

**TEACHING OF CLIMATOLOGY CONCEPTS IN GRADE12 THROUGH
MULTIMEDIA: A CASE OF FOUR SCHOOLS IN JOHANNESBURG
NORTH, GAUTENG PROVINCE**



Name & Surname: Mokurubane Simon Sethole

Student Number: 479389

Supervisor's Name: Dr Nokulunga Ndlovu

Co-supervisor's Name: Dr Khanyisile Mbatha

A thesis submitted to the Wits School of Education, Faculty of Humanities, University of the Witwatersrand in fulfilment of the requirements for the degree of Master of Education

Johannesburg 2023

DECLARATION

I declare that this **INVESTIGATION OF HOW THE TEACHING OF CLIMATOLOGY CONCEPTS IN GRADE12 THROUGH MULTIMEDIA IS DONE: CASES OF FOUR SCHOOLS IN JOHANNESBURG NORTH, GAUTENG PROVINCE** is my own unaided work. It is being submitted for the degree of **Master of Education** at Wits School of Education, Faculty of Humanities at the University of the Witwatersrand. It has not been submitted before for any degree or examination at any other University.



Mokurubane Simon Sethole (Mr)

15 March 2023

DEDICATION

This dissertation is dedicated to the following people:

1. My late father, Oupa Sethole, and my mother Masimone Sethole, thank you for support and prayers.
2. My colleagues, Phalatse, Makhetha, Thabane, Mogapi, Tshangela, Shoyisa, Mdunge and Jeewan. Thank you for your endless support, it really means a lot.

ACKNOWLEDGEMENTS

I acknowledge with gratitude the following people whose invaluable contribution made this study a success:

1. My supervisor, Dr Nokulunga Ndlovu and co-supervisor Dr Khanyisile Mbatha for your clear guidance and support. Thank you so very much!
2. The Grade 12 Geography educators, their students, parents, guardians and schools for giving me the opportunity to conduct the study.

ABSTRACT

The introduction of Information and Communication Technology (ICT) within education system in the 21st Century has been a motivating and encouraging phenomenon, which has completely revolutionised the way in which teaching and learning happen within the classroom. With ICT comes the usage of multimedia that has proven its significance due to its positive impact on the teaching and learning processes. This study explores and compiles good teaching practices that Grade12 educators demonstrate when teaching the climatology concepts using multimedia. Four qualified and well-experienced Geography Educators were selected from good performing schools that has ICT infrastructure. Teacher's lessons of about 35 to 45 minutes where they taught climatology concepts using multimedia, were observed and recorded. Qualitative data collected were analysed using thematic analysis whereby categorization and combining of the trends was applied.

The findings of the study reveal that the teachers under study have similar pedagogical practices during instruction when using multimedia even though their approach and multimodalities were different. This highlights the uniqueness of each individual teacher and thus proves that there is no linear way in which multimedia teaching should happen.

In addition, the findings of the study reveal that the teachers valued the importance of investing time in designing multimedia adequately. They argue that teacher's knowledge of which multimedia to use during instruction, and how such multimedia should be used, are significant to the effectiveness of their teaching of climatology concepts in Geography. Moreover, the lesson observations revealed that multimedia was used as a centralised tool to reinforce concepts taught during the lesson - in particular, the infographic. Even though teachers used different multimodalities at different stages of their lessons, it seems that teachers used multimedia as a reference tool or point.

It is evident that teaching of climatology concepts with multimedia is multifaceted and it involves detailed and systematic planning, well thought instruction through efficient design and implementation and careful interactions between the teachers, students and multimedia (didactical triangle).

LIST OF ABBREVIATIONS

ICT Information Communication Technology

GDE Gauteng Department of Education

(NSC) National Senior Certificate

(CTML) Cognitive Theory of Multimedia Learning

CAPS Curriculum Assessment Policy Statements

DBE Department of Basic Education

HSRC Human Sciences Research Council

WITS University of the Witwatersrand

WSoE Wits School of Education

NCS National Curriculum Statement

PPT PowerPoint Presentation

LIST OF FIGURES

Diagram 5.5.1.1 Mrs Cloete's approach to multimedia teaching

Diagram 5.5.1.1 Mrs Naidoo's approach to multimedia teaching

Diagram 5.5.1.1 Mrs Motaung's approach to multimedia teaching

Diagram 5.5.1.1 Mr Mkhwanazi's approach to multimedia teaching

Figure 4.2.1 A diagram of the study's methodology and design (adapted from Maluleka, 2018)

Figure 4.4.1 A framework for cognitive theory of multimedia learning drawn from (Mayer 2001)

Figure 4.4.2 Teacher's approach to multimedia teaching (Conceptual Framework)

Figure 5.5.1.1 A satellite image showing the relationship between Coriolis force and pressure gradient force within a tropical cyclone

Figure 5.5.1.2 A diagram showing different stages of a tropical cyclone

Figure 5.5.1.3 An image showing areas in which tropical cyclones occur

Figure 5.5.2.1 A diagram showing different pressure belts around the world and associated global winds

Figure 5.5.2.2 A diagram showing the angle of the sun in winter and summer seasons in the northern hemisphere and southern hemisphere

Figure 5.5.2.3 A diagram indicating how warmer winds blow from the equator to the poles and cold winds blow from the poles to the equator to bring about energy balance across the earth

Figure 5.5.2.4 A diagram showing the angle of the sun in different seasons

Figure 5.5.2.5 A diagram showing formation of the ITCZ and its position in different seasons

Figure 5.5.2.6 A diagram showing the impact of the Coriolis force and pressure gradient force along the pressure gradient

Figure 5.5.2.7 A diagram showing tri-cellular model of global air circulation

Figure 5.5.2.8 A diagram showing global winds around world

Figure 5.5.3.1 An annotated diagram showing global pressure belts

Figure 5.5.3.2 A diagram showing the formation of low and high-pressure cells

Figure 5.5.3.3 A diagram showing different pressure belts around the world

Figure 5.5.3.4 An extract from students' textbook showing the direction in which the wind is deflected in the southern hemisphere and northern hemisphere

Figure 5.5.3.5 A diagram showing pressure belts and global winds around the world

Figure 5.5.4.1 A synoptic weather showing mid-latitude cyclone passing over South Africa

Figure 5.5.4.2 A diagram showing areas in which mid-latitude cyclones occur

Figure 5.5.4.3 A diagram showing a cold front

Figure 5.5.4.4 A diagram showing different stages of a mid-latitude cyclone

Figure 5.5.4.5 An aerial photograph showing a mid-latitude cyclone passing over South Africa

Table 5.2.1 A table showing the participants involved in the study

Table 5.3.1 A table outlining climatology concepts taught and the multimedia used to teach them

Contents

DECLARATION	ii
DEDICATION.....	iii
ACKNOWLEDGEMENTS.....	iv
ABSTRACT	v
LIST OF ABBREVIATIONS.....	vi
LIST OF FIGURES	vii
Contents	ix
CHAPTER ONE	1
INTRODUCTION AND OVERVIEW OF THE STUDY	1
1.1. INTRODUCTION AND BACKGROUND.....	1
1.2. RATIONALE AND MOTIVATION FOR THE STUDY	3
1.3. FOCUS OF THE STUDY	4
1.4. PURPOSE AND SIGNIFICANCE OF THE STUDY	5
1.5. OBJECTIVES OF THE STUDY	6
1.6. THE RESEARCH QUESTIONS.....	6
1.7. LAYOUT OF THE STUDY.....	6
1.8. CONCLUSION	7
CHAPTER TWO	8
LITERATURE REVIEW.....	8
2.1. INTRODUCTION	8
2.2. WHAT IS MULTIMEDIA?	9
2.3. ABSTRACT CLIMATOLOGY CONCEPTS AND MULTIMEDIA	9
2.4. GEOGRAPHY AS A DISCIPLINE AND MULTIMEDIA.....	11
2.5. MULTIMEDIA IN THE SOUTH AFRICAN GEOGRAPHY CURRICULUM AND POLICIES.....	13
2.6. PEDAGOGICAL VALUE OF USING MULTIMEDIA IN TEACHING	14
2.7 USAGE & BENEFITS OF INFOGRAPHICS	15
2.8 LIMITATIONS OF MULTIMEDIA IN TEACHING AND LEARNING	17
2.9. CONCLUSION	18
CHAPTER THREE.....	20
3.1. INTRODUCTION	20
3.2. MAYER’S INTERPRETATION OF MEANINGFUL LEARNING	20
3.3. DESIGNING MULTIMEDIA INSTRUCTION TO SUPPORT EFFECTIVE TEACHING AND MEANINGFUL LEARNING.....	23
3.4. CONCLUSION	25

CHAPTER FOUR	27
RESEARCH DESIGN AND METHODOLOGY	27
4.1. INTRODUCTION	27
4.2. RESEARCH DESIGN	27
4.3. INTERPRETATIVE PARADIGM.....	29
4.4. THEORETICAL FRAMEWORK AND CONCEPTUAL FRAMEWORK.....	31
4.5. RESEARCH APPROACH.....	38
4.6. RESEARCH METHODOLOGY.....	39
4.7. SAMPLING	40
4.8. TRIANGULATION.....	42
4.9. RESEARCH METHOD	42
4.9.1. SEMI-STRUCTURED INTERVIEWS.....	43
4.9.2. LESSON OBSERVATIONS	43
4.10. DATA ANALYSIS	44
4.10.1 TRANSPARENCY AND TRUSTWORTHINESS.....	46
4.11. ETHICAL CONSIDERATIONS	47
4.12. CONCLUSION	49
CHAPTER FIVE	50
PRESENTATION OF DATA.....	50
5.1. INTRODUCTION	50
5.2. PROFILE OF RESEARCH PARTICIPANTS	50
5.3 CLIMATOLOGY CONCEPTS TAUGHT AND THE TYPE OF MULTIMEDIA USED	51
5.4 SEMI-STRUCTURED INTERVIEWS.....	53
5.4.1 INTERVIEW WITH Mrs Cloete	53
5.4.2 INTERVIEW WITH Mrs Naidoo	56
5.4.3 INTERVIEW WITH Mrs Motaung	58
5.4.4 INTERVIEW WITH Mr Mkhwanazi	61
5.5 LESSON OBSERVATIONS	64
5.5.1 Mrs Cloete's lesson observation	65
5.5.2 Mrs Naidoo's lesson observation	72
5.5.3 Mrs Motaung's lesson observation.....	85
5.5.4 Mrs Mkhwanazi's lesson observation	94
5.6. CONCLUSION	103
CHAPTER SIX	104

DISCUSSION OF FINDINGS	104
6.1. INTRODUCTION	104
6.2. DISCUSSIONS OF MAIN FINDINGS	105
6.2.1. How do teachers integrate the use of multimedia in the teaching of climatological concepts?	105
6.2.2. What pedagogical value does multimedia bring during the instruction in teaching climatology concepts?.....	110
CHAPTER SEVEN.....	119
RECOMMENDATIONS AND CONCLUSIONS	119
7.1. INTRODUCTION	119
7.2. SUMMARY OF FINDINGS	119
7.3. LIMITATIONS OF THE STUDY	121
7.4. RECOMMENDATIONS.....	121
REFERENCE LIST	123
APPENDIX A Observation Schedule.....	128
APPENDIX B Interview questions for the teachers	130
APPENDIX C: APPROVAL LETTER FROM THE GRADUATE STUDIES COMMITTEE OF THE WSoE ..	131
APPENDIX D: APPROVAL LETTER RE: REQUEST TO CONDUCT RESEARCH IN GAUTENG SCHOOLS	132
APPENDIX E: A LETTER ADDRESSED TO HEADS OF SCHOOLS	133
APPENDIX: F	134
APPENDIX: G	135
APPENDIX: H	136
APPENDIX I	137
APPENDIX J	138
APPENDIX K	139
APPENDIX L	140
APPENDIX M (Infographics summarizing Mid-latitude cyclones)	141
APPENDIX N (Infographics summarizing tropical cyclones)	142
APPENDIX O	143

CHAPTER ONE

INTRODUCTION AND OVERVIEW OF THE STUDY

1.1. INTRODUCTION AND BACKGROUND

Multimedia is a term used to refer to the use of text, picture, sound, audio and video clips, animation, and graphics (Najjar, 1996a). Research has shown that the usage of ICT in the form of multimedia helps improve teaching and learning. Lynch et al. (2008) views multimedia as allowing students to grapple with real-world problems, access appropriate information quickly and easily, share their ideas with their fellow students, and construct new knowledge and meaning for themselves in relevant and interesting contexts.

While many studies have been conducted on the usage of multimedia in teaching and learning, such as Clark (1994b & 2014) & Makransky (2019 & 2021), Dr. Richard Mayer has made significant contributions on the benefits of various multimodalities in the teaching and learning processes. In his publications, Dr. Mayer has extended knowledge on how students learn better with the usage of multimedia. His research revolves around the technology (multimedia), instruction as well as the cognitive abilities of students to learn. In a nutshell, he explores in his writing how multimedia can increase the effectiveness of the teaching and learning processes. He also writes extensively about the cognitive abilities of students that needs to be triggered in order for real long time learning to happen as indicated in his various writings such as: Mayer (2008, 2014, 2015, 2017 & 2019).

In an attempt to solve lack of understanding of concepts in teaching and learning, Mayer (2001) writes about how students learn effectively when they are presented with multimedia that is thoroughly and carefully thought off. He argues that multimedia is effective when presented in the form of pictures and spoken or written text next to each other. Mayer (2001) argues that words spoken during the lesson (hearing) and picture presented during the lesson (seeing) help with the sensory memory. He notes that students can successfully select words and images effectively that will allow knowledge to be transferred to the working memory whereby both verbal and visual knowledge will be integrated together in order to process such knowledge to long-term memory.

Geography is a visual subject and as such, it demands that teachers use multimedia to make explicit abstract concepts. This study adopts Mayer's assertions on multimedia and it helps to describe what geography teachers do when they use different technologies to enhance student understanding of this subject that has concepts that students find difficult to concretize. Times Educational supplement (1961) as cited in Sofowora & Egbedokun (2010) showed the expressed mounted pressure advocating for the removal of Geography from the school curriculum in Nigeria. This problem of students not doing well in Geography will lead to students not wanting to take Geography as part of their subject package particularly in High school.

The South African Department of Basic Education Diagnostic Report (2020, p.103) reported a huge decline in the quality of passes in Geography. There were "many candidates who did not have a sound knowledge of the basic geographic concepts and therefore were not be able to answer questions of a high cognitive demand" (DBE Diagnostic Report, 2020, p.105). Understanding of basic geographic concepts appears to be a major problem facing Grade 12 students in Geography in South Africa. In fact, this lack of basic understanding of Geography concepts is also shown in the work of Balderstone and Lambert (2000) where they found that Geography thinking among individual student in secondary schools as being confusing and inarticulate.

This study contends that the usage of multimedia has a special place in the advancement of teaching climatology concepts, which appears to be abstract concepts. Gauteng Department of Education (GDE) has been on the roll out of the ICT infrastructure throughout the province since they have acknowledged the significant role that technology plays in the education system. There are a handful of scholarly articles written on the benefits of multimedia in teaching and learning. However, there has not been much written about how multimedia should be used in the teaching of abstract concepts like the ones in the climatology section of the syllabus in order to improve teaching and learning.

In the context of this study, geographical knowledge and skills are demonstrated through words or written language. Consequently, most Grade 12 students find it difficult to communicate and comprehend climatological concepts appropriately. This study investigates how teachers can best implement the usage of multimedia to help students improve their understanding of climatology abstract concepts.

