) and the C group had an average of 14.33 (28.67%). The mean results of the E group has significantly improved from 18.88 mean to a 29.87 mean with a overall 10.87 mean value improvement after the DAIM intervention. On the other hand the C groups scored a 14.33 mean value in the pre-test to a 15.45 mean value in the post-test with a mere 1.36 overall mean value improvement with no intervention exposure. We can notice a significant improvement of 10.87 in the overall mean results in the E group as opposed to the 1.36 mean values in the C group. This difference in mean value score improvements between the two groups can be attributed to the DAIM intervention that was applied only to the E group and not to the C group. Both groups completed the MTL in the pre-post test.

The Dialogical Argumentation Instructional Model (DAIM) provides an alternative lens for explaining many of the empirical findings in science/IKS education.

Yet, it arises independently from mathematical derivations that are neither empirical nor normative.

DAIM also addresses the shortcomings of alternative frameworks for scientific reasoning

What implications does dialogical argumentation have for the practice of science education and instruction? From a curricular perspective, one immediate implication is that if individuals are to behave rationally, they need to see judgments about data and evidence being an assessment not only of the probability of the hypothesis being correct but also of it being wrong. Such evidence is essential to making an assessment of the CAT and TAP. Within the field of argumentation, Erduran and Jiminez (2007:48) stated that "a significant body of argumentation literature in science education has been based on Toulmin's work", and dialogical argumentation could be used to provide a mathematical structure to Toulmin's model for argument. This sort of argumentation instruction is likely to be particularly useful for students entering scientific research and practice. In this way, DAIM can help bring increased use of statistical reasoning into real-world applications.

DAIM can also be taught as a model for the reasoning processes of science.

Highlighting the importance of scientific reasoning, for instance, can improve awareness of common pitfalls to rational reasoning in the classroom. Learners become more aware of the type of answers given in tests and classroom discussions. Learners will consider if a common answer made by them can be supported by valid evidence and backing to substantiate the claim in context. According to Kuhn (2009) for students to argue more effectively, clear instructions must be provided in class and educators require professional help and guidance in argumentation and ground rules must be established that will guide and help the participants and ensure they get the most out of the exercise (Kuhn, 2009).

Own experience in classroom to enact policy of integrating science and IKS

It would be very difficult for teachers that are used to the traditional chalk and talk method of teaching to implement a dialogical instructional method in their classroom without any prior training in the DAIM instructional model. It was a huge challenge for me as the researcher to plan and design various lessons that coincide with the integration of science and IKS.

Instructional viewpoint from learners to use DIAM in class

The unfamiliar practise of DAIM came as a surprise to many learners who only started to like and enjoy the method after their understanding and familiarity was increased by the involvement with the research study. Most learners were confused by the new teaching practise that allows a form of argumentation during class sessions. This indicates that argumentation practices are not commonly used by teachers, at least in this school, and likely

in others. Considering the benefits of an argumentation-based approach in terms of aiding conceptual understanding of science and IKS in this case, the promotion of argumentation-based instruction should be investigated.

Teachers' view to compartmentalize two worldviews

Teachers that are long in practise are used to the old "chalk and talk" method of teaching. They have created a sort of comfort zone over the years in which they feel no need for change. If they conform and agree to curriculum change, they have to learn new things and record and gather new resource materials, which can be too much to adapt to at their age. In a cross-conversation with teachers it was easy to sense the unwillingness to adapt to the new curriculum, it was also commonly sensed that for DAIM to be successful one needs to bridge the gap of the fear of change that currently resides in most public school teachers.

Challenges to implement DAIM in the classroom

Some of the challenges that emerged are

- To promote the dialogical instructional methodology amongst teacher colleagues

- To incorporate additional IKS lessons and interventions with learners who are educationally at risk of repeating a grade.

- To undertake the necessary science/IKS interventions with gifted learners

- The literacy and numeracy levels at many schools are low resulting in some learners not being able to read and comprehend. Most of the time instructions have to be read out to learners, and this has an adverse effect on the DAIM intervention in the classroom.

Lessons learnt that might benefit others

When assessing the approach to instruction, the time constructs need to be altered so that learners should do more and the teacher should reduce instructional time. During the research, it was discovered that the majority of learners do not complete assignments at home. Further qualitative research by interviewing these learners indicated that they are faced with a lack of parent supervision, lack of research facilities and overcrowded households. After much consideration and to elicit better results and better performance, I ascertained that the instructional time should be reduced to 15 minutes and that time on tasks should increase to 45 minutes. What I discovered was that the learners automatically have more time to discover scientific concepts through a more hands-on approach during practical sessions. I have realised

that grade 9 learners need more than enough time to handle equipment in an appropriate and confident way. Learners are no longer actively busy during science lessons.

The academic learning time when learners are engaged in individual activities should be extended to 60 minutes. The reason for suggesting this extension to the academic learning time is to accommodate those learners who find it difficult to complete their assignments at home due to a lack of facilities and other challenges that they are faced with almost on a daily basis. They could now comfortably make use of the school media centre to complete their individual assignments during the academic learning time frames. The school management team in consultation with the school governing body has decided to earmark money from the annual budget to pay for a suitable parent to supervise and to give revision activities to those learners who are left without a teacher. This arrangement allows the other teachers to make full use of their contact time without being interrupted by the presence of learners from other grades within their class.

5.2 IMPLICATION OF FINDINGS

Dialogical Argumentation Instructional Model (DAIM) has several potential implications for classroom pedagogy:

First, it adds further emphasis to the significance of findings that alternative misconceptions of IKS must be addressed if students are to gain secure understandings of scientific concepts.

Teachers need to be aware that lowering the likelihood of false positives (alternative "wrong" ideas) is as instructionally powerful as raising the likelihoods of true positives (the "correct" idea). Teachers need to be familiar with what they want to achieve in the classroom and undertake proper planning to achieve the desired outcomes.

Second, if learning does indeed occur through an argumentation-like process of data weighing and integration, this reinforces constructivist notions of knowledge acquisition.

From this perspective, simply providing the correct answer is not sufficient. Students must be given evidence to a claim and allowed to grapple with assessing other views in order to properly update their belief assessments. Specifically, acceptance of new concepts is a function not only of how well the teacher presents the case for a new idea, but also the extent to which they address the strength of the student's misconceptions. For students with strongly held claims, it may take multiple exposures to evidence to change these beliefs. The DAIM

model suggests this is normal, even when the learner is evaluating the evidence rationally. Therefore, even if a student does not initially accept a new concept, instruction can still be considered a success as long as the learner is more open to the idea than they were initially.

Perhaps most fundamentally, this account of scientific reasoning from a dialogical argumentation perspective offers a rationale for why argument and critique are central to scientific activity.

If, as suggested, beliefs are transformed not solely by confirming evidence but by negating alternative evidence, it suggests a central role for the critique of the construction of knowledge both for the scientist and the learner of science. It also suggests why the few merchants of doubt who wish to cast aspersions on the scientific evidence for climate change have been so successful. A dialogical argumentation perspective would suggest that the case for climate change would be made much more successfully not by asserting the validity of the scientific evidence but rather by undermining the validity of the naysayer's case. Or to put it another way, knowing why the wrong answer is wrong matters as much as knowing why the right answer is right.