1.2. RATIONALE AND MOTIVATION FOR THE STUDY

As a Geography teacher who has taught the subject at an FET (Further Education and Training) level (Grades 10 to 12) for almost a decade now, I am interested in knowing how other teachers from schools that already use ICT in the form of multimedia, use it to enhance teaching and learning. Across Gauteng province it seems that the GDE is taking the approach of enrolling ICT infrastructure so that teachers can transition from the old traditional way of teaching to a more technologically advanced method of instruction. However, there has been schools in the province where technology has been installed but the results have not changed. Consequently, this seem to suggest that there are teachers not using technology effectively in enhancing teaching and learning and ultimately adequate results.

To be specific to the study at hand, most Grade 12 students are not doing well under the climatology section in the Geography syllabus and ultimately, this poor performance affects their overall pass in the subject. Climatology section accounts for 25% of the whole Geography syllabus in the exam. This percentage is significant with regards to the students attaining quality passes in the subject. Climatology section is associated with abstract concepts, of which many students find difficult to comprehend. Language and pedagogical tools that teachers use inside their classrooms seem to have major influence in the ways in which students comprehend information. However, teachers, as experts “are often unaware of how difficult it is to grasp abstract concepts that cannot be readily visualized by students or which are outside their realm of direct experience” (Dupigny-Giroux, 2010, p.1205).

There is an urgent need for Geography teachers to share good practices of using multimedia in their classrooms in order to help other teachers who are struggling to teach using multimedia as well as those teachers that their students are struggling to

understand climatology concepts. If good teaching practices with multimedia are shared amongst all teachers in the province and across South Africa, that will help in making sure that the pass rates in climatology section and geography as a subject improve.

1.3. FOCUS OF THE STUDY

My emphasis in this study is on how Grade 12 Geography teachers use multimedia to teach abstract climatology concepts effectively and efficiently. The study looked at the pedagogical value that multimedia brings during instruction as well as the interactions between the teacher, students and multimedia.

Furthermore, this study sought to provide a better understanding on how different multimedia could be potentially used in the enhancement of teaching and learning within Geography classrooms particularly when teaching climatology concepts. This was done by analysing presentations made by the teachers in the classroom and the multimedia that they used, as well as the interview questions they answered. The status quo was done also to gain a better understanding of how teachers selected the multimedia and the rationale behind choosing that specific multimedia. This study was conducted within the field of ICT in education and Cognitive Theory of Multimedia Learning.

According to Mayer (2002, p.27), meaningful learning outcomes depend on the cognitive activity of the student during learning rather than on the student's behavioral activity during learning. For Mayer learning happens within the cognitive ability of the child and thus multimedia should be used to trigger the cognitive ability in a way that will allow the child to process the content knowledge efficiently and effortlessly. Thus, Mayer argues that multimedia messages that are designed considering how the human mind works are more likely to lead to meaningful learning than those that are not. It is within this context that this study seeks to understand what kind of multimedia teachers within Geography classrooms particularly under climatology section should be used in order to attain meaningful learning that considers the students cognitive abilities.

Given that, this research sought to highlight how the participants use multimedia in teaching of climatology concepts to achieve effective teaching and meaningful learning. Furthermore, to highlight the interactions between the teacher, students and multimedia which are key in writing a detailed comprehensive teaching and learning processes.

1.4. PURPOSE AND SIGNIFICANCE OF THE STUDY

The purpose of this study was to examine how the teachers who are already integrating multimedia are using it to enhance the teaching and learning of climatological concepts of the Geography syllabus in Grade 12 in high schools which are in the Northern part of Johannesburg.

Many geography teachers are faced with the problem of Grade 12 geography students not understanding climatology concepts and subsequently failing the section in the exams. This study seeks to understand the contribution that multimedia has in teaching of Grade12 climatology concepts. When the contribution that multimedia has in teaching of climatology concepts has been established, then Geography teachers will be able to use that knowledge to enhance their teaching. Consequently, other Grade12 teachers, in return, will be better equipped in knowing ways in which they can use to help their students in better understanding climatology concepts.

Moreover, insight gained from this study will be useful for Grade 12 teachers who are trying to implement the usage of multimedia within their classrooms and online teaching platforms, particularly during the Covid-19 pandemic. New knowledge added will be more specific to the concepts related to climatology as compared to more generalized contributions as indicated in most literature.

In the light of Gauteng Department of Education advocating for the enrolment of ICT infrastructure across the province in recent times, the findings of this study will inform geography teachers in the schools where ICTs have been introduced about the pedagogical value these technologies bring and how teachers can design multimedia to enhance an understanding of climatology concepts.

1.5. OBJECTIVES OF THE STUDY

I have accomplished the purpose of this study by fulfilling the following objectives:

- Examined how Grade 12 Geography teachers use multimedia to teach climatology in high schools within the Northern part of Johannesburg.
- Determined the pedagogical value that multimedia brings when teaching climatology concepts in high schools within the Northern part of Johannesburg.

1.6. THE RESEARCH QUESTIONS

To accomplish the above objectives the following questions were asked:

Main Research Question

- How can teachers use multimedia to enhance the teaching of Grade12 climatology concepts in high schools in the Northern part of Johannesburg?

Research Sub-Questions

- How do teachers integrate the use of multimedia in the teaching of climatological concepts in high schools in the northern part of Johannesburg?
- What pedagogical value does multimedia bring during the instruction in teaching climatology concepts in high schools in the northern part of Johannesburg?

1.7. LAYOUT OF THE STUDY

The structure of this thesis consists of SEVEN chapters and will be presented in the following manner.

CHAPTER ONE

This chapter provided discussions around the overview of the study. In this chapter discussions are centred on the background and contextualisation of the study, rationale and motivation of the study, purpose and focus of the study, problem statement, objectives of the study, research questions, significance of the study, preview of the study, and the layout of the study.

CHAPTER TWO

A review of local and international related literature is presented in this chapter.

CHAPTER THREE

This chapter is a continuation of the literature reviewed and it outlines the thinking behind Mayer's interpretation of how meaningful learning happens with the aid of multimedia. This chapter will also discuss the value that infographics bring into the teaching and learning processes.

CHAPTER FOUR

This chapter outlines the research paradigm, research methodology, research design as well as theoretical perspectives employed in this study. It provides a detailed description of the research approach and methods that were employed, and the justification of these choices based on the purpose of the study.

CHAPTER FIVE

This chapter presents the data of this study. The chapter is divided in the following sequence:

- Data from the lesson observations.
- Data from structured individual interviews.

CHAPTER SIX

This chapter discusses the main findings of the study in relation to existing literature that was reviewed.

CHAPTER SEVEN

This chapter outlines the conclusions, and recommendations of the study.

1.8. CONCLUSION

This chapter highlights a broad overview of the study by presenting some background on the introduction of multimedia into teaching in general as well as teaching abstract concepts which appears to be in the geography syllabus under the climatology section.

CHAPTER TWO

LITERATURE REVIEW

2.1. INTRODUCTION

In the recent years, there has been a shift from a traditional way of teaching to technologically advanced way of teaching. The technologically advanced way of teaching typically involves the usage of multimedia in many ways. There are volumes of literature written regarding the usage of multimedia during instruction and its benefits and affordances in general in teaching and learning (Mayer, 2014). Mayer and other multimedia researchers have also written extensively on the pedagogical benefits of multimedia and how multimedia aids cognitive processing of knowledge presented to the students [Harp, & Mayer (1998), Mayer, Heiser & Lonn (2001), and Mayer & Moreno (2002)]. However, little, if any has been written on how multimedia would specifically enhance teaching and learning of abstract climatology concepts in Geography. Hence, major part of this study, is envisioned to highlight the pedagogical benefits of multimedia when teaching abstract concepts. Moreover, unpack the effectiveness of multimedia teaching and how meaningful learning is promoted by the usage of multimedia. The discussions in this section will be addressed in the following manner:

- What is multimedia?
- Climatology concepts and multimedia
- Abstract concepts and multimedia
- Multimedia in the South African Geography curriculum
- Pedagogical value of using multimedia
- Usage and benefits of infographics
- Limitations of multimedia in teaching and learning
- Performances of schools in Gauteng vs South Africa in Geography

2.2. WHAT IS MULTIMEDIA?

According to Shank (2005) definitions of multimedia vary. Richard Mayer, who has written extensively on multimedia, defines multimedia as presentation of content that relies on both text and graphics. Shank (2005, p.2) states, “This definition, in my opinion, is a good start, but it doesn’t provide deep enough insights about the essential factors that can make multimedia effective (or less effective) for learning”. However, she argues that definition given by Neo, M & Neo, K. T. (2001) is more descriptive, they argue that is the combination of various digital media types such as text, images, sound and video, into an integrated multi-sensory interactive application or presentation to convey a message or information to an audience. As for, Agnew, Kellerman & Meyer (1996) multimedia is seen as the combination of various digital media types such as text, images, sound and video, into an integrated multi-sensory interactive application or presentation to convey a message or information to an audience.

As indicated earlier that multimedia has different definitions, which are slightly different depending on the perspective the author is holding. For the purposes of this study, multimedia is understood as the term used to refer to the usage of texts, picture, sounds, audios and video clips, animations and graphics in teaching and learning. Shank (2005) notes that multimedia uses a variety of technological tools to facilitate people’s understanding on the problems that they are dealing with in any context.

2.3. ABSTRACT CLIMATOLOGY CONCEPTS AND MULTIMEDIA

“Computer multimedia can provide dynamic, interactive models in the classroom which would be difficult to provide without computer technology. For example, an interactive model of the Coriolis effect, with animated diagrams and video clips, has been developed to teach this infamously difficult concept” (Krygier, Reeves, DiBiase & Cupp, 1997, p. 19). Coriolis Effect or force is a climatological concept that can be taught easily in Geography using animated diagram or video clips. Effect of the Coriolis Effect as the results of the rotation of the earth is one of the many abstract climatology concepts that Geography teachers have struggled to teach for many years. Thus, Krygier et al. (1997) argue that the instructor (or a student) can iteratively examine the effect that the

rotation of the earth has on circulation patterns in different hemispheres. Furthermore, they argue that the instructor can download video clips of current satellite imagery to illustrate how the more abstract model relates to actual circulation patterns. Different multimedia can be creatively integrated in the multimedia instruction in order to facilitate effective learning and meaningful learning.

According to Li (2011) multimedia technology has been widely applied in different industries. However, he argues that recently its function is more and more obvious in geography teaching. The reason for this could be that most of the concepts taught in Geography are practical and relate to the world that we live in such as Global warming and Tropical Cyclones. He further argues that abstract concepts of space represented by earth movement and formation of eclipse, three-dimensional animation can be adopted to solve the problem. Multimedia seems to be very effective in bringing real life pictures in front of the students inside the classroom, subsequently, students are able to comprehend the content knowledge. "Geography teaching consists of various aspects ranging from astronomy, customs, mineral resources and climates changes to plate movement" (Li, 2011, p.584).

Beneker & Van der Vaart (2020) stresses that explanatory power does not lie in abstract concepts themselves or concrete facts but in the combination of both, which allows the detection of sense-making connections. Moreover, Vernon (2020) argues that the journey towards powerful knowledge and the development of an epistemic self is not considered to take a linear path but instead a spiral, constantly moving between the very concrete and the very abstract. According to Bernstein (2000), an increasing classification leads to more demanding recognition and realization rules focusing on correct connections. How then can multimedia help with recognition and realization rules, when classifications (abstract concepts) are taught? Researchers like Mayer have established multimedia teaching principles such as contiguity Principle and multimedia Principle, which indicates how abstract concepts should be taught to promote meaningful learning.

Li (2011, p. 582) provides an example where multimedia can be used and speculates within which dimensions that it is possible. “Strong concepts of space representing by earth movement and formation of eclipse, three-dimensional animation can be adopted to solve the problem. For formation of convective rain and Orographic rain, atmosphere movement and water movement two-dimensional animation is enough”. Abstract concepts can be taught using combination of multimedia such as pictures, audio and video clips so that students can effectively engage with the content knowledge by seeing and hearing and this will allow the students to store knowledge in the long-term memory. Beyond capturing students’ attention with multimedia such as video and animation, is there anything more to multimedia? I believe there is still more that we need to discover about the role multimedia has in teaching and learning of Geography concepts. However, teacher’s pedagogy should not allow multimedia to do the teaching for them, but rather use multimedia to help with their teaching. Frank & Barzilai (2006) noted, teachers using technology should understand first that their roles are different from their traditional lecturing roles, and they should realize that by using technology, teachers are no longer just providers of knowledge but rather exchangers, since students exposed to technology are typically more intimately involved in creating knowledge (Hofstetter, 2001)

2.4. GEOGRAPHY AS A DISCIPLINE AND MULTIMEDIA

Geography is one of the subjects offered at the FET level in schools across South Africa. CAPS (2011) outline that Geography is the study of human and physical environments and it combines topics related to physical and human processes over space and time. With the use of Geography, we can better understand our complex world. Geography has an element of technical and scientific concepts taught within it. According to DaSilva & Kvasnak (2012) the discipline of geography has advanced as a science and through this development as a science, it requires better scientific methods to keep up with the new ways of communicating information to students. Geography has many scientific and abstract concepts envisaged in it and thus there is a need for Geography teachers and instructional designers to come with effective ways in teaching these concepts with multimedia.

Moreover, Hofstetter (2001) demonstrates that geography is a highly visual discipline, which makes it a natural subject for multimedia use. He argues that since geography is about the study of the Earth's crust and its change, the analysis of the cultural and physical landscapes makes the visual side of geography very strong. The cartographic side of geography is visual when students create in their minds mental maps, in connection with multimedia presentations. Not like any other discipline, Geography requires the illustration of concepts to enhance the understanding and comprehension for the students, which can be achieved by the usage of technology in the form of multimedia. Thus, Rich, Pitman & Gosper (2001) suggest that the use of technology is increasingly common in geography teaching and learning, and they outline a still relatively unusual initiative involving the integrated use of a variety of IT-based components across all aspects of a large course unit. The technical, scientific and abstract nature of the concepts taught in Geography requires advancement in technology particularly with multimedia fast tracked.

DaSilva & Kvasnak (2012, p.20) asserts that in a survey of geographers in the United Kingdom, McKendrick (1999) reported the experiences of those using audio-visual (multimedia) resources to support teaching and learning in their classrooms. He states that the results of the survey suggest geographical teaching has embraced audio-visual (multimedia) resources and that these are, on the whole, being employed effectively in geography classrooms. Technology in the form of multimedia plays a critical role in terms of promoting effective teaching and meaningful learning in Geography classrooms. Thus, McKendrick (1999) concludes that integration of audio-visual resources into the mainstream curriculum and that active learning on the part of the students are essential to ensure effective and sustainable deployment of audio-visual technology. Multimedia help students to easily comprehend and understand content knowledge due to the nature of multimedia tools which can be seen and heard. Thus, Mikropoulos (1996) argues that multimedia cannot necessarily help students to think better, however, what it does in many aspects is to allow them to experience more content knowledge and in various ways.

“School geography is a discipline where the need of media is obvious. The aims of multimedia technology in teaching geography are information acquisition, data processing, skill development, knowledge construction, and conclusions’ inference.” (Mikropoulos, 1996, p. 2). It appears that multimedia technology is a necessity inside Geography classrooms due its benefits and affordances provided to the students and teaching. Thus, Byron (1993) states that visual presentation of information (multimedia) is a characteristic feature of geography such as maps, diagrams and still photographs, which are used extensively in teaching and learning. Visual presentation and representation remain an integral part of a geographical education (Aitken, 1994; Rose, 1997).

2.5. MULTIMEDIA IN THE SOUTH AFRICAN GEOGRAPHY CURRICULUM AND POLICIES

After the introduction of the Curriculum and Assessment Policy Statements (CAPS) in South Africa in 2010, the emphasis has shifted from traditional way of teaching to a more technological orientated way of teaching through using a variety of multimedia to teach in Geography classrooms. In addition, it is in the Geography CAPS document where the integration of multimedia has been emphasized for the teachers to use in order to construct, facilitate and enhance student’s understanding. This belief that multimedia enhances teaching and learning, is also indicated in White Paper (2016) when it states the introduction of ICT can connect students and teachers to better share information, ideas with one another through effective combinations of pedagogy and technology in support of educational reform.