5.3 LIMITATIONS

Constraints within the study

It was not easy to conduct this type of study in a public school setting. Besides that, the concept of dialogical argumentation was new to all the learners and the process of argumentation needed to be explained in detail. The majority of the learners thought of argumentation as a means of conflict and were conditioned to believe that argumentation amongst individuals normally ends up in verbal or physical confrontation. The biggest challenge was to get learners to listen and respect each others' viewpoints and claims.

Location

The area in which the study was conducted is located in a previously disadvantaged community of the Helderberg Region. It was noticed in the daily activities in the school and community that unemployment, poverty, crime and gangster activity are still some of the challenges that this community is facing daily. Some learners' come to school without money and even with empty stomachs and no lunch packs for the day and this made them uneasy with

the whole process of the research investigation which normally takes time and commitment from all involved. Clearly, the socio-economic setting affects the external and internal environments that affect the classroom environment, students' learning resources, and importantly, learners' attitudes to learning, which are illustrated by the unfamiliarity with an argumentation-based instruction method, with learners assuming this format usually leads to confrontation. Location factors need to be considered when considering or planning to introduce a new teaching method such as the DAIM approach.

End of year school term

The pre-test data was collected between August and September months in the third term of the school calendar almost near the end of the year. The initial plan was to conduct the study early in the 1st and 2nd school term. Following protocol and after several attempts the WCED (Western Cape Education Department) research department granted the permission (APPENDIX 1) for the research study, on the condition that the research study must be concluded within that period.

The study did not interrupt the academic flow of the school. Most of the public schools are busy with lesson revision and preparing their learners' for the final examinations in the fourth term. Access to additional class observation visits, interviews with teachers and even assistance from staff members was very difficult, because of teachers' academic work load and commitments to complete their syllabus, which was a valid and acceptable reason. Most of the interventions and post-test data collection took place after school hours to accommodate for the time losses and unnecessary disruptions during class times. The excitement of the learners' involved in the study wore off towards the end, as evidenced by two learners one from (E) group and the other one from the (C) group who opted out at the post-test stage, because they felt they were wasting valuable time after school. I feel that this third term was not the right time to undertake the study because of the many constraints which hampered the finalisation of the study. I would suggest that earlier terms in the year should be sufficient which would also allow ample time for the implementation of a quasi-experimental design research study.

Duration of Intervention

The intervention took place after the September school holidays in 2011. As a non-teaching staff member of the participating school only pre-arranged meetings after school hours or early mornings between assembly time with the group could be scheduled. Thus, due to time limits the intervention was only spread over a period of 4 weeks. The original and ideal plan was to spread the intervention over an 8 week period so that learners could draw conclusive experience from the argumentation sessions and group-workshops being presented. The intervention period was also interrupted by rigorous administration and curriculum duties that sometimes lead to the cancellation of intervention meetings scheduled for after school.

A possible positive outcome of the after school intervention meetings were that learners could focus directly on the intervention process at hand without any external distractions from other learners. The participating educator was always present and keen to assist with the intervention phase, and this also helped to build a better "teacher-learner relationship" between the researcher and the learners, because none of the learners were known to the researcher or vice-versa. It also takes time to build mutual relationships on common ground especially in the field of educational research.

Hegemony of the Language of learning and teaching

Most of the learners' that participated in the study were Afrikaans home language speakers. English is their second language at school and they are also referred to as first additional language speakers. All the materials and instruments used in the study were printed in English. This was a major setback towards the research because not all of the subjects could express their ideas properly in the English language. In some cases the questionnaire was translated into Afrikaans to speed up the process at hand. In small and larger group feedback sessions most learners had chosen to express their opinions and beliefs in their mother tongue language Afrikaans, but again trying to answer the questionnaire in English they sometimes used the wrong phrases to express their views.

5.4 RECOMMENDATIONS

Teaching and classroom practice need to focus on improving learners' performances. This study recommends that teachers plan lessons that are high in IKS quality that can engage actively and critically with indigenous knowledge, including disciplinary knowledge to improve science problem-solving in the classroom. It will provide students with a better cognitive mindset to learn and understand important science concepts and processes in depth rather than superficially, and to use these in ways to explain meaning, rather than simply reciting concepts.

Recommendations towards a DAIM supportive classroom environment

A dialogical instructional supportive pedagogy in science classrooms, where learners will feel safe to take intellectual risks, is recommended. Learners will be able to regulate their own academic behaviour and stay on task. Teacher and students are respectful towards each other but also engage with argumentation that draws on the beliefs, values and ways of knowing of different cultures. The DAIM approach facilitates the participation of all students and to build inclusive science classrooms, a connectedness to the world beyond the classroom – this would link school knowledge to student's home or cultural knowledge and to events beyond the classroom setting.
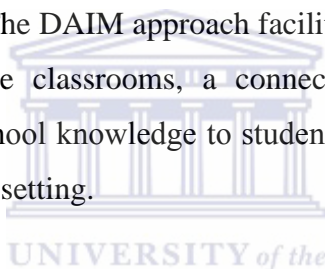
Recommendations towards Curriculum design and Development

To introduce dialogical forms of instruction, it is recommended to teachers to work with colleagues and through discussion examining various dialogical instructional strategies, learning activities and curricular materials used in the classroom, thus looking at one's teaching in a more structured manner. Further investigation into the authenticity of the teacher's narrative and interpretation should be followed by interviewing learners exposed to the DAIM intervention.

Recommendations towards teacher enrichment research

Experimental or action research can be a worthwhile endeavour for a number of reasons:

- Research and reflection allow teachers to gain confidence in their work by learning about themselves, their learners, their colleagues and their environment.

- The DAIM method requires a lot of time, sacrifice and energy from the teacher but its benefits favour better classroom practice.

Recommendations to design school science technology activities to enhance learners' understanding in the use of wind and solar energy.

Schools need to invest in designing activities where learners will be able learn and interact with how weather and geography affects our solar energy resources. Learners can then engage and experiment with scientific examples, such as solar energy and insulation to learn where photovoltaic power (solar panels) have the greatest potential. Learners can also investigate various geographic regions in their community, their climatic conditions and how they can influence solar-and wind energy potential.

- Learners need to get familiar with the latest wind and solar technology and to use the renewal energy natural resources to tap into a sustainable energy supply.
- Classroom activities and lessons can range from a 1 period lesson up to a week and learners can be assessed accordingly.

Activities can also include lessons were learners will learn about practical aspects of renewable energy, such as using the right type of materials in a home that conserve energy and the importance of building-orientation and window sizing. Learners will be able to engage in activities to measure temperature changes in several thermal storage samples. By the end of such a lesson unit, learners will have been exposed and will appreciate the need to plan construction with proper materials. They will learn that simple measures, such as landscaping and installing thermal storage, make a big difference in energy consumption.

- Exposing learners to various activities that relate to career opportunities in the field of meteorological sciences, that are in line with the specific aims 3.3 set out in CAPS (2011) policy statement from the department of Education.

Recommendations towards educational and organizational management:

That a dialogical instructional model project be undertaken by a group of people on the staff rather than teachers working in isolation.

To engage and work on one problem at a time as identified from the pilot investigation. This could include e.g. the design of interactive (dialogical argumentative) lesson plans or class activities that focus on the immediate environment and surroundings of the school community. This will promote 'collegiality' among staff and learners by emphasising the following

characteristics: Be committed to learners; Plan well; Respect and recognise learners; Identify the children's problems and provide relief through food, clothing; Focus on solutions; Focus on skills; Focus on better management than the previous day; Promote accountability.