According to the CAPS document (2011) The National Curriculum Statement (NCS) Grades R-12 gives expression to the knowledge, skills and values worth learning in South African schools. One of the aims outlined in the CAPS document (2011, p.4) is “to produce students that are able to use science and technology effectively and critically showing responsibility towards the environment and the health of others; and demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation. The usage of multimedia technology within Geography

classrooms allows teachers to expose their students to the technology and to how show different aspects of the syllabus linked with each other.

In addition, CAPS document (2011, p.8) outlines that “During Grades 10, 11 and 12 students are guided towards developing the following knowledge, skills and attitudes: promoting the use of new technologies, such as Information Communication Technology (ICT) and Geographical Information Systems (GIS)”. One of the key geography skills, knowledge and values expected to be obtained by the students when they exist the schooling system is to be able to use different technologies. It is important that teachers start using some of these technologies in order to expose the students so that they can use them and later solve problems with the tools within them. Thus, White Paper (2016) asserts that the introduction of information and communication technologies (ICTs) in education represents an important part of Government's strategy to improve the quality of learning and teaching across the education and training system. With the introduction of ICTs within schools in South Africa, multimedia will be easily incorporated into the classrooms. White Paper (2016, p.20) states that quest for active contextual learning to promote understanding will be supplemented by multimedia applications that require students to create realistic contexts for problem-solving, data analysis and the creation of knowledge in the learning process. Skills and knowledge envisaged in both the CAPS document and the White Paper are the same with the emphasis on the usage of multimedia technology.

2.6. PEDAGOGICAL VALUE OF USING MULTIMEDIA IN TEACHING

The usage of multimedia has been seen as a solution by many educational institutions, parents, teachers and students across the world. Proponents of multimedia claim that their use could change the way we understand, think, learn and work (Barrett, 1992). However, from a teacher's perspective there are still challenges in terms of how they need to use multimedia for effective teaching and learning. According to Lehtinen (2000) during the 1980s and 1990s, there was a rapid increase in commercially produced multimedia learning materials. However, he argues that at the same time, there was both

optimism and skepticism about the pedagogical quality of the multimedia material available. Even though the benefits of multimedia across literature in educational technology, it is still very important to consider other factors that contribute to effective teaching and learning.

According to Mikkilä & Olkinuora (1994, p. 152) learning materials such as multimedia can be seen as an important factor influencing the quality of the learning process. Dillon & Gabbard (1998) assert that the teacher can use multimedia material as a teaching tool and hence improving pedagogical value of a certain multimedia material. For instance, multimedia can be used for illustrating, animating, simulating, and demonstrating target phenomena; and bringing experiential, emotional, or phenomenological elements into material in order to increase students' motivational interest in certain contents. On the other hand, Tergan (1997) argues that if content to be learned is relatively demanding and complex for the age group in question and one doesn't receive scaffolding from the teacher, those students who have low self-regulatory capability may feel cognitive overload and destructive friction despite being generally motivated by the appealing-looking multimedia material. Thus, Olkinuora, Mikkilä-Erdmann & Nurmi (2004) argue that the quality of the pedagogical design of such materials and ways of implementing them in instruction are the most important factors, not the technology applied in the multimedia materials as such.

2.7 USAGE & BENEFITS OF INFOGRAPHICS

In recent years, multimedia in the form infographics has been widely accepted and used in many industries and most importantly in education. Thus, Smiciklas (2012) asserts that infographic is one kind of visual communication (multimedia), that is gaining popularity and has becoming one of the most effective forms of content for communicating information in the digital era. In addition, Kharbach (2012) also notes that infographics have become great educational materials to use in both teaching and learning. This now leads to these questions: What are infographics? How are they used in education to improve performance of the students? What are the benefits of using multimedia in teaching and learning? These are some of the questions, which this subsection in this study will be attempting to answer. According to Kharbach (2012), infographic comes from

combination of two words information and graphics. He argues that it is multi-modal in the sense that it can have different forms of text, flowcharts, diagrams, images and many more. He highlights the fact that infographics are defined as a visualization of data or ideas that tries to convey complex information to an audience in a manner that can be quickly consumed and easily understood. There is an element of scaffolding that is associated with infographics because it considers how complex and abstract concepts should be simplified for the students to consume information presented the easiest possible way.

Vanichvasin (2013, p.137) asserts that in recent years “special attention was therefore drawn to enhancing the quality of learning through the use of infographics in two dimensions”. Lankow, Ritchie & Crooks (2012) suggested three basic provisions of all effective visual communication (multimedia) methods. They argue that all teaching methods using multimedia should consider appeal of the tool used, how the tool will help with comprehension and how the tool will help the viewer with retention of the data presented. Instructional designers and teachers should design infographics that allows easy communication that should engage the students. In addition, the way infographic is structured, communication should effectively provide knowledge that enables a clear understanding of the information for the students. Lastly, communication should impart memorable knowledge (Lankow, Ritchie & Crooks, 2012).

In addition, Vanichvasin (2013) notes that infographic is considered as visual aid that can be used to give content, explain content, use as learning activity such as mind map or case study, show example and conclude content with the aim to support learning and make student feel satisfied with this learning tool. There are numerous ways in which infographics can be used, responsibility lies with the teacher in terms of how they want to implement it during instruction for effective teaching and learning. Thus, Lankow, Ritchie & Crooks (2012) highlight that infographics provide a format utilizing visuals that not only appeal to an audience hungry for information but also aid in the comprehension and retention of that material. On the other hand, some scholars argue that it is useful for teachers to teach students to create infographics as the exercise will allow students

to comprehend information and retain it for longer period. MacQuarrie (2012) asserts that courses that teach students to create their own infographics using a variety of tools may encourage engagement in the classroom and may lead to a better understanding of the concepts they are mapping onto the graphics. Both students and the teachers can create Infographics, and in both instances, it appears that comprehension and retention of knowledge is supported from a student's perspective.

Multimedia scholars have written about the many benefits that infographics provide to teaching and learning. In the study that Vanichvasin (2013) conducted, he found that infographics played an important role in communicating with and connecting to students by way of not only presenting knowledge and stimulating interest but also reaching and engaging students through varied learning activities that infographics were interactively used. He argues that visual communication tool in the form of infographic attracted interest, stimulated learning, helped recognize content easily and made easy for them to understand. Thus, Kharbach (2012) that infographic can become great education materials to use in both teaching and learning in the sense that it could promote basic communication. Based on the findings of this study, it appears infographics have many affordances to teaching and learning. Infographics can promote, enhance and better learning and it provides visual appeal of the content, easy recognition of the connections that exists between concepts and makes concepts easily understandable.

2.8 LIMITATIONS OF MULTIMEDIA IN TEACHING AND LEARNING

According to Qi (2009, p. 265) multimedia has also its negatives towards teaching and learning in general. He argues that most teachers cannot control the rhythm in a class, quickening teaching process and as a result, students are passively led by PowerPoint Presentations (PPPs) and cannot think creatively in class. Teachers should perhaps look at the pacing of their lessons through using any technological or computer related teaching aids. Furthermore, Qi (2009) asserts that multimedia sometime fosters laziness. He states, "Many teachers use the same PPPs when teaching the same lesson. Teachers do not change contents on PPP according to students' reaction and teachers pay no attention to exploring teaching patterns. In the long run teachers become lazy and don't fully prepare for every class". Thus, Mayer (1997) argues that the idea of introducing multimedia within the

classroom was to move away from the traditional way to a more modern way where students will be able to construct knowledge and cooperatively learn with others and not let multimedia do the teaching for the teachers.

Moreover, Shank (2005) asserts that multimedia adds complexity both to the screen and to the tasks that students need to perform. She argues that by definition, a learning environment is already an unfamiliar and perhaps complex space. For the fact that multimedia can happen in succession and quickly, for example video or audio clips, this already places an anxiety on the student part to understand as many concepts while the multimedia is playing. “Lockstep or highly constrained navigation, for example, can make students feel as if they are being coerced rather than led, with no control over their own learning” (Shank, 2005, p.11).

Lastly, Shank (2005) notes that teachers need to consider whether the combination of media adds to the learning experience. Too much multimedia at once may not necessarily help students to learn effectively, but to achieve the exact opposite. Thus, Mayer (2002) speaks about instructional designer who needs to avoid cognitively overloading students. Shank (2005) proposes that instructional designer and teachers need to ask themselves the following questions before they present it to the students. Is it confusing? Is it frustrating? Is it too much? If any of these questions answered yes, it means there is high probability that multimedia will not promote effective teaching and meaningful learning.

2.9. CONCLUSION

This section has defined multimedia as the usage of texts, picture, sounds, audios and video clips, animations and graphics in teaching and learning. Many multimedia researchers have seen multimedia as a solution in effectively teaching abstract climatology concepts to achieve meaningful learning. Multimedia is a characteristic feature of geography as a discipline, and it has been happening for many years. The South African curriculum (CAPS) and White Paper advocate and support the usage of multimedia technology in Geography classrooms for effective teaching and learning. Infographic has been widely used by Geography teachers because of its ability to narrate and summarize

the lesson or topic or concepts from start to finish with the combinations of visuals and text. There are numerous limitations of using multimedia like incorporating too many multimedia at once and/or multimedia being integrated inadequately without a purpose.

CHAPTER THREE

3.1. INTRODUCTION

This section of the study reviews literature based on designing multimedia instruction for meaningful learning. Even though some of the concepts have been spoken about in the theoretical and conceptual frameworks section of this study, in this section the study will explain these concepts in more details. The study will first outline the thinking behind Mayer's interpretation of how meaningful learning happens with the aid of multimedia. Secondly, it will unpack how to design multimedia instruction to support effective teaching and meaningful learning.

3.2. MAYER'S INTERPRETATION OF MEANINGFUL LEARNING

According to Mayer (2002), cognitive theory of multimedia learning is based on the three basic ideas about how the human mind works (Refer to Figure 4.4.2 on page 32). The one part represents the auditory-verbal channel and the other represents visual-pictorial channel. "Words enter the cognitive system through the ears (if the words are spoken), and pictures enter through the eyes. In the cognitive process of selecting words, the student pays attention to some of the words, yielding the construction of some word sounds in working memory" (Mayer, 2002, p.60). The emphasis at this stage is at the parts of the body that receives the specific type of multimedia presented to it. Thus, Mayer (2002) asserts that in the cognitive process of selecting images, the student pays attention to some aspects of the pictures, yielding the construction of some images in working memory. In the cognitive process of organizing words, the student mentally arranges the selected words into a coherent mental representation in working memory that we call a verbal model. The multimedia presented to the student at this stage plays a major role concerning how the content knowledge presented with multimedia is to be processed in the brain.

Mayer (2002) argues that over a long period emphasis has been on the verbal forms of instruction such as text and spoken language, but he argues that things recently have changed with the introduction of technology. Thus, Pailliotet & Mosenthal (2000) states that despite the disproportionate emphasis on verbal forms of instruction, advances in computer graphics and the proliferation of pictorial representations on the World Wide Web have led to an increasing interest in exploiting the potential of pictorial forms of instruction as aids to meaningful learning. Improvement in technology has enhanced the usage of other multimodal besides spoken language and written text.

Mayer (2002) discusses principles that are significant to multimedia instructional designer in enhancing teaching and learning. Some of these principles are also discussed briefly in under theoretical and conceptual framework section, but in this section this study elaborates more on these principles. These principles are Multimedia Principle, Contiguity Principle, Coherence Principle and Modality Principle. These principles are elaborated upon below, starting with the multimedia principle. Mayer discusses eight principles, but this study will focus only on four, which are believed by many scholars to form integral part of effective design and integration of multimedia learning.

1. Multimedia principle

According to Robinson (2004) multimedia principle is based on the idea that meaningful learning occurs from words and pictures than from words alone. He argues that this principle answers the question “Does adding pictures to a verbal explanation help students to understand the explanation better?” Mayer & Anderson (1991) asserts that students learn more deeply from a multimedia explanation than from a verbal explanation alone. They conducted three studies in which students viewed a narrated animation about pumps or brakes or simply listened to a narration. They discovered that students learn more deeply from a multimedia explanation than from a verbal explanation. Thus, Mayer (2002, p.63) asserts “These results point to the importance of pictorial representations in helping students to understand explanations and allow us to offer the multimedia principle: Students learn more deeply from multimedia presentations involving words and pictures than from words alone”. Based on the multimedia principle it can be concluded

that the usage of visuals and text together is better the usage of text or spoken words alone.

2. Contiguity Principle

Mayer (2002) asks the “How should words and pictures be coordinated in multimedia presentations?” He argues that according to the cognitive theory of multimedia learning, students are more likely to engage in productive cognitive processing when corresponding words and pictures are presented at the same time. The key with this principle is with location of where different multimodal are coordinated on the presentation. Thus, Robinson (2004) notes that meaningful learning results from presenting words and pictures simultaneously rather than successively. This principle implies that simultaneous presentation would increase the opportunity for matching the pictures and words that need to be processed at the same time in order to facilitate construction of connections between multimodal. Condition that promotes meaningful learning, which I call the contiguity principle: Students learn more deeply from multimedia presentations in which animation and narration are presented simultaneously rather than successively. The key issue concerning this principle is the idea that simultaneous presentation of multimedia is better and efficient than successive presentation of multimedia.

3. Coherence Principle

According to Mayer (2002), coherence principle answers the question “How can we make multimedia presentations more interesting?” Harp & Mayer (1998) argue that the rationale behind coherence principle is based on interest theory, which suggests that adding interesting adjuncts arouses the student, and this arousal results in increased attention to the incoming material. Thus, Mayer (2002) asserts that seemingly reasonable interest theory of learning posits that students learn more from an expanded version of a multimedia presentation (one containing interesting adjuncts) than from a basic version (one containing no interesting adjuncts). Robinson (2004) recalls that prior research shows that adding interesting but irrelevant text to a passage does not enhance learning and sometimes hinders it. Similarly, he argues that the multimedia theory suggests that

adding interesting but irrelevant material to a multimedia presentation can overload one or both processing channels and this can disrupt the integration of pictorial models, verbal models, and prior knowledge. The coherence principle can be proposed: Students learn more deeply from multimedia presentations in which extraneous words, sounds, and video are excluded rather than included (Mayer, 2002). The underlying factor with the coherence principle is the idea that students learn better with basic version of multimedia presentation than an expanded version of a multimedia presentation.

4. Modality Principle

According to Robinson (2004), Mayer's research shows that students learn more deeply from animation and narration than from animation and on-screen text. He argues that the modality principle was first identified in a paper-based study in which students learned to solve geometry problems more productively from printed illustrations and concurrent narration than from printed illustrations and printed text. In the study that was conducted by Mayer & Moreno (1998, 1999) experiments 1 and 2; experiments 1 and 2) students performed better on transfer tests when the multimedia presentation consisted of animation and narration than animation and on-screen text. Modality principle sees one presentation of multimedia being better over the other one, and in this case, animation and narration being better than animation and screen text.

3.3. DESIGNING MULTIMEDIA INSTRUCTION TO SUPPORT EFFECTIVE TEACHING AND MEANINGFUL LEARNING

Mayer (2004, p. 385) argues that multimedia instruction refers to the instruction that includes words (e.g., printed or spoken text) and pictures (i.e., static graphics such as illustrations, diagrams, charts, maps, and photos, or dynamic graphics such as animation and video). He argues that multimedia instruction can be presented on paper such as printed text and figures, on a computer as narrated animation and annotated graphics, on a handheld device as a game involving printed words and graphics), or face-to-face as a narrated slide presentation. Narrated slide presentation is the multimedia instruction used mostly within our classrooms in South Africa within schools that have ICT infrastructure.

According to Mayer (2014) in the field of education, instruction has traditionally been based on verbal media, including spoken words for example in lectures, discussions, or tutorials) and printed words (e.g., in textbooks). However, in recent history, instruction has taken a different shape with the introduction of technology. Mayer (2014) argues that over the past 350 years there have been visionaries who proposed an instructional approach that combined words and pictures, and scientists who investigated the effectiveness of such multimedia instruction for student learning. Which then brings us to the idea of teaching and learning with technology in the form of multimedia. Thus, Mayer (2014) asserts the history of multimedia instruction has evolved and one of the aspects of it was in the 1900s, when scientific study of multimedia learning in computer-based environments was given more attention by multimedia scholars. This is the time; Lefevre (2004) states that in the field of engineering, machine books containing annotated illustrations of machines began appearing in the Middle Ages as a means of communicating between engineers and investors as well as between engineers and the artisans carrying out the work.

In addition, Mayer (2008) asserts that central issue in the science of instruction concerns how to help people learn. He argues that multimedia instruction works by priming appropriate cognitive processing in the student mind's during learning, by guiding the students in selecting of relevant material, organizing of the material into a coherent cognitive representation, and integrating of the representation with other relevant knowledge. The primary objective of the teacher is to design multimedia instruction that will help the students to learn better through organising the multimedia in a structured manner. Thus, Mayer (2008) argues that the central challenge of instructional design is how to encourage students to engage in appropriate cognitive processing during learning while not overloading the processing capacity of the verbal or pictorial channel. The teacher's responsibility is to design teaching material in an effective manner to allow easier processing from the learning side but also to avoid presenting too many multimodal, which might overload students cognitively. The teacher needs to know the

concepts he wants the students to know and consequently focus the student's attention to such concepts.

Moreover, Sweller (1999) argues that there are several multiple approaches or principles that teachers need to consider while designing multimedia instruction. He asserts that key elements in the science of instruction are:

- (a) Reducing extraneous processing—cognitive processing that does not support the instructional goal and is attributable to confusing instructional design
- (b) Managing essential processing—cognitive processing needed to mentally represent the incoming material and that is attributable to the complexity of the material
- (c) Fostering generative processing—cognitive processing aimed at making sense of the incoming material, including organizing it and integrating it with prior knowledge

In summary, reducing extraneous multimedia in teaching should be a priority for instructional designer and they must think creatively in terms of presenting required information that students need to learn within a specific period. Cognitive processing of content knowledge made easier by multimedia presentation thus enhancing meaningful learning should be the ultimate goal that teachers strive towards in teaching. Managing of essential information is key in ensuring successful multimedia instruction because it will direct the teacher on the approaches needed in terms of the amount of information that needs to be presented and the quantity. Lastly, the focus of the instructional designer such as a teacher should be to organise and integrate content knowledge using multimedia in such a way that incoming knowledge is processed effectively without putting any strain on the cognitive processing.

3.4. CONCLUSION

This section has described in details how multimedia instruction should designed in order to promote effective teaching and meaningful learning. Mayer researched 8 principles that need to be considered by multimedia instructional designer and he argues that if these principles are implanted in the lesson effective teaching and meaningful learning

is imminent. However, Mayer highlighted the fact that additional research needs to be taken in order to establish if indeed the interactivity principle and personalization principle can influence multimedia teaching and learning. This section also looked at how students comprehend content knowledge when it is presented in the form of multimedia. Mayer argues that there are three memories that knowledge must be processed in from sensory memory to working memory until knowledge is stored in the long-term memory.

CHAPTER FOUR

RESEARCH DESIGN AND METHODOLOGY

4.1. INTRODUCTION

Research design and methodology section outlines the research paradigm, research methodology, design as well as theoretical perspectives employed in the study. This section will provide a detailed description of the research approach and methods that were employed. The section also provides justification of these choices based on the purpose and objectives of the study. This study adopts a qualitative approach because it enables the researcher to examine, understand and explain how some Grade 12 Geography teachers used multimedia in their classroom to teach abstract climatology concepts. Quantitative approach is known by promoting the explanation of data in depth. For this study, qualitative approach affords the researcher to present detailed insights into how Grade 12 Geography teachers incorporate multimedia to enhance teaching and learning. Qualitative approach also allows the researcher to report in detail about the interactions that exist between the teacher, students and the multimedia for effective and meaningful learning to happen. Lastly, this section explores consideration that was given to data analysis, ethical issues such as confidentiality, informed consent, and anonymity.

4.2. RESEARCH DESIGN

According to Makombe (2017) a research paradigm is worldview about how to conduct research. He argues that research paradigms include the methodology, approach, ontology, and epistemology to conduct the research. Furthermore, research paradigms are ‘the entire constellation of beliefs, values, techniques, and so on shared by members of a given community’ (Kuhn, 1970, p.175). In addition, Burns and Grove (2003, p.195) see research design as “a blueprint for conducting a study with maximum control over factors that may interfere with the validity of the findings”. Thus, De Vos, Schulze, & Patel (2005) argue that research paradigm is a logical and coherent strategy used to collect and generate data about desired knowledge. It is also “the researcher’s overall

for answering the research questions or testing the research hypothesis”, (Polit, Beck, & Hungler, 2001, p.167).

Given the thoughts above, this study adopted well thought off paradigm, which applies the logical and coherent strategy in the collection, generation and analyzation of data for the desired created knowledge. This study used Maluleka’s (2018, p.68) template as an example of a summary of a research design to summarise this research. The outline is on the table below.

Figure 4.2.1: A diagram of the study’s methodology and design (adapted from Maluleka, 2018)

<u>PARADIGM</u>	Interpretative
<u>THEORETICAL PERSPECTIVES</u>	Constructionism vs. deconstructionism
<u>RESEARCH APPROACH</u>	Qualitative
<u>RESEARCH METHODOLOGY</u>	Phenomenological Research approach
<u>RESEARCH METHODS</u>	Lesson observation Semi-structured interviews
<u>DATA ANALYSIS</u>	Transcription of data Coding and identification of categories Themes identification Quality criteria Credibility Transferability Dependability

<u>ETHICAL CONSIDERATIONS</u>	Confidentiality Informed consent Anonymity
--------------------------------------	--

4.3. INTERPRETATIVE PARADIGM

This study used interpretivism paradigm approach whereby knowledge is derived from the experience of the members of the society. Thus, Weber (1991) argues that interpretivism emphasizes on the study of distinct human behavior in the distinct situations from where they belong, this belief rejects the use of pre-proposed methodologies in research. Thus, Rubin & Babbie (2010) assert that Interpretivism is based on the premise that seeks to understand and interpret everyday happenings (events), experiences and social structures - as well as the values people attach to these phenomena.

According to Maluleka (2018, p.69) interpretivist paradigm is related to phenomenology, because it seeks to explore participants' understanding and engagement with the phenomena. Phenomenology is a science whose purpose is to offer methods of inquiring into the meanings of individual lived experiences (Creswell, 2013). Phenomenology allows this study to interrogate the views, values and conceptions that teachers have when they teach climatology concepts using multimedia. In addition, phenomenology will allow the researcher to observe and analyse the interactions that exist between the teacher, students and multimedia in order to promote effective teaching and meaningful learning.

In addition, Alharahsheh & Pius (2020) state that interpretivism developed through critique of positivism with subjective perspective. They argue that interpretivism is more concerned with in depth variables and factors related a context, it considers humans as different from physical phenomena as they create further depth in meanings with the assumption that human beings cannot be explored in a similar way to physical phenomena. Unlike, positivism which is more reliant on status que with more of the research findings being descriptive. Therefore, this might be challenging for researchers to gain further insight of in-depth issues to be considered part of their research (Alharahsheh & Pius, 2020). This alludes to the fact that even though the interprevisit

and positivist share similar qualities, it is deal for this study to adopt the former. The reason being, this study wants to compile good practices that teachers exhibit with multimedia when teaching climatology and consequently, it is justifiable to engage with the participants at first hand in order to observe, understand and interpret teaching and interactions happening in their lessons.

Henning, van Rensburg and Smit (2004) as cited in (Maluleka, 2018) argue that the interpretivist paradigm can be used in qualitative research due to its descriptive nature, as it seeks to present the participants' reality from their own viewpoints. This is because all humans continuously try to make sense of their worlds (Weber, 1864-1920) - and the process involves continuously interpreting, creating, give meaning, defining, justifying and rationalising daily actions (Babbie & Mouton, 2008). It is significant to present participant's realities as alluded by Weber, and ultimately such realities are interpreted to allow the researcher to make a conclusion analysis of the reality.

Interpretivism also focuses on exploring the complexity of social phenomena with a view to gaining understanding. Its purpose is to understand and interpret everyday happenings (events), experiences and social structures - as well as the values people attach to these phenomena (Collis & Hussey, 2009; Rubin & Babbie, 2010). This means that truth is contextual. It depends on the situation, the people being observed, and even the person doing the observation. Thus, the researcher as a social actor needs to appreciate diverse views that people bring to the fore (Oates, 2006; Saunders, Lewis & Thornhill, 2013). This is because, interpretive researchers acknowledge that access to reality (given or socially constructed) is only through social constructions such as language, consciousness, shared meanings, shared or individual memories and instruments (Myers, 2008).

Furthermore, interpretivists value individual experiences, and gather data through participant observation, interviewing and analysing documents (Lather, 2006) - all of which inform this study's research methods. These methods are viewed as being best within the interpretive research paradigm, because they involve interpretation and observation (Livesey, 2006). In turn, these methods require from the researcher an

understanding of how participants *reconstruct*, experience, as well as re-interpret and re-present the world.

Based on the discussions above, this study adopted interpretivism as a research paradigm because the study acknowledges the fact that knowledge is derived from the interactions of human beings within a particular social context. Interpretivism is suited for this study because this study aims to understand the preparation, lesson designs as well as the instruction that different geography teachers apply in their classrooms with the usage of multimedia. Interpretivism allows for different teachers to show and tell their side of the story in terms of the approach that they hold when teaching climatology concepts with multimedia. As an interpretivist researcher it is important to understand motives, meanings, reasons and other subjective experiences which are time and context bound (Neuman, 2000). For this study, motives, meanings and reasons are important because the study wants to understand kinds of multimedia used and the rationale behind using those multimodalities.

4.4. THEORETICAL FRAMEWORK AND CONCEPTUAL FRAMEWORK

In this section, this study will be unpacking some theoretical and conceptual frameworks that underpins the study. These two frameworks were used to analyse the literature review and data analysis sections of the study. Firstly, the study will discuss the main pillars of the Cognitive Theory of Multimedia Learning (CTML) and various research that supports. Secondly, the study will unpack the conceptual framework adopted in the study in terms of how teachers should implement multimedia in their teaching. Lastly, the study will merge these two frameworks in an attempt to explain how effective teaching with multimedia will promote meaningful learning.

According to Maluleka (2018) theories within the social sciences are understood as models or frameworks for observation and understanding the social world, which shape both what we see and how we see it. Theories also enable researchers to make links between the abstract and the concrete; the theoretical and the empirical; thought statements and observational statements (Fox and Bayat, 2007). For Mooney, Knox, and Schacht (2007) theories provide us with perspective. A theoretical perspective or theoretical framework

deals with the theory or theories that the researcher chooses as guide for the study under investigation. The framework below looks at how the students process the information from the time multimedia presented to them until the knowledge is stored in the long-term memory. Cognitive Theory of Multimedia Learning (CTML) is taken from the work of Mayer (2001).

THEORETICAL FRAMEWORK

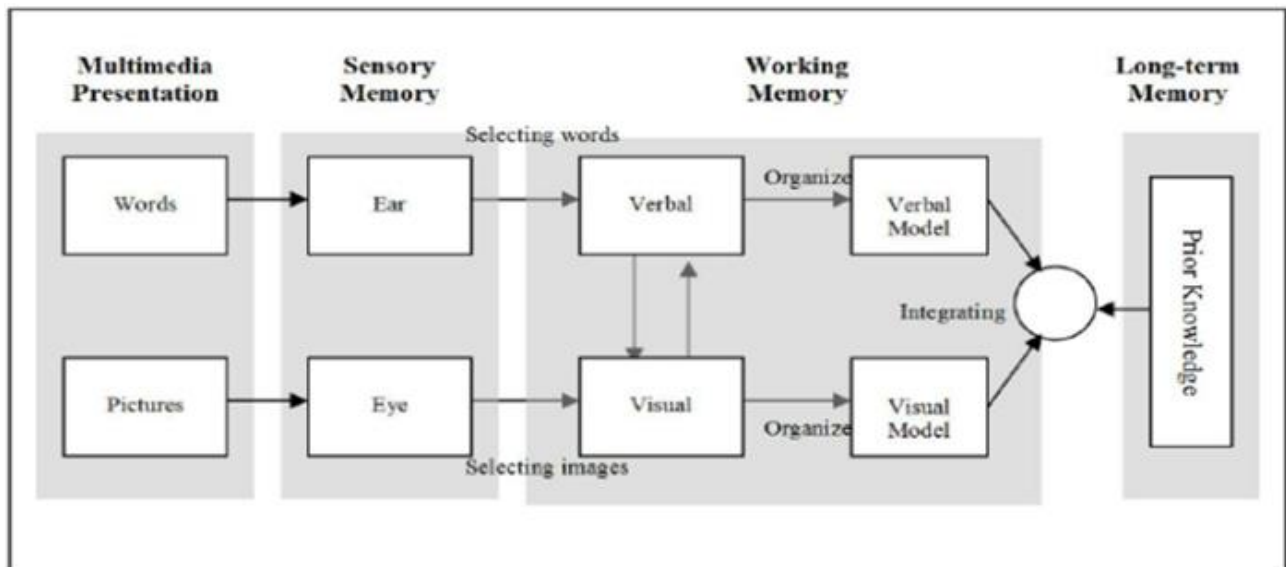


Figure 4.4.1: A framework for cognitive theory of multimedia learning drawn from Mayer 2001

Many educational researchers like Mumtaz (2000) & Anderson (1997) have concluded that multimedia has a positive impact concerning teaching and learning. The cognitive theory of multimedia learning was popularized by the work of Richard E. Mayer and other cognitive researchers who argue that multimedia table supports the way that the human brain learns. They assert that people learn more deeply from words and pictures than from words alone, which is referred to as the multimedia principle (Mayer 2005a). The big question is, “how does multimedia promotes meaningful learning?”.

Mayer (2005b) asserts that multimedia researchers generally define multimedia as the combination of text and pictures; and suggest that multimedia learning occurs when we build mental representations from these words and pictures. These researchers argue that

words can be text or written whereas pictures can be in the form illustrations, photos, animation, or video. According to Sorden (2012, p.2) “The theoretical foundation for the cognitive theory of multimedia learning (CTML) draws from several cognitive theories including Baddeley’s model of working memory, Paivio’s dual coding theory, and Sweller’s Theory of Cognitive Load. As a cognitive theory of learning, it falls under the larger framework of cognitive science and the information-processing model of cognition. The emphasis of the CTML on the brain in terms of how the student process information until it finally stored in the long-term memory, where the student officially owns the information.

The information-processing model suggests several information stores (memory) that are governed by processes that convert stimuli to information (Moore, Burton & Myers, 2004). As a result, Sorden (2012) argues that cognitive science can provide powerful insight into human nature, and, more importantly, the potential of humans to develop more efficient methods using instructional technology. According to multimedia researchers, it seems like the key to unlock meaningful learning, lies with the instructional technology and how it is presented to the students (pedagogy). So, how does learning happen according to multimedia researchers? According to Mayer (2009) CTML centers on the idea that students attempt to build meaningful connections between words and pictures and that they learn more deeply than they could have with words or pictures alone. The emphasis is on the presentation of both text and pictures in order to help students to build mental connections that will help them to make understand the work presented to them.