Recommendations on the use of local IKS in schools:

Indigenous knowledge is an important part of the lives of the poor. It is an integral part of the local ecosystem. IKS is a key element of the "social capital" of the poor; their main asset in the struggle for survival, to produce food, to provide for shelter or to achieve control of their own lives.

Indigenous knowledge also provides problem-solving strategies for local communities and helps shape local visions and perceptions of environment and society. IKS is of particular relevance to the poor in the following sectors or strategies: Midwives and herbal medicine; Agriculture; Animal husbandry and ethnic veterinary medicine; Use and management of natural resources; Primary health care (PHC), preventive medicine and psycho-social care; Community development; and Poverty alleviation.

Indigenous knowledge is important, and respecting it is an essential first step for development projects, allows better innovation and adaptation of technologies, adds to scientific knowledge, increases understanding between teachers and learners, increases the local capacity to experiment and innovate, and empowers local people.

School interaction with elders in the community on the topic of IKS
The Elders in the community can be approached to lead and deliver traditional protocol. They are given a small offering in exchange for their commitment to invest their time and energy into the work at hand. They can be asked to lead the gatherings such as parent meetings, social functions, fundraising events with prayer and ceremony. Meetings and school gatherings always begin with prayer and ceremony. It is entirely appropriate to ask this of them. It may not be what we are familiar with at school, but the school community will soon realize the benefits of IKS and respecting of the protocol and ceremonial practice.

Classroom interaction with elders in the community on the topic of IKS
The Elders can also be asked to do classroom visits and be part of IKS activities and share their indigenous knowledge with the learners. The Elders are well aware that any given group put together is there to learn from one another, and so investing indigenous wisdom and

knowledge towards this endeavour would only benefit the learners. The Elders will share what is acceptable and give caution for what they view as sacred knowledge that is only to be shared in the context of ceremony.

5.5 CONCLUSIONS

At the school serving as the research site, geography is not a favourite subject of learners because of the lack of resources. Most of the learner's current knowledge on weather and the environment are derived from school knowledge, and very little knowledge was gleaned from an indigenous knowledge perspective. In fact, some learners were completely unfamiliar with the concept of IKS. Some had never had any encounter with the term IKS. Teaching strategies should be initiated that showcase the importance of tapping into indigenous knowledge for easier and more relevant consumption of geographical concepts.

In summary, indigenous knowledge systems (IKS) are important for both the local communities and the global community. The school science curriculum developers and research partners need to recognize the role of IKS, understand its workings in the context of the local communities, and integrate systematically the most effective and promising of such practices into the development programs they design. The impact and sustainability of international practices could be enhanced if they are adapted to the local conditions and the indigenous practices. Yet, IKS is still an underutilized resource in the development process. Special efforts are therefore needed to understand, document and disseminate IKS for preservation, transfer or adoption and adaptation elsewhere.

By helping to share IKS within and across communities the development community can learn a lot about the local conditions that affect those communities. IKS should complement, rather than compete with global knowledge systems in the implementation of projects. By investigating first what local communities know and have in terms of indigenous practice, development partners could better help improve upon these practices by bringing to the dialogue international practices from development experiences in other parts of the world. Moreover, this process can contribute to better cross-cultural understanding and to the promotion of culture in development. But, above all, investing in the exchange of indigenous knowledge and its integration into the development process can help to reduce poverty.

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Email: alvinriffel@yahoo.com

UNIVERSITY *of the*
WESTERN CAPE

APPENDIX A1

Letter of permission to conduct research, 2011

<div align="right">
Mr A.D Riffel
15 Le Grange Street
Strand
7140
28 January 2011
</div>

The Principal: Mr G Phillips
Strand Secondary School
C/o Twelve Street and Onverwagcht Street
Strand
7140

Dear Sir/Madam

RE: <u>FIELD WORK FOR MASTERS IN EDUCATION THESIS</u>

I herewith would like to apply for permission to perform a research study at your school. I have chosen Strand Secondary school cause of it versatility within the Strand community and my personal attainment with the school. The school is my **Alma mater** and has play a huge role in my academic successes, and I would like to complete this research project at your school.
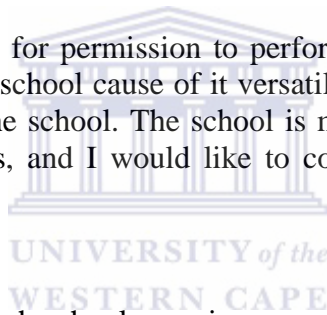
I have more than 12 years of high school experience as a teacher and I am currently enrolled for my M.Ed Thesis at the University of the Western Cape. I hereby wish to request permission to do my field work teaching observation in Grade 9 Social Science (Geography) class as a data gathering exercise for my thesis. 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 report of my findings to the school. For ethical consideration in data gathering, the stamp of the school and signature will suffice for the purposes of proof of consultation and permission by school management.

Best wishes.

Alvin Riffel (Principal Researcher)   Supervisor: Prof. M Ogunniyi

………………………..   ....

APPENDIX A2

Research Approval Letter: Western Cape Education Department – The Director: Research Services

WESTERN CAPE
Education Department

Provincial Government of the Western Cape

RESEARCH

awyngaar@pgwc.gov. za
tel: +27 021 476 9272
Fax: 0865902282
Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 20110811-0020
ENQUIRIES: Dr A T Wyngaard

Mr Alvin Riffel
Education Faculty
UWC
Bellville

Dear Mr Alvin Riffel

 RESEARCH PROPOSAL: EFFECTS OF A DIALOGICAL ARGUMENTATION BASED ON INSTRUCTION ON GRADE 9 LEARNERS CONCEPTIONS OF A METEOROLOGICAL CONCEPT: COLD FRONTS IN THE WESTERN CAPE, SOUTH AFRICA

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 **08 August 2011 till 30 September 2011**
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: Audrey T Wyngaard
for: **HEAD: EDUCATION**
DATE: 11 August 2011

Learner Survey – Attitudes towards Geography

High School Survey : Attitudes towards Geography

Section A – Personal Information

Complete the table below. No name is required only your initials and your current grade.

Code:....................	Grade 9:					
Gender	Male			Female		
Age	10-12 yrs	13-15 yrs	16-18yrs	19-21 yrs		Other
Religion	Christian	Moslem	Indian	Hindu	Judaism	Other
Language	Afrikaans	English		Xhosa		Other(Specify)

Section B – Survey Information

Part 1 – Importance of Geography

Read the following statements and complete questionnaire by indicating your level of agreement with an X. Remember ONLY one X per item is allowed.

Items		Level of Agreement				
		Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1.	I like the geography teacher because he/she makes the subject very interesting.					
2.	Learners are encouraged to participate in classroom activities.					
3.	The school should make geography a compulsory subject.					
4.	I like doing Geography as a subject.					
5.	I shall like to visit places where I can learn more about the weather and the environment e.g. Weather stations.					
	Items	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

6.	Our geography teacher provides adequate help for learners who have difficulty with the subject.					
7	Geography teachers are usually willing to help learners with their study of the subject even outside of classroom time.					
8.	Geography lessons are worth the time and effort I put in.					
9.	Cold fronts bring much of the rain that South Africa needs.					
10.	Predictions made by the Weather man are unreliable.					
11.	Geography knowledge can help reduce the effects of Global Warming.					
12.	Predictions made by the Weather man help me to know what dress to wear the next day.					
13.	Knowledge of the environment is important for our survival on earth.					
14.	Without the cold fronts South Africa is likely to be a desert or semi-desert.					
15.	Geography helps me understand the environment better.					
16.	Geography helps me to understand seasonal changes especially cold fronts.					
17.	I like Geography as subject because I can use the knowledge daily.					
18.	Geography helps me understand the world better.					
19.	Geographical science is difficult to understand.					
20	Geography has too many concepts that I do not understand.					