According to Mayer & Moreno (1998), CTML is based on three assumptions: the dual-channel assumption, the limited capacity assumption, and the active processing assumption. The dual-channel assumption is that working memory has auditory and visual channels. Secondly, the limited capacity assumption is based on cognitive load theory, which states that each subsystem of working memory has a limited capacity. The third assumption is the active processing assumption, which suggests that people construct knowledge in meaningful ways when they pay attention to the relevant material, organize it into a coherent mental structure, and integrate it with their prior knowledge (Mayer, 1996 & 1999).

According to Sorden (2012, p.3) CTML accepts a model that includes three memory stores known as sensory memory, working memory, and long-term memory (see Figure 1.1). Sweller (2005) defines sensory memory as the cognitive structure that permits us to perceive new information, working memory as the cognitive structure in which we consciously process information, and long-term memory as the cognitive structure that stores our knowledge base. The sensory memory is key in the sense that it is the part of the brain that receives information when it is presented in the form of multimedia. It appears that if the sensory memory does not capture the knowledge that is presented to it, the last two memories will not be able to process the knowledge and even store it in the long-term memory. Thus, Sorden (2012) argue that students are only conscious of information in long-term memory when it has been transferred to working memory.

It is key that student's sensory memory is triggered with an effective multimedia so that they can perceive the knowledge, so that it can then be transferred into the working memory before it lands onto the long-term memory. Schnotz (2005) refers to sensory memory as sensory registers or sensory channels, for example the dual channel sensors as eye-to-visual working memory and ear-to-auditory working memory. What the students see and hear are important in the efficient functioning of the sensory memory and working memory and ultimately the long-term memory. Thus, Mayer (2010a) asserts that working memory attends to or selects information from sensory memory for processing and integration. Sensory memory holds an exact sensory copy of what was presented while working memory holds a processed version of what was presented and can process only a few pieces of material at any one time. From the multimedia researchers, it is clear that the most important part of meaningful learning happens in the brain, whereby sensory memory must be presented with stimulating information in the form of multimedia and subsequently the information will be processed and transferred to the working memory and later long-term memory.

However, it is not only the multimedia that is key with regards to teaching and learning but issues related to pedagogy, content knowledge and language play a critical role in the process of effective teaching and learning. Sorden (2012) argues that multimedia

instructional design attempts to use cognitive research to combine words and pictures (multimedia) in ways that maximize learning effectiveness. Thus, Mayer (2003, p.128) introduces the concept of multimedia instructional message in order to foster meaningful learning. He argues that teacher's presentation of knowledge should consist of words and pictures that are designed to foster meaningful learning. Words spoken or written appear to be a problem concerning enhancing subject content knowledge and thus prohibiting understanding of concepts taught. "... the goal of multimedia instructional messages is to foster meaningful learning (Mayer, 2003, p.128).

Meaningful learning can be assessed through problem-solving transfer tests in which the student is asked to use the presented material in new ways" (Mayer, 2003, p.128). Usage of multimedia in the form of text & pictures together enhances student's understanding and ultimately allows problem solving skills to be applied in new contexts. However, Mayer warns of overloading students cognitively while using multimedia. According to De Jong (2010) there is a limit to the amount of information that can be processed at one time by working memory. In other words, he argues that learning is hindered when cognitive overload occurs and working memory capacity is exceeded. Teacher's responsibility is to design multimedia in such a way that it leads to effective teaching and meaningful learning, and it avoids overloading students cognitively. The framework below (See figure 4.4.2) indicates the processes that a typical teacher needs to follow while planning to teach using multimedia.

CONCEPTUAL FRAMEWORK

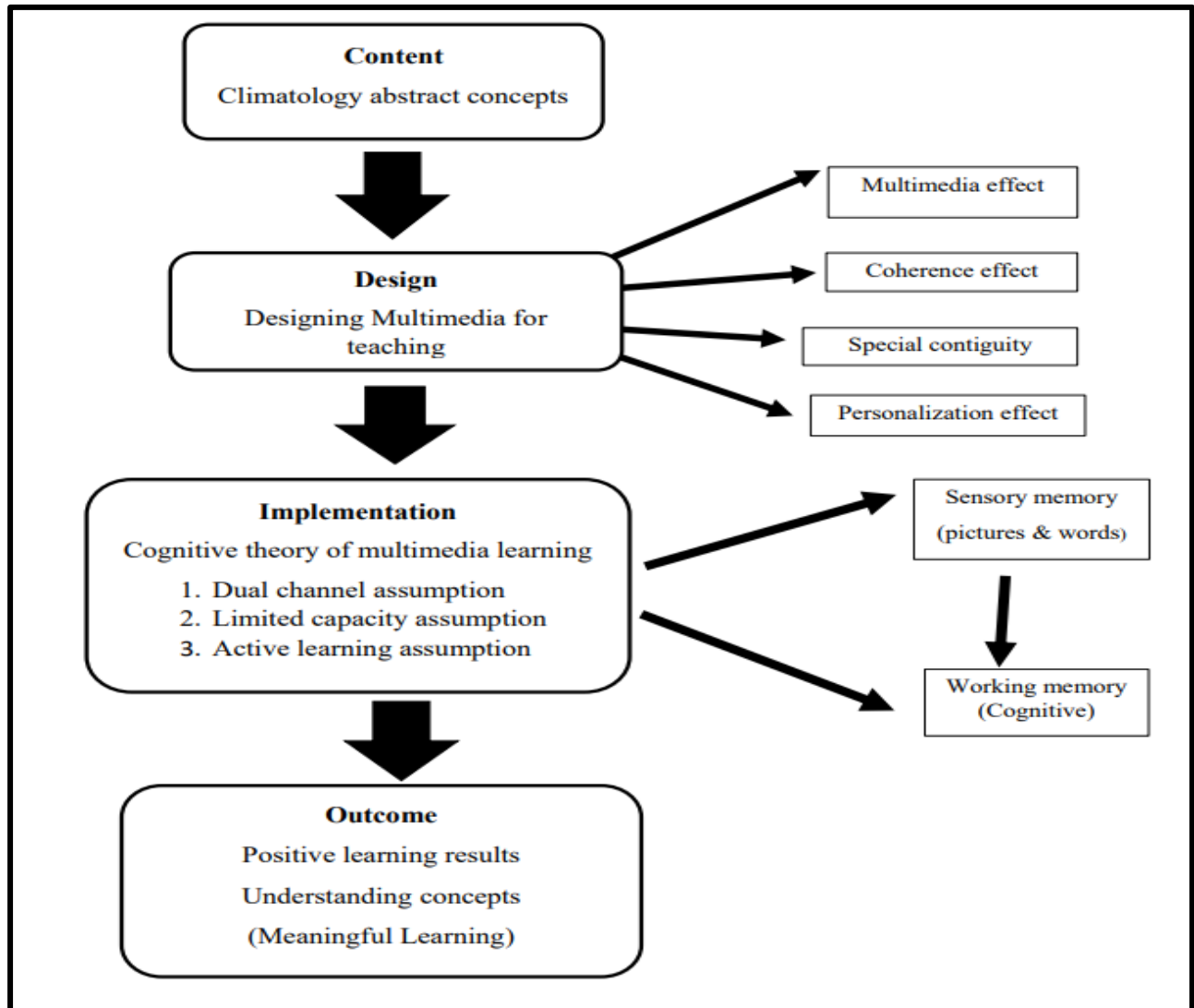


Figure 4.4.2: Teacher's approach to multimedia teaching

When teachers confronted with abstract concepts in teaching and they find it difficult to teach those or the students struggle to understand the concepts, according to the multimedia researchers like Mayer there is a solution with the usage of multimedia in their classrooms. Thus, Akkoyunlu & Yilmaz (2005) assert that the use of multimedia could

affect teaching and learning positively when properly designed compared to traditional way of instruction in terms of students' performance. Multimedia researchers seem to agree that there are numerous ways in which concepts can taught in order to deliver effective teaching which fosters meaningful learning. Numerous strategies are suggested by multimedia researchers in terms of how multimedia can and should be used in teaching to foster meaningful learning.

Mayer's Cognitive theory of multimedia learning argues that teachers need to be cognizance of managing cognitive load of content knowledge delivered to the students. Mayer, Fennell, Farmer, & Campbell (2004) cite evidence that, two important ways to promote meaningful learning are to design activities that reduce cognitive load, which frees working memory capacity for deep cognitive processing during learning, and to increase the student's interest, which encourages the student to use this freed capacity for deep processing during learning. Thus, multimedia should be used as tools to process information easily in order to transfer it from the working memory to long term memory.

In addition, Sorden (2012, p.14) "cognitive load theory (CLT) suggests that instructional techniques that require students to engage in activities that aren't directed at schema acquisition and automation can quickly exceed the limited capacity of working memory and hinder learning objectives". He explains that teachers should not create unnecessary activities in connection with a lesson that require excessive attention or concentration that may overload working memory and prevent one from acquiring the essential information that is to be learned. Thus, the teacher needs to design instructional multimedia material thinking about how much students can comprehend within a specific period. In the other hand, Sorden (2012) speaks about multimedia instructional design whereby the layout should be visually appealing and intuitive, but the activities should remain focused on the concepts to be learned, rather than trying too much to entertain. He argues that the focus should be on the concepts taught, instead of using multimedia for decoration purposes, which can be a huge distraction for the students.

In addition, there is an enormous amount of work that the teacher needs to do while designing and selecting multimedia tools to be used during instruction. Thus, Mayer (1997) stresses the importance of five cognitive processes of using multimedia that teachers need

to consider before the instruction. He asserts that these processes of active learning are selecting, organizing, and integrating (selecting words, selecting images, organizing work, organizing images, and integrating new knowledge with prior knowledge), and theory-grounded and evidence-based multimedia instructional methods. Thus, it is critical for the teachers to select appropriate multimedia that will facilitate and enhance learning during instruction.

Mayer & Moreno (2002) outlines four principles that teachers or instructional designers need to follow when they consider using multimedia for teaching. These principles are Multimedia Principle, Personalization Principle, Special Contiguity Principle and Coherence Principle. These principles have already been discussed in Chapter three when designing multimedia sub-section was discussed.

This section of the study has expanded on the process that takes place when multimedia presented to the students by using cognitive theory of multimedia learning. There are three memories that knowledge presented to the students using multimedia need to go through. Sensory memory, working memory and long-term memory. Teachers have a responsibility to present multimedia in such a way that it will promote effective teaching and meaningful learning. There are four principles that teachers need to consider when designing multimedia instruction which are Multimedia Principle, Contiguity Principle, Modality Principle and Coherence Principle. It is assumed that if these principles are taken into consideration while teachers are designing multimedia teaching, effective learning will be promoted.

4.5. RESEARCH APPROACH

This research study has used qualitative method. The reason this study used qualitative method is “When studying individuals, qualitative researchers conduct a study with the intent of reporting these multiple realities. Evidence of multiple realities includes the use of multiple quotes based on the actual words of different individuals and presenting different perspectives from individuals” (Creswell, 2007, p.18). Furthermore, Denzin and Lincoln (2000) assert that qualitative research is research that is multi-method in its

focus, which involves an interpretive, naturalistic approach to its subject matter. They argue qualitative researchers study things in their natural settings, attempting to make sense of or interpret phenomena in terms of the meaning people bring to them. The main purpose of this study was to investigate how Grade 12 Geography teachers use multimedia effectively in their teaching and compile these good practices to help other Geography teachers in terms of how they need to use multimedia.

Qualitative approach was relevant for this study because, according to Creswell (2013) it describes complex phenomena and provide in-depth information, as well as rich narrative through questionnaires, unobtrusive lesson observations, interview transcripts without subjection to rigorous statistical analysis (Creswell, 2013). Qualitative approach provided extensive explanations and discussion of how Geography teachers in Grade 12 used multimedia in their teaching for effective and meaningful learning. Whereas, with quantitative approach the explanations are not in depth since it focuses on the generalizations of the data. In addition, qualitative approach further provided this study with the opportunity to get detailed views in terms of what multimedia they choose for their lessons and the reasoning behind those decisions, this was done with the interviews that were conducted with the participants.

The rationale for using a qualitative approach in this research as said earlier in this section was to examine and describe the way in which Grade 12 Geography teachers used multimedia in order to achieve effective teaching and meaningful learning. This research approach was suitable to capture those moments when participants are actively engaged in teaching using multimedia and later understand their thinking towards how and why they chose such multimodalities.

4.6. RESEARCH METHODOLOGY

According to Noor (2008) the choice of which method to employ in the research study is totally dependent upon the nature of the research problem. He argues that there are two basic methodological traditions in social sciences research such as positivism and post-positivism. In simple terms, positivism adopts a position of an objective researcher whereby facts collected about the world and then explanations arranged based on the

facts that are collected. On the other hand, Noor (2008) asserts post-positivism is based on the idea that reality is socially constructed rather than objectively determined, facts are not necessarily measured on how often they occur but to appreciate the different constructions and meaning that people place upon their experience. Research methodology appears to be a way to find out the result of a given problem on a specific matter or a particular problem that needs a solution in research studies, which often referred to as research problem.

This study intended to understand the thinking process that goes beyond teacher's mind when designing lessons and during instruction when using multimedia. Ultimately, this study aimed to explore and understand the interactions that exist between the teacher, students and multimedia used. The thinking process and interactions inside the classroom appear to be critical when the researcher listens and observes different teachers within their classrooms for the purposes of understanding the rationale behind various teaching techniques. Thus, Creswell (2007) asserts that conducting a qualitative study means that researchers try to get as close as possible to the participants being studied. By getting close to the participants during the study, enabled me as the researcher to use the language that they use during the instruction while using multimedia for effective instruction and meaningful learning.

4.7. SAMPLING

This study used purposeful and convenient sampling because the participants chosen in this study helped the researcher to understand the problem at hand. Focusing on purposeful sampling, "The concept of purposeful sampling is used in qualitative research. This means that the inquirer selects individuals and sites for study because they can purposefully inform an understanding of the research problem and central phenomenon in the study" (Creswell, 2007, p.125). Thus, Creswell (2012) notes that sampling is concerned with the process of selecting individuals from the target population that the researcher plans to study, thus generalises the target population (Creswell, 2012).

Purposive sampling was chosen because it is identical to qualitative research (Etikan et al, 2016), unlike random sampling which advocates for quantitative studies (Morgan, 2008). This involved identifying and selecting individuals or groups of individuals that are especially knowledgeable about or experienced with a phenomenon of interest (Tashakkori & Teddlie, 2003; Cresswell & Clark, 2011). Based on these discussions, the study-selected participants were Grade 12 Geography teachers with experience of more than five years teaching Geography with multimedia or technology. The participants were from high schools where multimedia has been used for many years and the schools are performing better under the climatology section. The participants in the study achieved an average pass rate of 90% in Geography in the National Senior Certificate (NSC) examinations in the past five years. Furthermore, all the participants were qualified with bachelor's degree to teach Geography at high school level. The participants have an average teaching experience of 13 years in Grade 12 level. (Refer Table 5.2.1 on page 55).

In addition, the participants were '*somewhat*' specialists in the subjects since their performance in the Matric National Senior Certificate (NSC) examinations has been above national, province and district averages. Lastly, from purposive sampling perspective, the participants selected were from both suburban and township schools North of Johannesburg and the reason was to collect data from teachers who are teaching in different racial, cultural, ethnic groups and socio-economic backgrounds. Teachers from townships and suburban areas are confronted with different challenges concerning the exposure that students have towards access to technological devices and usage of them thereof. This allowed the study to have diverse data concerning the approach these group of teachers had towards using multimedia for teaching climatology concepts.

For this study, the participant's school were located in the same geographical proximity and it was easy to communicate with them concerning the times that I can observe their lessons and do interview since we are in the same geography district WhatsApp groups. The participants were willing to participate in the study since they assumed that the research findings will help other teachers to use multimedia for effective teaching and meaningful learning.

4.8. TRIANGULATION

Oppermann (2000, p.142) states that methodological triangulation refers to using more than one research method in measuring the same object of interest, for example, using participant observation, interviews as well as questionnaires. In addition, Cohen et al. (2000) have defined triangulation as an approach to data collection, which allows the researcher to use two or more methods of data collection. This study adopted two methods of collecting data, which are lesson observations and structured interviews to qualify the concept of triangulation. This study was hoping to collect data from different angles to avoid inconsistencies. Thus, Blaikie (1991) as cited in Oppermann (2000, p.143) notes that the common theme in discussions of triangulation has been the desire to overcome problems of bias and validity. If the triangulation is achieved when collecting data, then the researcher's biases and distortions, which are likely to occur when one method is used, can be reduced or even avoided (Maluleka, 2018).

4.9. RESEARCH METHOD

This study employed lesson observations and semi-structured interviews as research instruments to collect data. According to Corbin & Morse (2003), the reason for using interviews is that they allow respondents to express themselves in their own ways and pace, with minimal hold on what they can contribute to the research. This is crucial to this study because one of the objectives of the study was to understand teacher's rationale behind how they chose multimedia and why they decided to use different multimedia the way they used them during instruction. With interviews, the participants answered these questions explicitly without limiting or dictating the way they responded.

On the other hand, Creswell (2007) states that through observations, researchers are able to examine how participant's behaviours differed from their stated intentions perhaps in the interviews. Observations in this study allowed the researcher to see how participants used multimedia in teaching of climatology concepts for effective and meaningful learning. Lesson observations allowed the researchers to examine the interactions that

existed between the teacher, students and multimedia without being limited in any way whatsoever.

This study was composed of four Grade 12 experienced Geography teachers and they voluntarily participated. These participants received a letter with information about the study, a consent form and an observation schedule for them to see the type of things the researcher will be interested in (see: Annexures A). After the participants completed teaching their lessons, they did their respective interviews with the researcher.

4.9.1. SEMI-STRUCTURED INTERVIEWS

This study utilized the semi-structured interviews (see: Appendix B) as a method of data collection mainly because, it allowed the researcher to probe for more information and encourage participants to talk freely, and without being restricted by a structured and pre-determined set of questions (Creswell, 2012). Interviews can be very productive since the interviewer can pursue specific issues of concern that may lead to focused and constructive suggestions (Shneiderman and Plaisant, 2005). These interviews were also an opportunity for the participants to clarify some of the pedagogy that unfolded during the lesson observation while teaching with multimedia. It was also an opportunity for the researcher to dig deeper in his exploring the participants' usage of using multimedia in teaching climatology concepts in Grade 12. The interview session with each participant took approximately 30 - 35 minutes and were conducted after school to avoid the disruption of teaching and learning.

4.9.2. LESSON OBSERVATIONS

Although there are many ways in which a phenomenon can be studied, Gillis and Jackson (2002) assert that observations are the best tool that allow a researcher to observe phenomenon in practice. They are process of gathering first-hand information through observing people at the research site (Creswell, 2012). Thus, present the researcher with valuable data from a first-hand perspective. Data derived from this method tends to be

narrative in nature, which speaks to the qualitative and interpretivist approach to research, rather than statistical data which is quantitative.

Lesson observations afforded the researcher the opportunity to observe the participants' behaviour and the students, particularly the behaviour that is not easily describable or captured by an audio-recorder. It also meant that the researcher had no form of participation during the observed lessons and the role of the researcher was limited to video-recording and taking notes during the observed lessons. To ensure that participants' responses were captured accurately without missing any information, the observations were audio-recorded with the permission of the participants. The lesson observations took approximately 35 - 45 minutes per participant.

4.10. DATA ANALYSIS

Smith & Firth (2011) argue that methods for undertaking qualitative data analysis can be divided into three categories:

- Socio-linguistic methods that explore the use and meaning of language such as discourse and conversation analysis;
- Methods that focus on developing theory, typified by grounded theory;
- Methods that describe and interpret participants' views such as content and thematic analysis.

These three methods were followed in the analysis stage of this study. In addition, according to Flick (2014, p.5) "qualitative data analysis is the classification and interpretation of linguistic (or visual) material to make statements about implicit and explicit dimensions and structures of meaning-making in the material and what is represented in it". It is making sense of the generated information and/or facts that the researcher has collected from the field (Merriam, 2001). Babbie & Mouton (2004) assert that data should be processed and analysed in accordance with the research objectives, to ensure that the collected data is relevant to the focus of the study and research questions.

The first method of the data analysis entailed analysing of the interviews. The responses of participants were manually transcribed from the audio recording into a spreadsheet using pseudonyms. Pseudonyms were used to conceal and protect the participants' real identities. Each question had a column heading, and the other row was created in order to accommodate each participants' answers. Each possible answer was categorized into segments and each segment allocated a code (Creswell, 2012). This was followed by combining of codes into different categories to help with the establishment of meaningful relationships between different and similar categories and also help to identify emerging themes. According to Nieuwenhuis (2007, p.105) coding is defined as marking the segments of data with symbols, descriptive words or unique identifying names. In this study, coding was done to easily identify patterns that existed in the data collected, which then led to them. Themes were then used to explore the use and meaning of language in relation to how participants selected multimedia and their reasoning behind selecting the multimedia that they used in their respective lessons.

The second method of data analysis involved the analysis of the lesson observations, and these were recorded. According to Creswell (2012) observations are a process of gathering first-hand information through observing people at the research site. This process entailed the transcription of the video recorded observations using pseudonyms to identify the participants and their students, although students' responses were not used extensively in the data presentations and data discussions. Pseudonyms were used to conceal and protect the participants' real identities. This was followed by the researcher studying the transcribed data to identify words that the participants frequently used to establish similarities and differences between them.

In addition, the researcher identified the type of multimedia used as well as the frequency that the participants referred to this multimedia. The researcher also summarized by coding in different colours the times that participants asked questions by referring to the multimedia. After the coding, the researcher grouped the participants'

responses into themes that emerged. These were then compared to the themes that emerged under the structured interviews, and the literature reviewed.

The last method of data analysis entailed the analysis of the themes. This method was employed because it allowed the researcher to compare, describe and interpret the themes that emerged from both the interviews as well as lesson observations. All these methods of data analysis were used interchangeably at different stages of the data analysis stage.

After all the data analysis processes were concluded for both interviews and classrooms observations; it became apparent that the participants involved in this study had different approaches concerning their teaching using multimedia (This will be discussed in the discussion of findings section later). However, it appeared that most students were engaged in the lessons throughout since they were also asking questions based on the multimedia.

4.10.1 TRANSPARENCY AND TRUSTWORTHINESS

The issues of transparency and trustworthiness were considered throughout the study. According to Creswell (2013) in qualitative study, issues of transparency and trustworthiness are done by removing the researcher's voice from the data and focusing on the essence of the experiences of research participants. Thus, (Naidoo, 2014, p.51) asserts that in qualitative research, the researcher seeks believability, insight and trustworthiness through a process of verification. Therefore, "when qualitative researchers speak of research "validity and reliability" they are usually referring to research that is credible and trustworthy" (Nieuwenhuis, 2007, p. 80). Creswell (2013) suggests that examples of this include using transcendental, non-interpretive approaches to data reporting. The focus of this study was to report on the actions of the participants that emerged during teaching and learning the same way as they were.

To explain in detail how the transparency and trustworthiness of the study maintained from the beginning to the end, this study used three determinants as explained by Trochim & Donnelly (2007). These determinants are credibility, transferability, and dependability. For this study to maintain credibility, the researcher used multiple theories such as interpretivism and phenomenology, and reviewed literature intensively and extensively. In addition, to maintain credibility, this study used related theoretical and conceptual frameworks to validate the claims made by participants or even themes that emerged from the data.

4.11. ETHICAL CONSIDERATIONS

This research study was conducted in an ethical manner based on processes required by the University of the Witwatersrand to be completed before the researcher can go out and collected the data. All the processes validating the ethical manner in which the researcher adhered to will be discussed in this section. Babbie & Mouton (2007) as cited in Maluleke (2018) affirms that whilst researchers have the right to collect data, they also have the responsibility to ensure that they do not collect data at the expense of the participants' right to privacy. So, all ethical processes were followed as indicated below:

After the research proposal was approved by the graduate studies committee of the Wits School of Education (See: Appendix C) and permission to conduct the study was obtained from the Ethics Committee in Education of the Faculty of Humanities, (Wits university) (protocol number:2022ECE06M (see appendix O). The process of requesting access to use schools as research sites was initiated. To access these schools, the researcher had to first apply for permission to conduct research at those schools with the Gauteng department of Basic Education, thus ensuring that all protocols were observed. Only after permission was granted did the fieldwork occur (see: appendix D).

Letters requesting permission to do research in the schools were sent to the principals, educators, students and parents giving full details of the purpose, methodology, significance of study and an estimated time of completion (see: appendixes E, F, G & H). Letters were also sent to students even though the study did not directly involve them.

This was done because they were recognized as indirect participants in the study and they were present in the classroom during observations.

In addition, accompanying these letters were consent forms directed to all involved (see: appendixes I, J, K & L). All stakeholders involved gave consent in the form of filling in the consent form provided and/or in the form of a letter. Creswell (2003) asserts that informed consent is a tool used to ensure that participants understand what it means to participate in a research study, to decide in a conscious, informed manner whether they want to be part of the research study or not.

Visits to each research site by the researcher occurred once. All visits occurred during the third academic term of schools which was few weeks a month or so before the preliminary examinations.

To introduce the study to the participants happened virtually since the researcher had contact details of all participants obtained from geography WhatsApp group of the district. These virtual meetings happened in order to clarify any issues that participants might have had, in terms of the purpose of the study, and the format in which data will be generated and published.

The second meeting with the participants involved the collection of data. Three of four school visits happened in one week and last visit happened in the following week. During observations, the lessons were recorded on the focus on the participants with regards to how they used multimedia. In all video recordings students are not shown their faces (With exceptions when the teacher was moving around in the classroom).

Issues of anonymity, confidentiality, and the right to withdraw were also discussed with the participants. In terms of anonymity, participants were informed that their identities will be kept confidential and the information they provided will in no way reveal their identities (Cohen et al., 2007). Therefore, the participants' identities were protected

using pseudonyms in the transcriptions, as well as the research findings published in this study. Furthermore, they were guaranteed that their consent forms and letters were not going to be published anywhere. Hence, signed consent forms and letters from the stakeholders were not published in this study.

Lastly, in terms of confidentiality, the participants were assured in writing that their information and identities will be kept confidential, and that information gathered through the study will only be used for academic purposes. This means that data generated will only be used for this degree requirements. This was important to clarify to the participants because, the concept of confidentiality in a research study requires the researcher to keep all information shared by the participants during the data collection period confidential, and not link such information with the participants' identity publicly (Cohen et al., 2007).

4.12. CONCLUSION

In this chapter, the theoretical perspectives, research approach, research methodology, the research methods employed in the research design, the sampling process, data collection and analysis, and the ethical considerations were discussed and justified. The results of the data collected through lesson observations and interviews will be presented and analysed later in this study.

CHAPTER FIVE

PRESENTATION OF DATA

5.1. INTRODUCTION

This section of the study present data generated during the data collection process. The data collected include both the lesson observations as well as the responses derived from the interviews done with the teachers. It should be noted that interviews happened first, followed by the lesson observations. However, before this data is presented; biographies of participants are highlighted to understand the nature and type of teachers involved in the study in terms of the skills and expertise. These skills and expertise supposedly in turn inform the way in which these teachers teach climatology concepts with the usage of multimedia within geography classrooms. Pseudonyms are used to identify the educators in the study.

5.2. PROFILE OF RESEARCH PARTICIPANTS

The table below represents the skills and expertise that the teachers have. These teachers are on average highly experienced, and they have been using multimedia in teaching on average for 7 years. They are all qualified with Bachelor of Education degrees.

Table 5.2.1: A table showing the participants involved in the study.

Teacher names	Years of teaching experience (Grade 12)	Years of teaching with ICTs (Multimedia)	Qualifications	Location of the school	Average pass rate last 5 years (Geography)
Mrs Cloete (Teacher 1)	15 years	10 years	Bachelor of Education with honours	suburban	98%
Mrs Naidoo (Teacher 2)	20 years	9 years	Bachelor of Education	suburban	98%
Mrs Motaung (Teacher 3)	7 years	5 years	Bachelor of education	Township	95%
Mr Mkhwanazi (Teacher 4)	9 years	6 years	Bachelor of Education	Township	92%

5.3 CLIMATOLOGY CONCEPTS TAUGHT AND THE TYPE OF MULTIMEDIA USED

The table below indicate the concepts that were taught by all four teachers involved in the study. Low and high-pressure cells, Coriolis force, polar front and mid-latitude cyclones are some concepts which were taught by all four teachers. The table also summarizes the multimodal that were used during the lessons to explain the climatology concepts. Written text, images, video clips and infographics were some common multimodal used during the teaching of climatology concepts.

Table 5.3.1: A table outlining climatology concepts taught and the multimedia used to teach them.

Teacher names	Abstract climatology concepts taught	Multimedia used to teach
Mrs Cloete (Teacher 1)	Low pressure cells & High-pressure cells, Coriolis force and latent heat	Written text, images/pictures, diagrams, video clips and infographics
Mrs Naidoo (Teacher 2)	Low pressure cells & High-pressure cells, Coriolis force, polar front, Hadley cell, Ferrell cell, Polar cell and Mid-latitude cyclones	Written text, images/pictures, diagrams, video clips
Mrs Motaung (Teacher 3)	Low pressure cells & High-pressure cells, Coriolis force, polar front, Hadley cell, Ferrell cell, Polar cell, Mid-latitude cyclones, pressure belts and Pressure Gradient Force	Written text, images/pictures, diagrams,
Mr Mkhwanazi (Teacher 4)	Low pressure cells & High-pressure cells, Coriolis force, polar front, Jet Streams, Warm and Cold fronts	Written text, images/pictures, diagrams, video clips and infographics

5.3.1 ABSTRACT CLIMATOLOGY CONCEPTS TAUGHT

There are numerous climatology concepts that were taught during the 4 lessons observed that can be classified as abstract concepts, as indicated above [Refer to Table 5.3.1]. Abstract concepts identified in the 4 lessons include Low-pressure cells & High-pressure cells, Coriolis force, pressure gradient force, Hadley cell, Ferrell cell, Polar cell, Mid-latitude cyclones, latent heat, Jet streams and tropical cyclones.

Low-pressure cell & High-pressure cells are pressure cells responsible for the formation of global air circulation. Global air circulation is partly responsible for the formation of polar front, which is necessary for the formation of mid-latitude cyclones. Coriolis force

is the force that comes as a result of the earth's rotation. This force is responsible for the wind deflecting to left in the Southern Hemisphere and to the right in the Northern hemisphere along the pressure gradient. Jet streams are strong winds which blow in the upper atmosphere and are partly responsible for the formation of mid-latitude cyclones. Mid-latitude cyclones are systems of Low-pressure cell, that moves from west to east and travels in the middle latitude. This weather system is responsible for bring wet, cold and windy weather conditions in Southwestern Cape in winter months.