Part 2 – Geography Class Environment

Statement		Level of Agreement				
Class Environment		Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1.	Too much homework is assigned in the geography class.					
2.	There are sufficient textbooks and instructional materials for the learning of geography.					
3.	Geography is a very wide subject					
4.	The geography classroom has a lot of useful charts, maps and many useful learning materials.					
5.	Too little tests given in the geography class					
6.	The geography class is very lively because learners have opportunities to discuss topics about our environment.					
7.	Teachers use computers in the geography classroom.					
8.	I like to work in groups in the geography classroom.					
9.	I like working alone while doing my class assignment in geography.					
10.	We have no sufficient equipment, tools, maps, atlas, computers, etc. in the geography classroom.					

Part 3 – Geography Knowledge

Statement		Tick with 'X' only		
Geography as subject		Yes	Uncertain	No
1.	Geography subject can explain Climate Change.			
2.	Geography knowledge can improve understanding of Global Warming.			
3.	Geography subject only deals with weather phenomena.			
4.	Geography makes me understand the environment and nature better.			
5.	Geography teacher makes the subject interesting in class.			
6.	I like the practical part of the Geography subject.			
7.	I understand most of the concepts in Geography.			
8.	I like doing Geography homework.			
9.	I can express my own ideas and opinion in the Geography class.			

APPENDIX C

Conception of Weather (COW) questionnaire

QUESTIONNAIRE:

LEARNER'S CONCEPTIONS ON WEATHER RELATED CONCEPTS

Code: .... Grade:..............

This questionnaire is about your conceptions and understanding on weather related concepts. 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.

SECTION A: PERSONAL INFORMATION

Code:	.Grade:				
Gender	Male				
Age	10-12 yrs	13-15 yrs	16-18yrs	19-21 yrs	Other (Specify)
Religion	Christian	Moslem	Indian	Hindu	Judaism	Other

SECTION B: Personal views about (geography) or social science

Please indicate by a cross(X) your feelings about science. Give reasons for each answer you give.

1. Learning Geography through school science is interesting.

Strongly Agree ☐   Agree ☐   Disagree ☐   Strongly Disagree ☐

Reason...
....
....

2. Using my indigenous knowledge to learn geography helps me to understand weather better.

Strongly Agree ☐   Agree ☐   Disagree ☐   Strongly Disagree ☐

Reason...
....
....

3. I can use what I learn in a geography class at home and in my community.

Strongly Agree ☐   Agree ☐   Disagree ☐   Strongly Disagree ☐

Reason...
....
....

4. I believe more in my indigenous knowledge than geography knowledge to understand the weather.

Strongly Agree ☐   Agree ☐   Disagree ☐   Strongly Disagree ☐

Reason...
....
....

5. I am only interested in geography to pass my exams.

Strongly Agree ☐   Agree ☐   Disagree ☐   Strongly Disagree ☐

Reason...
....
....

6. There is a relationship between what I learn in geography and weather patterns.

Strongly Agree ☐   Agree ☐   Disagree ☐   Strongly Disagree ☐

Reason...
....
....

Source of information: Science ☐   Religion ☐   Personal View ☐   Cultural View ☐

7. Cold fronts and bad weather (like heavy rain and strong winds) are 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 bad weather, because it cannot kill you.

Strongly Agree ☐   Agree ☐   Disagree ☐   Strongly Disagree ☐

Reason..
....
....

Source of information: Science ☐ Religion ☐ Personal View ☐ Cultural View ☐

9. Geography explains the effects of cold fronts better than what I learn from home.

Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐

Reason..
....
....

Source of information: Science ☐ Religion ☐ Personal View ☐ Cultural View ☐

10. When cold fronts appear in the Western Cape we should be aware of bad weather patterns and heavy rain.

Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐

Reason..
....
....

Source of information: Science ☐ Religion ☐ Personal View ☐ Cultural View ☐
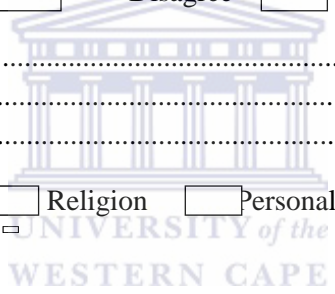
11. Without cold fronts Western Cape will be dry like the Kalahari Desert.

Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐

Reason..
....
....

Source of information: Science ☐ Religion ☐ Personal View ☐ Cultural View ☐

12. Cold fronts show that the sea gods are happy with us.

Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐

Reason..
....
....

13. Unless we stop cutting down the trees and burning the veldt the rainfall received will fall drastically. .

Strongly Agree ☐   Agree ☐   Disagree ☐   Strongly Disagree ☐

Reason..
....
....

14. There is a relationship between global warming and increased flooding and too much carbon dioxide from the industries.

Strongly Agree ☐   Agree ☐   Disagree ☐   Strongly Disagree ☐

Reason..
....
....

APPENDIX D

Meteorological Literacy Test (MLT)

Meteorological Literacy (MLT) -Test

Code: ....   Grade:....................

Know your weather instruments.

Although the most accurate predictions come from meteorologist, anyone can make local weather predictions by watching the sky and using simple equipment.

	Weather Instrument	Name	Measures	Units
A.		**Barometer**	Air Pressure	Millibar (mb) Hecto pescal (hP)
B.		**Min-Max Thermometer**	Minimum and Maximum Temperature	Degrees Celsius

C.		**Rain gauge**	Rain fall	Millimetres (mm)
D.		**Hygrometer**	Relative Humidity	Percent (%)
E.		**Anemometer**	Wind speed	Kilometres per hour
F.		**Compass**	Direction	Degrees

Activity 1:   Weather Instruments

1)   Which of the instruments shown above would best measure each of the following

conditions. Give reasons for your answers:

_____ a)   20(mm) rain fall on a specific day.

Give   reasons:

_____

_____

_____ b) a period of hot, humid weather

Give   reasons:

_____

_____

_____ c) a gentle land breeze

Give   reasons:

_____

_____

_____ d) that can point out the direction of an item

Give   reasons:

_____

_____

2)   Which instrument would give each of the following readings?

_____ a) a reading of 14 kilometres per hour (k/h)

_____ b) a reading of 53 (%) percent

_____ c) a reading of 3 (mm)millimetres

_____ c) a northerly (0°) direction

Activity 2:   Tick off the word (words) that will make each sentence a true statement.

1)   When air is cooled near the earth's surface or when warm, moist air moves over cool surface,

_____ is formed.

Snow	Fog	Lightning

2) Air pressure is measured in _____.

Degrees	percent	Centimetres

3) A _____ is used to measure air pressure.

thermometer	barometer	Hygrometer

4) Air temperature is measured in _____.

Degrees	percent	Centimetres

5) A _____ is a wind flow that occurs during night time hours.

land breeze	water breeze	Calm

6) If rain is forecast, the barometer pressure is _____ .