Tropical cyclones are low pressure system that develop along the equatorial regions but not within zero and five degrees around the equator because Coriolis force is nonexistence at that point. The Coriolis force is responsible for deflecting the wind into the system in a clockwise direction in the southern hemisphere and anticlockwise in the northern hemisphere. The Coriolis force is the force that comes as a result of the earth's rotation. Normally, wind blows from a high-pressure cell to a low-pressure cell along the pressure gradient, but Coriolis force then deflect it to the left in the southern hemisphere and to the right in the northern hemisphere. These concepts are abstract in nature since they cannot be seen with naked. Generally, these concepts explained using scientific terminology which is mostly technical for most students to comprehend.

5.3.2 MULTIMEDIA USED IN TEACHING

There are various multimodal that were using in four lesson that were observed. The main multimodal used in all four lessons were written text, images or pictures and diagrams. According to Gates (2018) diagrams and images provide a means of communication between students and between student and teacher. They argue that the benefits of using diagrams and images is supported by several elements deriving from the cognitive engagement with multiple representations and the specific affordances offered by a visual (Hegarty, 1992; Clements, 1983; Lean & Clements, 1981). Video clips were used in only three lessons while infographics were only used in two lessons as a summary to the work taught during the lessons. According to Bryan & Recesso (2006) students who have the opportunity of seeing videos write longer, more evidence based and more

pedagogically driven reflections on their performances than those who did not have access to video.

5.4 SEMI-STRUCTURED INTERVIEWS

The semi-structured interviews (see: appendix B) followed the observation of the lessons. The main purpose of these interviews was to understanding thinking and rationale that goes behind teaching climatology concepts using multimedia. In addition, the interviews were intended to understand the views that teachers have about multimedia in terms of helping with pedagogy and during the instruction.

The purpose behind these interviews was to address the following research question:

What pedagogical value does multimedia bring during the instruction in teaching climatology concepts?

By answering this research question:

- The researcher would firstly gain the understanding of the value multimedia brings into the teaching of climatology concepts in Grade 12.
- Secondly, the researcher needed to evaluate the implementation or introduction of multimedia during various stages of the lesson.

The data that emerged from these interviews was subjected to the conceptual framework adopted for this study [Figure 4.1.2]. It appears that interviewed teachers use different multimedia to help them reinforce certain concepts while teaching. The most used multimedia amongst others are pictures/images, video clips and infographics.

5.4.1 INTERVIEW WITH Mrs Cloete

The profiles of the participants have already been discussed in the earlier sections of this STUDY.

Multimedia that is mostly preferred to be used by Mrs Cloete are pictures or images & video clips. When asked how she selects multimedia to use for each lesson. Her response was:

Based on the topic that I am teaching, I normally find creative ways of incorporating different multimodal in my lesson. Normally, I just don't use one.

As a link to the previous question, Mrs Cloete was asked how does the usage of multimedia help during instruction. Replying to this question, it appeared that Mrs Cloete applies coherence principle when she selects multimedia for teaching. It seems that she selects multimedia that can be used to explain numerous concepts in one lesson. This is contradictory to what observed during lesson observations. Mrs Cloete used several multimedia such as two video clips, two images and two diagrams and these multimedia were used to explain various concepts during the lesson [Refer to diagram 5.4.1.1].

This is what she had to say:

It helps me to pace my lessons, normally just one image /picture will explain multiple concepts or show how those concepts are connected without necessarily using written words.

When she asked about how she uses multimedia creatively so that it does not teach on her behalf and how does multimedia help her to enhance the understanding of the climatology concepts. With her response, it looked as if Mrs Cloete applied coherence and modality principles because she likes annotating on the diagrams that she uses and she also pauses the video clips to explain concepts that she feels were not explained sufficiently. This is what Mrs Cloete had to say:

I normally, when I use a video, I will pause the video and then explain certain things that I think are not explained accordingly and in depth. Likewise, when I use a picture or diagram I will add certain things to explain the concepts better show different perspectives. With regards to enhancing the understanding of the concepts, I will certainly use multimedia to reinforce certain concepts better and also show different sides/views of a particular topic or concepts.

When she asked about how she avoids overloading students cognitively, it appeared as like Mrs Cloete takes limited capacity assumption into consideration while planning her lessons in the sense that she does not use a lot of multimedia in one lesson. However, this is inconsistent with what was observed during the lesson, as Mrs Cloete used a lot of multimedia in one lesson. She responded by saying:

I normally avoid using multiple multimodal. Normally, I choose one that is the best and focus on using that one to teach. Lesson planning is also key in avoiding to overloading my students cognitively.

Asked to suggest any strategies that she uses with multimedia in her teaching that she finds useful and beneficial for students. Multimedia, coherence and modality principles appear to be applied by Mrs Cloete as she likes annotating the diagrams and pausing video clips to explain additional concepts during the lesson. Annotation of diagrams and pausing of video clips were also evident during her lesson observations. Her response was:

I normally pause videos that I am using in my class and explain from my perspective. The other thing I do is to annotate different diagrams and pictures.

Lastly, she was asked about any recommendations of how teachers should use multimedia in teaching and learning and any commentary about multimedia in her teaching. Multimedia, Contiguity and Coherence principles seem to be taken into consideration when preparing multimedia because Mrs Cloete speaks about the need to know when and how introduce the multimedia during the lesson.

This is what Mrs Cloete had to say:

Teachers need to know exactly what they want to teach and how and then multimedia will then come as an assistance to help them teach exactly that. Teachers also need to purposefully and creatively choose multimedia. Lastly, I think teachers need to focus on the concepts that they want students to know and make sure they use multimedia to do exactly that.

In summary, Mrs Cloete claimed to be using different multimedia depending on the nature of the concepts that she teaches. Multimedia, coherence and modality principles seemed to underpin her approach towards multimedia teaching and learning, since she likes annotating diagrams and making notes along pictures that she uses. In addition, Mrs Cloete likes pausing videos and explain certain concepts in detail which indicates coherence principle. Mrs Cloete appeared to be taking limited capacity assumption since she spoke about using limited amount of multimedia during her lessons.

5.4.2 INTERVIEW WITH Mrs Naidoo

When Mrs Naidoo was asked about multimedia, she use the most in her lesson. She said:

Images and short YouTube videos, slides and notes. Because they make my teaching complete.

In relation to how Mrs Naidoo selects multimedia to use during her lessons. Multimedia and coherence principles seem to be the underlying principles that she uses when selects multimedia since she claims to choose variety of information from internet and integrate it to explain concepts during teaching. This is in line with what was observed during the lesson, as she used various multimedia, and she will use one multimedia for different concepts or to show the students how different concepts are related. This is what Mrs Naidoo had to say:

I create my own slides and incorporate images from various sites, old exam papers and textbooks. I will normally Google search topics and choose YouTube video clips that best illustrate the content I wish to teach. There is a large variety of data available on the web.

When Mrs Naidoo was asked about how the usage of multimedia help her with pedagogy and during instruction. Modality and multimedia principles seem to be applied in her teaching since Mrs Cloete speaks about using verbal and written together with visuals to enhance understanding to help understand the abstract concepts in geography classrooms. This was evident during lesson observations as Mrs Naidoo referred students to specific images to in order to answer certain questions that students asked during the lesson. She explained by saying:

It helps to reinforce the concepts by providing a visual content. Many students are not able to visualise global concepts as they have not travelled, and this medium provides them with a structured, visual and oral representation.

On how she uses multimedia creatively so that it does not teach on her behalf. It appears that multimedia, contiguity and coherence principles are always considered when Mrs Naidoo thinks about how she is going to explain different concepts using multimedia.

During the lesson observation, Mrs Naidoo integrated different multimedia and used them simultaneously in different parts of the lesson. She elaborated by saying:

I always teach the concepts first. Normally construct diagrammatic information on the blackboard. The students then make notes and copy down basic concepts, diagrams and information. Notes are handed out to reinforce the information. Video clips and illustrations are used as a summary or reinforcement to illustrate the concept.

When Mrs Naidoo was asked about how she uses multimedia to enhance the understanding of climatology concepts. She responded by saying:

Multimedia is merely a tool used to teach a concept to make it more visual and for students who are not exposed to the world to experience the concepts. Students are exposed to technology and they respond well to this medium of teaching.

With regards to the teaching strategies and techniques that help her to use multimedia effectively. It seemed like multimedia and contiguity principles are applied when Mrs Naidoo thinks about how she can integrate multimedia effectively during her lessons. She pointed out that different material can be collected from the internet and can be designed effectively to make the concepts easily understandable. And it seemed like Mrs Naidoo takes into consideration the active learning assumption when she speaks about making learning relevant to the students. This was visible during lesson observations when Mrs Naidoo using multimedia to bring everyday examples in the teaching of the concepts in her lesson. She said:

Luckily, we have projectors, iPads and Wi-Fi in each classroom. This gives us the opportunity to supplement any concept using the Web to find information. The information is also current and benefits the students to be able to witness and experience current geographical events. Multimedia provides us with the ability to make the geographical content more relevant and therefore the student is able to respond to it immediately. The main strategy for multimedia is to reinforce a concept and to make it relevant.

Asked how she avoids overloading students cognitively using multimedia and strategies that she finds useful in teaching with multimedia. It appeared as like limited capacity assumption was taken into when Mrs Naidoo explains how she avoids overloading students cognitively. She argued that she avoids long video clips and simply selects what is

necessary for the concepts that she teaches in a particular lesson. This is what she had to say:

The video clips must be short and relevant. No long scientific explanation needed. The students must not be exposed to hours of multimedia. It is merely a tool that is used to reinforce the concept and not replace it. Find fun, relevant illustrations, diagrams and videos. Some strategies are that multimedia is only useful when it is used correctly

In summary, Mrs Naidoo seemed to consider multimedia and coherence principles when she selects multimedia for teaching. She claimed that she uses materials from different sources to compile and design her lesson. The usage of pictures and text next to it were evident in her observations which supports the multimedia principle. Limited capacity assumption seemed to be taken into when Mrs Naidoo explains how she avoids overloading students cognitively. She claims that multimedia should be designed in such a way that it is easier to navigate through them.

5.4.3 INTERVIEW WITH Mrs Motaung

Mrs Motaung responses to the questions were straight forward and lacked details and explanation at times. However, this is how she responded to the interview questions. When Mrs Motaung was asked about multimedia that she use the most in her lesson and the reasons. She replied:

I use YouTube videos, Pictures & notes, because they make my lessons interesting.

When asked about how do she select multimedia to use for each lesson? She stated that:

Through lesson planning, I will make use of slides with summaries of notes and diagrams. I also use YouTube to search for video clips on the concepts in teaching to reinforce the content during the lesson.

Multimedia and contiguity principles seem to be applied when Mrs Motaung selects multimedia for teaching. She chooses diagram, summaries and video clips to enhance understanding of the concepts. This is contradictory to what was observed during the

lesson as Mrs Motaung constructed diagrams on the board that she used to explain various concepts during the lesson. No video clips were used during Mrs Motaung lesson as she claims to be using them during her lessons.

Mrs Motaung was asked about how multimedia helps her with pedagogy and during instruction. This is what she had to say:

I think multimedia helps me to strengthen the learning process. Students seem to understand and retain knowledge better. During instruction multimedia tends to empower the educational process by means of increasing interaction between myself, the students and the content taught. It also makes learning and teaching to be more dynamic and more applicable to the world outside the classroom.

On the question of how she uses multimedia creatively so that it does not teach on her behalf. She replied:

It is important to note that multimedia is just an aid to assist the teaching and learning processes. Especially with the students that are not exposed to the outside world like oceans, rivers, mountains and the like.

Concerning how Mrs Motaung use multimedia to enhance the understanding of the climatology concepts as well as the strategies and techniques she uses with multimedia in her lessons. Multimedia, contiguity & modality principles were indicated by the strategies that teacher claims to incorporate during her lessons. During lesson observation, she used artificial globe and images from the textbook to explain concepts like the Coriolis force effect and impact on the direction in which the wind blows in each hemisphere. This support Mrs Motaung claim that she incorporated various multimedia during her lessons. This is what she said:

I think incorporation of multimedia in teaching help to assist students to get on well with the different media elements, which then supports the processing of information. I normally unpack in details what is shown on different multimedia that I use in my class. However, lack of access to Wi-Fi makes it difficult to access current information particularly in class at the moment when learning is taking place.

Mrs Motaung was also asked about how she avoids overloading students cognitively using multimedia. Multimedia principle, coherence principle and limited capacity assumption

seem to be taken into consideration when Mrs Motaung used multimedia in her teaching. There were limited amount of text and diagrams that were used during Mrs Motaung lesson, which seem to suggest that she avoid using extraneous words, sounds and images. In addition, on the diagrams that she used there was written text next to concepts to be explained. She stated that:

I think that it is important that the whole lesson does not consist of just one multimedia. Teachers should use multimedia creatively to reinforce concepts that students find difficult to grasp.

Lastly, Mrs Motaung was asked to make recommendations of how teachers should use multimedia in their teaching and give commentary on the usage of multimedia in her teaching. It appeared that Mrs Motaung acknowledges the teacher's role as a mediator when using multimedia, which then suggest that she is aware that teachers need to use multimedia in a creative way during instruction, which supports all principles of multimedia learning. This is what she had to say:

I think teachers should always make sure that they well prepared for their lessons and think about other tools/aids that are there to help deliver the lesson and thus engaging students effectively.

In summary, multimedia and contiguity principles seemed to be applied when Mrs Motaung selects multimedia for teaching as she claims to choose diagram, summaries and video clips to enhance understanding of the concepts. Summaries and diagrams normally limit amount of content presented and it normally structured efficiently to enhance learning. This is also apparent when she used artificial globe and images from the textbook to explain concepts during her observations. Mrs Motaung also appeared to be limiting extraneous words and images as she supposedly understands the importance of not overloading students cognitively when teaching with multimedia.

5.4.4 INTERVIEW WITH Mr Mkhwanazi

Mr Mkhwanazi was the last interviewee for the study, like with Mrs Cloete, he did not provide explicit details with the questions that were asked.

Mr Mkhwanazi was asked about the multimedia that he use the most in his lessons. He replied by saying:

I normally use video clips, diagrams and Sound clips with visuals.

When Mr Mkhwanazi was asked about how he selects multimedia to use for each lesson. He had this to say:

Well, it depends on the topic that I teach and how far are we with the topic. I generally use multimedia to introduce and perhaps end my lessons. Multimedia works quite well with revision at the end of each section.

Multimedia principle should have been taken into consideration by Mr Mkhwanazi because normally summaries include limited written text with pictures and diagrams. This was also evident during lesson observation when Mr Mkhwanazi used infographic to summarize the concepts that were taught during the lesson.

Mr Mkhwanazi was asked about how multimedia helps him with pedagogy and during instruction. It appeared that Mr Mkhwanazi considered coherence and modality principles when he pointed that multimedia help him to use time effectively by using specific pictures and video clips to explain variety of concepts within reasonable amount of time. Using multimedia to effectively save time and integrating multiple concepts were visible during class observations where Mr Mkhwanazi was using a video clip to explain various concepts during the lesson.

He responded by saying:

Well, multimedia helps in the usage of time effectively and integrating multiple concepts in one topic. It helps to focus student's attention to a specific thing. Jah well, students normally appreciate the use of a smart board and generally will interact more if there are visuals used during the lesson.

In terms of how he uses multimedia creatively so that it does not teach on his behalf. He replied by saying:

I often use smart board to show image and diagrams that will help me explain different concepts. Normally, I will use different videos & images when doing past papers to reinforce certain concepts.

In terms of how Mr Mkhwanazi uses multimedia to enhance the understanding of the climatology concepts as well as the strategies and techniques he uses with multimedia in his lessons. It appeared that multimedia and coherence principles as well as limited capacity assumptions were taken into consideration when Mr Mkhwanazi argues that he uses multimedia to summarize the concepts at the end of the lesson. Normally, summaries include limited text placed next to the diagram that it is intended to explain, and this indicates multimedia principle and coherence principle. In addition, when limited text and selected images are used, that avoids overloading students cognitively which considers limited capacity assumption. This is what he had to say:

When I conclude a topic, I use video clips with visuals that explains the concepts further and more detail. It helps to focus on a particular concept or topic as well as to summarize the topic at the end.