Rising	falling	Steady

7) High pressure is normally associated with _____.

good weather	bad weather	freezing weather

8) Cold air masses are _____ warm air masses.

lighter than	the same weight	heavier than

Activity 3:   Warm and Cold fronts

Question: Complete the diagram and fill in answers A to F using the list below.

a cold front   a warm front

cold air mass in a cold front   warm air mass in a warm front

cumulonimbus clouds   cirrus clouds

Warm and Cold Fronts
A *front* is an area where two different air masses make contact.

C. _____

A. _____

_____

cirrostratus

B. _____

cold air

altostratus

nimbostratus

F. _____

warm air

D. _____

_____

E. _____
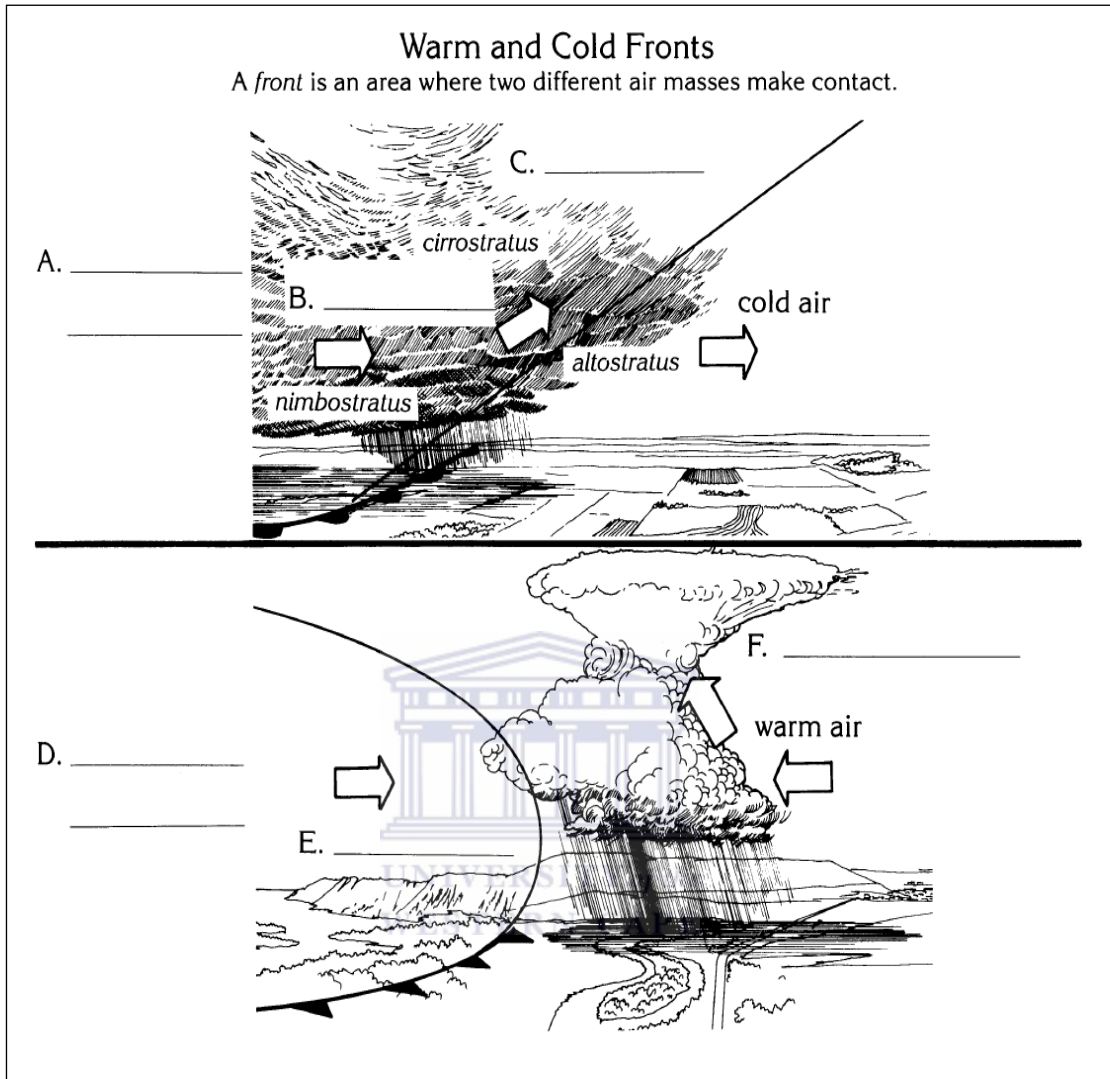
1. Write <u>warm front</u> if the phrase describes a warm front; write <u>cold front</u> if the phrase describes a cold front.

_____ 1.1) air masses with a gentle slope over surface of earth

_____ 1.2) formation of stratus type clouds

_____ 1.3) fast moving, heavy air mass

_____ 1.4) produces small violet, short periods of rain.

Activity 4: Weather Forecasting Application

Read the statement and underline the most appropriate answer and explain reasons for your answer:

You have just started your summer vacation. You are at a campsite with your family and you can't wait to start having fun. Your parents know you have been studying weather in class, so they have asked you to help decide what to do each day, based on your weather predictions. You don't have access to meteorological reports, so you must base your decisions on the indigenous knowledge-based weather predictors you learned about in class.

Day 1

You wake up early in the morning and notice that there is dew on the grass. Your parents say that means there is lots of moisture in the air and there will be rain. What should you do?

      a. Plan a day of indoor activities.

      b. Plan for a day outdoors.

Explain your choice: ....

....

....

Day 2

You have discovered a beehive near your camp. You go to investigate it again this morning. You see that there is a lot of activity, with bees flying in and out of the hive. You come back to your family and tell them that this indicates:

      a. They should have a good day for outdoor activities.

      b. They should stay indoors today.

Explain your choice: ....

....

....

Day 3

You had a wonderful day yesterday with swimming, hiking, and a campfire at night. At the campfire, you noticed the stars were very clear and bright. You also noticed that the smoke was not rising very quickly from the fire. With these observations, you announce to your family that tomorrow is a good day to:

a. Spend another day at the beach.

b. Plan for a day of indoor activities.

Explain   your   choice:

....

....

....

Day 4

Today you wake up and notice high clouds overhead. You see that the birds on the ground tend to be facing west. It had rained all day yesterday and most of the night. Your parents look at the clouds and say that it is going to be a bad day and we should go for a road trip. You:

a. Agree another day stuck inside is the only other option.

b. Say the day will be alright and a good day to go fishing.

Explain   your   choice:

....

....

....

Day 5

Last night you had another campfire. The wind suddenly started to blow from the east and you saw that the moon had a halo effect around it. You also noticed that the leaves on the trees were turning upside down as you headed to bed. You told your parents that this meant there was going to be rain. They said that it was too bad, for tomorrow was your last day. They said you should all pack up in the morning and head home early. You said:

a. Yes, we should head home early.

b. No, this weather would be gone by morning.

Explain   your   choice:

....

....

APPENDIX E

Activity 1

Group: ....   **Name: ....**

Tools for Predicting Weather

<u>Indicators of Early Spring</u>

1. Animals:

a. Fur – Animals have the ability to change colour to blend into their environments. For example, rabbits change their fur colour to brown before the snow begins to melt (Ron Ray).

b. Birds – The returning of birds from the south will indicate that spring is about to arrive (for example, crows). Redpoles begin to sing in the trees (Stuart Prosper).

c. Skunks – Skunks are one of the first animals to return in the spring. One elder stated "you know spring is here when the skunks are out" (Yvonne Chamakese).

<u>Indicators of the Length of Winter</u>

1. Animals:

a. Beehives – Wild beehives are built to a height so that they will not be covered by snowfall. A beehive built high above the ground will indicate above-normal snowfall and most likely slower melting in the spring and a longer spring (Stuart Prosper).

b. Beaver food stash – Beavers will store large amounts of food for a long cold winter (Ron Ray).

c. Muskrat lodge – Muskrats will build their lodges higher and fuller if they believe it will be a longer winter. A higher lodge will help with ice cover and storage (Stuart Prosper).

<u>Indicators of Storms</u>

1. Trees & Birds:

a. Leaves – The leaves on black poplar trees will turn upward to show their shiny side when rain is approaching (Ron Ray).

b. Birds – Most birds will disappear when storms are approaching (Stuart Prosper). The common tern, a shore bird similar to a seagull, will make more calls when weather is changing or precipitation is approaching. Their call sounds like a "yeah" as if they are agreeing with something (Stuart Prosper).

c. The grey squirrel – Found in coniferous forests, the grey squirrel makes a whistling call when weather is changing or precipitation is approaching. You can hear this rising, whistling call more often with a weather change (Stuart Prosper).

2. Moon:

    a. Shape – The shape of the moon will predict a storm the next day:

        1. Warning of storm – The moon will appear as a cup where the bottom is full and the top is curved.

        2. Rain or snow – The moon will tilt to give the impression that the cup will spill its contents.

        3. Storm – The moon will appear as an upside down cup. All the contents will appear to be pouring out of the cup.

        4. Nice day – A half-moon shape will appear with no curvature present. It does not matter which half of the moon appears (Yvonne Chamakese).

Indicators of Wind

1. Sunset and sunrise:

    a. Colour – There is an old saying that the colour of the sky will indicate the amount of wind present the next day: red sky at night – sailor's delight; red sky at morning – sailors take warning. First Nations culture views the red sky in this same context (Yvonne Chamakese).

2. Birds:

    a. Birds can help determine the direction of the wind. Birds will always face the wind so they are able to escape faster if they are in danger. They will get more lift from the wind if they face the same direction (Stuart Prosper).

3. Direction:

    a. East – Winds from the east will be interpreted as a storm approaching (Stuart Prosper).

    b. West – Winds from the west will suggest a change in the weather or sunny weather is approaching (Stuart Prosper).

4. Sundogs:

    a. A sundog will predict that the weather will be cold and windy. Sundogs also indicate that there is moisture in the air (Stuart Prosper).

Activity 2

Group:.............................   **Name: ....**

Cultural Weather Research

Complete this weather research:

Check with your friends, and the internet to see what you can find out about cultural sayings. Use a search/ Google for "weather sayings".

Record your three most informative sources here:
1.
2.
3.

Animal behaviour that predicts weather:
       Bees:

       Cows:

       Seagulls:

       Other:

Wind that predicts weather:
       East:

       West:

       Fishing:

       Other:

Clouds that predict weather:

       High clouds:

       Tall clouds:

       Other:

Other weather predictors:
       A person's joint pain: Chimney smoke:

       Storms that come up fast: Rainbow afternoon:

       Dew: Other:
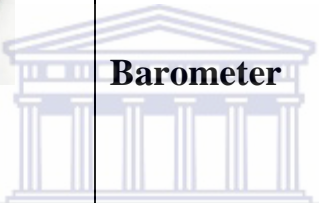
Activity 3

Know your weather instruments.

Group: ....   Name: ....

Although the most accurate predictions come from meteorologist, anyone can make local weather predictions by watching the sky and using simple equipment.

	Weather Instrument	Name	Measures	Units
A.		**Barometer**	Air Pressure	Millibar (mb) Hecto pescal (hP)
B.		**Min-Max Thermometer**	Minimum and Maximum Temperature	Degrees Celsius

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C.		**Rain gauge**	Rain fall	Millimetres (mm)
D.		**Hygrometer**	Relative Humidity	Percent (%)

E.		**Anemometer**	Wind speed	Kilometres per hour
F.		**Compass**	Direction	Degrees

Activity 2: Weather Instruments

1) Which of the instruments shown above would best measure each of the following

conditions. Give reasons for your answers:

_____ a) a 20mm rain fall on a specific day.

Give   reasons:
_____
_____

_____ b) a period of hot, humid weather

Give   reasons:
_____
_____

_____ c) a gentle land breeze

Give   reasons:
_____
_____

_____ d) that can point out the direction of an item

Give   reasons:
_____
_____
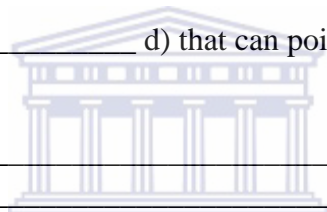
2)   Which instrument would give each of the following readings?

_____ a) a reading of 14 kilometres per hour (k/h)

_____ b) a reading of 53 (%) percent

_____ c) a reading of 3 (mm)millimetres

 _____ c) a northerly (0°) direction

Activity 4

Weather Forecasting Application

Day 1
You wake up early in the morning and notice that there is dew on the grass. Your parents say that means there is lots of moisture in the air and there will be rain. What should you do?

a. Plan a day of indoor activities.
b. Plan for a day outdoors.

Explain your choice.
Because   oral   history   says:
....
....
Because cultural knowledge says:

....
....

Day 2
You have discovered a beehive near your camp. You go to investigate it again this morning. You see that there is a lot of activity, with bees flying in and out of the hive. You come back to your family and tell them that this indicates:

a. They should have a good day for outdoor activities.
b. They should stay indoors today.

Explain your choice.
Because   oral   history   says:
....
....
Because cultural knowledge says:

....
....

Day 3
You had a wonderful day yesterday with swimming, hiking, and a campfire at night. At the campfire, you noticed the stars were very clear and bright. You also noticed that the smoke was not rising very quickly from the fire. With these observations, you announce to your family that tomorrow is a good day to:

a. Spend another day at the beach.
b. Plan for a day of indoor activities.

Explain your choice.
Because   oral   history   says:
....
....
Because cultural knowledge says:

....
....

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Day 4

Today you wake up and notice high clouds overhead. You see that the birds on the ground tend to be facing west. It had rained all day yesterday and most of the night. Your parents look at the clouds and say that it is going to be a bad day and we should go for a road trip. You:

a. Agree another day stuck inside is the only other option.
b. Say the day will be alright and a good day to go fishing.

Explain your choice.

Because   oral   history   says:

....

....

Because cultural knowledge says:

....

....

Day 5

Last night you had another campfire. The wind suddenly started to blow from the east and you saw that the moon had a halo effect around it. You also noticed that the leaves on the trees were turning upside down as you headed to bed. You told your parents that this meant there was going to be rain. They said that it was too bad, for tomorrow was your last day. They said you should all pack up in the morning and head home early. You said:

a. Yes, we should head home early.
b. No, this weather would be gone by morning.

Explain your choice.

Because   oral   history   says:

....

....

Because cultural knowledge says:

....

....
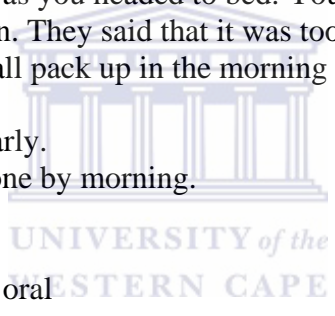
Activity 5

Weather Journal Handout

Personal Home Task: Your task is to make your own record of the weather for one week.

Here is what you need to do:

1. Record weather signs that you notice every day. (Note: Some signs like wind and dew are best observed early - before 8:00 a.m. - or after dark. At these times the effect of the sun's heat is not a factor.)

2. Use your cultural weather predictors to help make a prediction for what to expect for today and tomorrow.

3. If you see other signs during the day, make note of them and any changes in the weather that they could produce.

4. Record the daily forecast from the newspaper, TV, or internet. Include the temperature, wind, precipitation, and cloud/sun.

5. Record the five-day forecast from the newspaper, TV, or internet. Include the temperature, wind, precipitation, and cloud/sun.

6. Make a daily summary of the actual weather events of the day, and how the predictions could have been improved for the future. What signs were missed?

7. This journal must have entries for five days.

8. This journal must include two days in which you took observations throughout the day.

> **The journal will be due in one week!**
> **Get started tomorrow!**

Weather Journal Rubric

You will be assessed based on the following rubric:

Initial / Code: _____

Category	5	4	3	2	1
Journal Days	Five weather days observed.	Four weather days observed.	Three weather days observed.	Two weather days observed.	One weather days observed.
Signs	Recorded more than two weather signs each of the five days.	Recorded more than two signs for at least three days.	Recorded two or more signs for all days.	Recorded one weather sign for each day and two weather signs for three days.	Recorded one weather sign each day.
Use of cultural predictions	A cultural predictor was referenced in the forecast for all days, with multiple predictors used in three or more days.	A cultural predictor was referenced in the forecast for all days, with multiple predictors used in at least two days.	A cultural predictor was referenced in the forecast for four days	A cultural predictor was referenced in the forecast for three days.	A cultural predictor was referenced in the forecast for two days.
Media forecast	Reported the daily media weather and long-term forecast for all days.	Reported the daily media weather for all days, with the long-term forecast for at least three days.	Reported the daily media weather for all days.	Reported the daily media weather for at least three days.	Reported the daily media weather for one day.
Summary	There is a report of the actual weather compared to the personal and media forecasts, with suggestions of missed signs or confirmation of correct signs.	There is a report of the actual weather compared to the personal and media forecasts.	There is a report of the actual weather compared to the personal forecast, with suggestions of missed signs or confirmation of correct signs.	There is a report of the actual weather compared to the personal forecast.	There is a report of the actual weather for each day.
Full day of observation	There are two days of all-day observation. **(2 marks)**	There is one day of all-day observation. **(1 mark)**			

Weather Journal Checklist

Criteria	Dates	Task Completed
Record weather signs that you notice every day for five days.		
Use cultural knowledge to make predictions each day.		
Make note of any changes in the weather.		
Record the daily forecast from the newspaper, TV, or internet, including the temperature, wind, precipitation, and cloud/sun.		
Record the five-day forecast from the newspaper, TV, or internet. Include the temperature, wind, precipitation, and cloud/sun.		
Make a daily summary of the actual weather events of the day, and how the predictions could have been improved for the future.		
Two days of observations taken throughout the day		

Weather Journal Format

Initials: _____ Date: _____

Observation 1:..

Time: _____

Observation 2:...

Time: _____
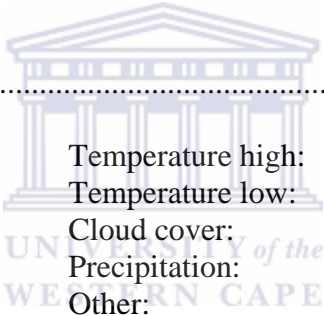
Observation 3:..

Time: _____

Personal Predictions:

The weather today should be: ....

The reason I predict this is: ....

Media Predictions: ....

Today:

Temperature high:	....
Temperature low:	....
Cloud cover:	....
Precipitation:	....
Other:	....

Long-term: ....

	1 Day	2 Days	3 Days	4 Days
Temp high				
Temp low				
Cloud cover				
Precipitation				
Other				

Summary: (Be sure to include: What weather happened today? How did you do? How did the media do? What is correct? What was missed?)

....
....
....
....
....
....

APPENDIX F

Consent Form

Informed Consent Form

This certify that I, _____, hereby agree to participate as a volunteer   in   a   research   project   sponsored   by _____, under supervision of _____.

The investigation and my part in the investigation have been adequately explained and defined to me, and I understand the explanation. The procedures of this investigation and their risks and discomforts have been described.

- I understand that I am free to not answer specific items or questions in the interview or questionnaire.
- I understand that any data or answer to questions will remain confidential with regards to my identity.
- I understand that the general results of the study will be made available to me , if required.
- I understand that no other intervention or administrative decisions will result from my participation in this study.
- I FURTHER UNDERSTAND THAT I AM FREE TO WITHDRAW MY CONSENT AND TERMINATE MY PARTICIPATION AT ANY TIME.

_____   _____

Date   Subject's Signature

_____

(Subject's address, optional: provide if you wish results sent)

I, the undersigned, am sponsoring _____ in this study.

The witness whose signature appears below, attests to this.

_____   _____

Date   Investigator

_____

Witness

Principal Researcher : Alvin Daniël Riffel
-Contact Details -
Address: 15 Le Grange Street, Strand, 7140
Tel: (021) 851 5134 / Cel: 082 640 0707
Fax: (021) 852 0966 / E-mail: alvin@weathershop.co.za

APPENDIX H

Lesson Plans and Assessment tools

Activity 1 : 45 Min

Indicators of Early Spring

1. Animals:

Indicators of the Length of Winter

1. Animals:

Indicators of Storms and cold fronts

1. Trees & Birds:

2. Moon:

Indicators of Wind

1. Sunset and sunrise:

2. Birds:

3. Direction:

4. Sundogs:

Activity 2: 45 Min

Cultural Weather Sayings take home research

Learners where send home with a task to collect as many possible weather saying that is still active in the community. This data was use to discussed various cultural weather sayings

Activity 3: 45 Min

Weather Instruments and weather data collection

- Learners where exposed to various weather instruments and the usage for weather data collection

Activity 4: 45 Min

IKS – Weather forecast application

The learner where exposed to a weather forecast scenario and groups where allowed to predict weather based on IKS knowledge

Activity 5: 45 Min

Knowledge Intergration and career choices in weather related work place

Activity 6: 45 Min

Weather Journal Handout

Personal Home Task: Your task is to make your own record of the weather for one week.

Activity 7: 45 Min

Weather Journal discussion session– Small and large Group discussion

Possible feedback from learner experiences and ideas

Activity 8: 45 Min

Peers and group assessment were done on all work that was covered in the process of the intervention stage. This gave learners the time to do self reflection on their own as well as their peers work. Assessment of weather journal were according to the rubric provide (Appendix H)

1.1 Structure of classroom lessons

Lesson 1 (Day 1) – Introduction

Explain to learners that identifying the seasonal cycles and weather patterns that were important to indigenous peoples. They observed the moon and animal behaviours to determine how much food should be prepared and stored for the winter months. Refining one's sensory perceptions helped to establish a knowledge base of the local environment and to prepare adequately for the weather. Seasonality provided the time framework for communal and personal activities.

Learners will make notes on the following terms:

• *Weather* - the day-to-day environmental conditions in a location.

• *Climate* - the weather conditions of an area averaged over many years.

Learners will then explore these concepts by discussing the following questions:

1. When you wake up in the morning and you think about going outside, what are you thinking about - weather or climate? How does this affect your day?

2. When you plan what you are going to do during the Easter holiday, are you thinking about weather or climate?

3. If you plan to travel to the mountains during Easter, are you thinking about weather or climate? Would you have the same plans if you stayed at home?

4. List some occupations that are weather dependent and some that are climate dependent.

(Learners will then make notes on Tools to predict weather from the information contained in **Appendix H.** Make special emphasis on the daily weather translations that could be used in the upcoming days.)

Lesson 2 (Day 2) – Cultural Weather Sayings Research

Learners will now conduct their own weather research. A day in the library or computer lab is recommended. Learners can spend the day finding answers to the guided questions and are encouraged to find new or alternate sources.

After the day of research, learners are asked to supplement their information at home.
Ask learners to share their research with their family and friends, and ask them to share any other information (home knowledge) they might have.
(See **Appendix H** for a learner worksheet entitled **Cultural Weather Research** and an answer key containing possible responses to the worksheet questions.)

Listed below are some websites that have provided enough information to provide answers to the
learners research questions:

  http://www.weathersayings.com

  http://www.metoffice.com

  http://www.kidsweather.com

  http://www.erh.noaa.gov

  http://weatherstories.ssec.wisc.edu

Lesson 3 (Day 3) – Cultural Weather Sayings Sharing

This day is designed for the learners to share their research results.

Learners will have the opportunity, either in small groups or through a teacher-directed discussion (dialogical argumentation), to share their information and to ask for clarification.

When learners are satisfied they have a complete weather sayings resource, learners can complete the summary activity.

This activity is an opportunity for learners to apply the cultural weather sayings they have researched. Learners are given possible scenarios for a typical summer situation.

Each learner is asked to choose a course of action for the upcoming day's activity. He/she must choose and then explain his/her choice, including what cultural knowledge has been used to make the decision. When learners have presented their choices individually, they may form small groups to discuss their choices.

(See **Appendix H** for a Weather Forecasting Performance Task learner handout)

Lesson 4 (Day 4) – Weather Forecasting Journal

This activity is to be completed as a performance task to show learners' understanding and application of cultural sayings.

This journal assignment can be completed immediately after the introduction activities or it can wait until learners have learned more about modern forecasting techniques.

This task takes place over the course of five days as a homework project. It involves the learners in weather observation and data collection.

Learners collected personal weather data (temperatures, wind, clouds, animals, etc.), as well as the meteorological forecast for the day. Learners are encouraged to add in weather observations as the day progresses. They are also required to write a summary at the end of the day, discussing how the predictions worked, missed, and what observations may have been omitted. An appropriate format to be used in the journal each day should be discussed. This will ensure that all the observations and analysis will be completed on a daily basis.

(See **Appendix H** for a Journal Handout, Checklist, Rubric, and possible Journal Format)

2. ASSESSMENT

IKS – Weather Forecast Application

Weather Forecasting Application Answer Key

Day 1

You wake up early in the morning and notice that there is dew on the grass. Your parents say that means there is lots of moisture in the air and there will be rain. What should you do?

a. Plan a day of indoor activities.

b. **Plan for a day outdoors**.

Explain your choice:

Because cultural knowledge says: "Dew on the grass, rain won't come to pass."

Day 2

You have discovered a beehive near your camp. You go to investigate it again this morning. You see that there is a lot of activity, with bees flying in and out of the hive. You come back to your family and tell them that this indicates:

a. **They should have a good day for outdoor activities**.

b. They should stay indoors today.

Explain your choice:

Because oral history says: "Animals act strange with a weather change."
Because cultural knowledge says: "If bees stay at home, rain will soon come; If they fly away, fine will be the day."

Day 3

You had a wonderful day yesterday with swimming, hiking, and a campfire at night. At the campfire, you noticed the stars were very clear and bright. You also noticed that the smoke was not rising very quickly from the fire. With these observations, you announce to your family that tomorrow is a good day to:

a. Spend another day at the beach.

b. **Plan for a day of indoor activities**.

Explain your choice:

Because oral history says: "East wind means storm approaching."

Because cultural knowledge says: "Chimney smoke descends, our nice weather
ends." "When stars shine clear and bright, we will have a very cold night."

Day 4

Today you wake up and notice high clouds overhead. You see that the birds on the
ground tend to be facing west. It had rained all day yesterday and most of the night. Your
parents look at the clouds and say that it is going to be a bad day and we should go for a
road trip. You:

a. Agree another day stuck inside is the only other option.

b. **Say the day will be alright and a good day to go fishing**.

Explain your choice:

Because oral history says: "Birds show wind direction. West wind change in
weather and sun approaching."

Because cultural knowledge says: "The higher the clouds, the better the weather."
"When the wind blows from the west, fish bite best; when it blows from the east,
fish bite least."

Day 5

Last night you had another campfire. The wind suddenly started to blow from the east and
you saw that the moon had a halo effect around it. You also noticed that the leaves on the
trees were turning upside down as you headed to bed. You told your parents that this
meant there was going to be rain. They said that it was too bad, for tomorrow was your
last day. They said you should all pack up in the morning and head home early. You said:

a. Yes, we should head home early.

b. **No, this weather would be gone by morning**.

Explain your choice:

Because oral history says: "When leaves show their undersides, rain is coming."

Because cultural knowledge says: "A ring around the sun or moon means rain or snow is coming soon." "Storms that come up fast never last."

3 Weather Journal Assessment

Assessment on the learner weather journal where based on the rubric as indicated in table

TABLE 3.1: Rubric for assessment of Weather Journal

Category	5	4	3	2	1
Journal Days	Five weather days observed.	Four weather days observed.	Three weather days observed.	Two weather days observed.	One weather days observed.
Signs	Recorded more than two weather signs each of the five days.	Recorded more than two signs for at least three days.	Recorded two or more signs for all days.	Recorded one weather sign for each day and two weather signs for three days.	Recorded one weather sign each day.
Use of cultural prediction	A cultural predictor was referenced in the forecast for all days, with multiple predictors used in three or more days.	A cultural predictor was referenced in the forecast for all days, with multiple predictors used in at least two days.	A cultural predictor was referenced in the forecast for four days	A cultural predictor was referenced in the forecast for three days.	A cultural predictor was referenced in the forecast for two days.
Media forecast	Reported the daily media weather and long-term forecast for all days.	Reported the daily media weather for all days, with the long-term forecast for at least three days.	Reported the daily media weather for all days.	Reported the daily media weather for at least three days.	Reported the daily media weather for one day.
Summary	There is a report of the actual weather compared to the personal and media forecasts, with suggestions of missed signs or confirmation	There is a report of the actual weather compared to the personal and media forecasts.	There is a report of the actual weather compared to the personal forecast, with suggestions of missed signs or confirmation of correct	There is a report of the actual weather compared to the personal forecast.	There is a report of the actual weather for each day.

	of correct signs.		signs.		
Full day of observation	There are two days of all-day observation. **(2 marks)**	There is one day of all-day observation. **(1 mark)**			