Mr Mkhwanazi was asked to suggest any strategies that he uses with multimedia in her teaching that he finds useful. His response was:

Using sound clips with visuals to reiterate the topic. I generally like to use multimedia for introducing and concluding the topics.

Limited capacity assumption and modality principle seem to have been considered by Mr Mkhwanazi when he argued sounds clips with visuals help to reinforce the concepts that are taught during the lesson. Modality principle supports the idea that students learn better when content is presented as a narration and narrated content is unlikely to overload students cognitively and thus support limited capacity assumption.

To conclude the interview, Mr Mkhwanazi was asked to make recommendations of how teachers should use multimedia in their teaching and give commentary on the usage of multimedia in his teaching. This is what she had to say:

Teachers can use multimedia to augment teaching by emphasizing important concepts. Also, multimedia can be used by teachers to expose students to real life scenarios through real life pictures, diagrams and video experiments which most textbooks fail to present in an effective way. Besides being able to project previous question papers & using sound clips, I think the multimedia are very effective in engaging multiple dimensions of teaching a particular lesson.

In summary, coherence and modality principles seemed to be evident in the approach that Mr Mkhwanazi takes when he teaches using multimedia. He alluded to the fact that multimedia helps him to use time effectively by using specific pictures and video clips to explain variety of concepts with reasonable amount of time. Limited capacity assumption appeared to be considered by Mr Mkhwanazi when he argued that multimedia should be used to augment teaching by emphasizing important concepts during the lesson. It appeared that selecting minimal and effective multimedia for teaching plays an important role in avoiding to cognitively overload students. Modality principle seemed to be taken into consideration as he argues video clips narrates story better than any type of multimedia.

To conclude, these interviews reveal that teachers prefer and use similar multimedia in their teaching of climatology concepts in Grade 12 such as video clips, images and diagrams. There are various principles that teachers seem to take into consideration when they design and teach climatology concepts such as multimedia, coherence, contiguity and modality principles. It is evident through the interactions with the teachers that they generally consider limited capacity assumptions by presenting adequate content knowledge to their students to avoid cognitively overloading them. In general, teachers in the study think and strategize about how they can concretize abstract climatology concepts in order to help students learn adequately. Infographics and video clips were used as multimedia summarize concepts taught during the lesson.

Most teachers claim that they use multimedia as a tool to reinforce certain concepts and perhaps help students to see different dimensions of a particular concept. There were

no major differences in terms of how teachers from townships view multimedia as compared to the teachers from suburban areas. However, it appeared that teachers from suburban areas seem to give more elaborative responses in term of how multimedia enhances their teaching and learning as compared to teachers from township. The reason could be that suburban teachers have been using multimedia for a long time and they know their benefits in detail as compared to teachers from townships that technological aids in their schools have been added in recent times. Most teachers claim that they use multimedia as a tool to reinforce concepts and perhaps help students to see different dimensions of abstract climatology concepts.

5.5 LESSON OBSERVATIONS

All lessons observed in this study were about 40-45 minutes long and the purpose was to find out how teachers in the study used multimedia in teaching of climatology concepts in Grade 12. Data from all four teachers will be presented in the order used in the Table 5.2.1 above. The data from each teacher will be presented using the order in which various multimodal were introduced in the lesson and how these multimodal were used to explain and elaborate abstract climatology concepts. It is worth noting that, teachers in the study approached multimedia teaching in a similar way in terms of techniques and principles that were followed during the instruction. However, data derived from interviews suggests that teacher's understanding of the effectiveness of multimedia differed and the reasoning for choosing a particular multimodal differed from one teacher to another even though the outcomes of their lessons were similar.

The data that emerged from these lesson observations was scrutinized using a framework for cognitive theory of multimedia learning drawn from Mayer (2001) [Refer to Figure 4.1.1]. In order to understand how multimedia is used by the teachers in the study, conceptual framework adopted for this study was used to understand teacher's approach to multimedia teaching [Refer to Figure 4.1.2].

5.5.1 Mrs Cloete's lesson observation

Mrs Cloete delivered a lesson on tropical cyclones. Tropical cyclones is a second topic taught under climatology section at the beginning of the Grade 12 Geography academic year. She emphasized that the lesson was to consolidate or reinforce the content taught at the beginning of the year and to prepare the students for the preliminary examinations. Diagram 5.5.1.1 below indicates the approach that Mrs Cloete had in teaching climatology concepts using multimedia.

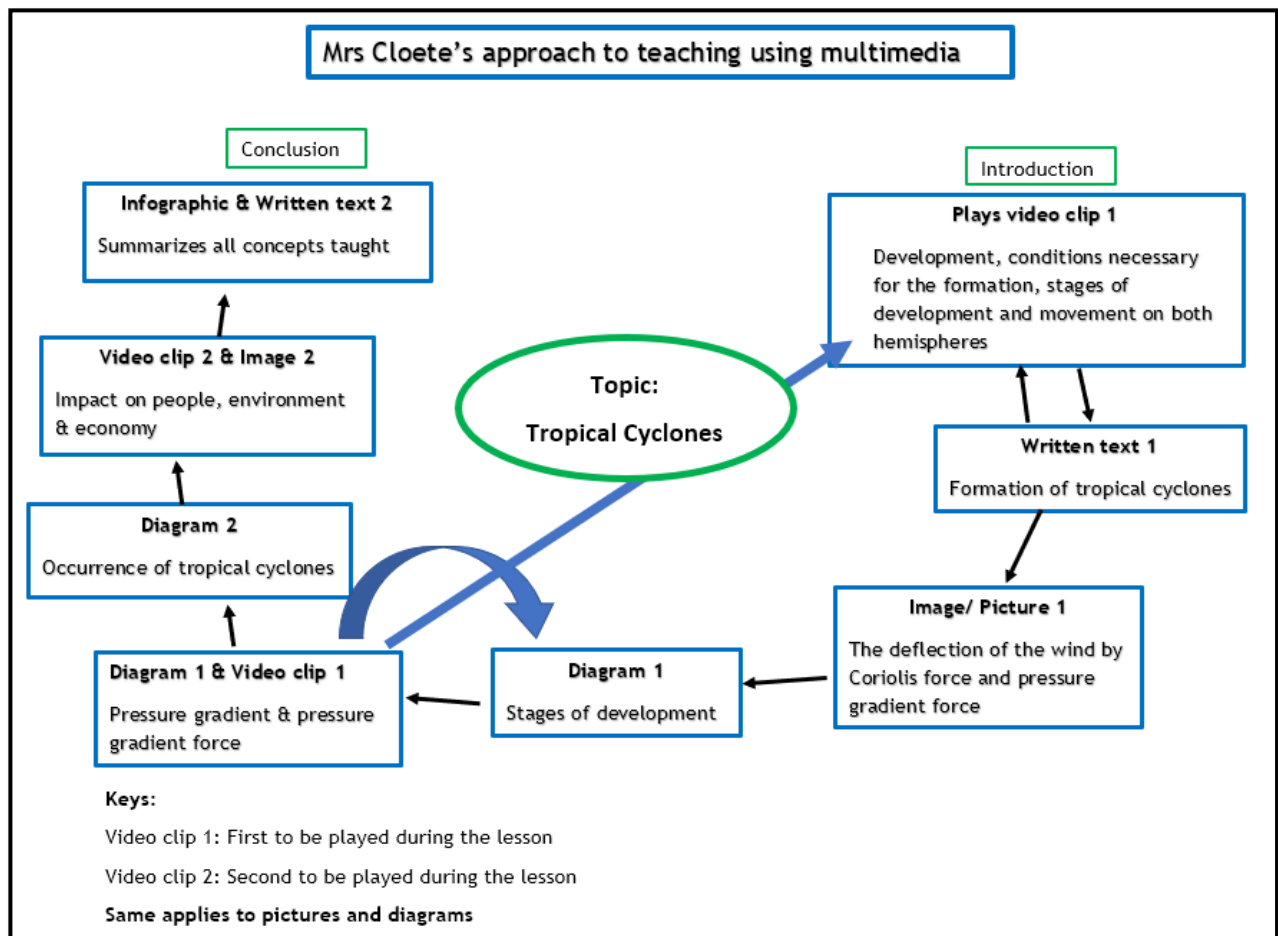


Diagram 5.5.1.1 Introduction sequence of multimedia during instruction.

The diagram above indicates the sequence in which multimedia were introduced from the introduction to the conclusion of the lesson. There were instances where the teacher will refer to the multimedia that was used earlier in order to explain certain concepts at the later stage of the lesson, hence some arrows showing back and forth. Certain multimedia

were used numerous times to explain different concepts hence they appear more than once in the sequence of the lesson. Thicker arrows indicate an extended time teacher spent while referring to the multimedia while thinner arrows indicate lesser time.

Designing multimedia for teaching.

Mrs Cloete used PowerPoint Presentation (PPT) in her lesson. In the PPT there were a variety of multimodal that information was presented such as infographics, images/pictures, videos clips and text. Mrs Cloete played a video clip which summarized how tropical cyclones develop, conditions that are necessary for their formations, stages of development and the direction in which they move in both hemispheres. She went through the text of summary of the conditions that are necessary for the formation of tropical cyclones.

While Mrs Cloete was going through the written summary of the conditions necessary for the formation of tropical cyclones, she kept on referring the students back to the video clip played at the beginning of the lesson to consolidate some of the points indicated on the written summary. She read the text that was on the PPT and then referred back to the video to indicate to the students that a low-pressure cell develops when there is warm air rising. She went on to say that:

Warm air rises because the sea surface temperatures of the ocean are above 27 degrees Celsius, because the oceans had enough time to warm throughout summer and thus tropical cyclones normally occur late summer into early autumn.

The reason Mrs Cloete wanted the students to see that when warm air rises, it creates a low-pressure cell could be that all low-pressure cells are associated with cloudy conditions and ultimately rainfall. These are characteristics of tropical cyclones, and the students were made aware of that at the beginning of the lesson.

Mrs Cloete paused video clip for a while to show the students how the low-pressure system sucks the air around it in order to intensify the low pressure at the surface. Lastly, she showed the students that latent heat that is released when condensation takes place is kept within the system and it is responsible for the energy that the low-pressure system

has. It appears that Mrs Cloete applied the multimedia principle as she used both the written and spoken text as well as the video clips interchangeably to explain the conditions necessary for the formation of tropical cyclones.

Mrs Cloete highlighted the importance of the Coriolis force which is responsible for deflecting the winds into the system thus strengthens the wind within the tropical cyclones. While explaining this concept she referred the students to a picture of tropical cyclone which showed the wind being deflected into the tropical cyclone because of the Coriolis force along the pressure gradient [Refer to Figure 5.5.1.1 below]. Mrs Cloete applied multimedia, contiguity and coherence principles by using limited text on the picture, and the text was placed next to intended or described concepts. According to Mayer (2003) effective teaching and meaningful learning occurs when multimedia is used in cognizance of different principles like multimedia principle and coherence principle. He argues that multimedia should be free of any extraneous words or sounds that will distract students and potentially overload them cognitively

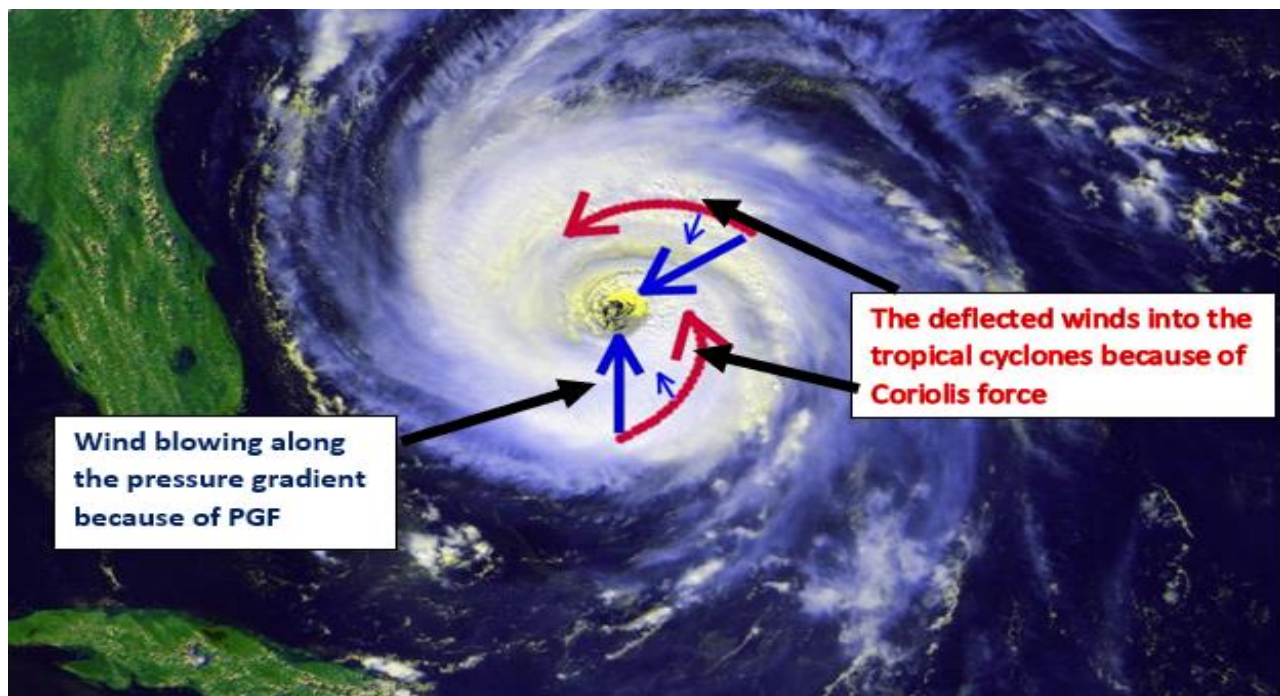


Figure 5.5.1.1: A satellite image used by Mrs Cloete to show the relationship between Coriolis force and pressure gradient force within a tropical cyclone

In terms of explaining the stages of the development of tropical cyclones, Mrs Cloete used a diagram on the PPT, whereby there was a written text next to each diagram [Refer to Figure 5.4.1.2] showing stages of development. Mrs Cloete read the text next to the diagram and then indicated the information on the diagram. She indicated that:

“At the formative stage the pressure at the centre of the low-pressure cell is well above 1000 hectopascals as you can see it on the diagram over here”

Contiguity principle and coherence principle were applied by Mrs Cloete in the sense that while explaining the text and diagram on the PPT, she put up another diagram that was showing stages of development of tropical cyclones and she emphasized the importance of the students being able to interpret different diagrams on the stages of development. Mrs Cloete emphasized on the students being able to see the pressure change at the centre of the tropical cyclone from formative stage to immature stage. She is quoted saying

“As you can here, uhm... the pressure at the formative stage is well above 1000 hectopascals but as you can see here, the pressure drops significantly to below 1000 hectopascals at immature stage”

Mrs Cloete explained that immature and mature stages of tropical cyclones are very similar since the pressure at the centre of the systems is way below 1000 hectopascals. She went on to say:

“As you can see on the diagram, the pressure remains in these two stages [mature and immature stages] remains well below 1000 hectopascals, there only difference is that the wind at immature stage is gale force winds which just less than 100km/h but at the mature stages, we have hurricane strength winds which are way above 200km/h.

Mrs Cloete explained the strength of the wind and the pressure by referring to the video clip and diagram showing stages of tropical cyclones [Refer to the Figure 5.5.1.2 below].

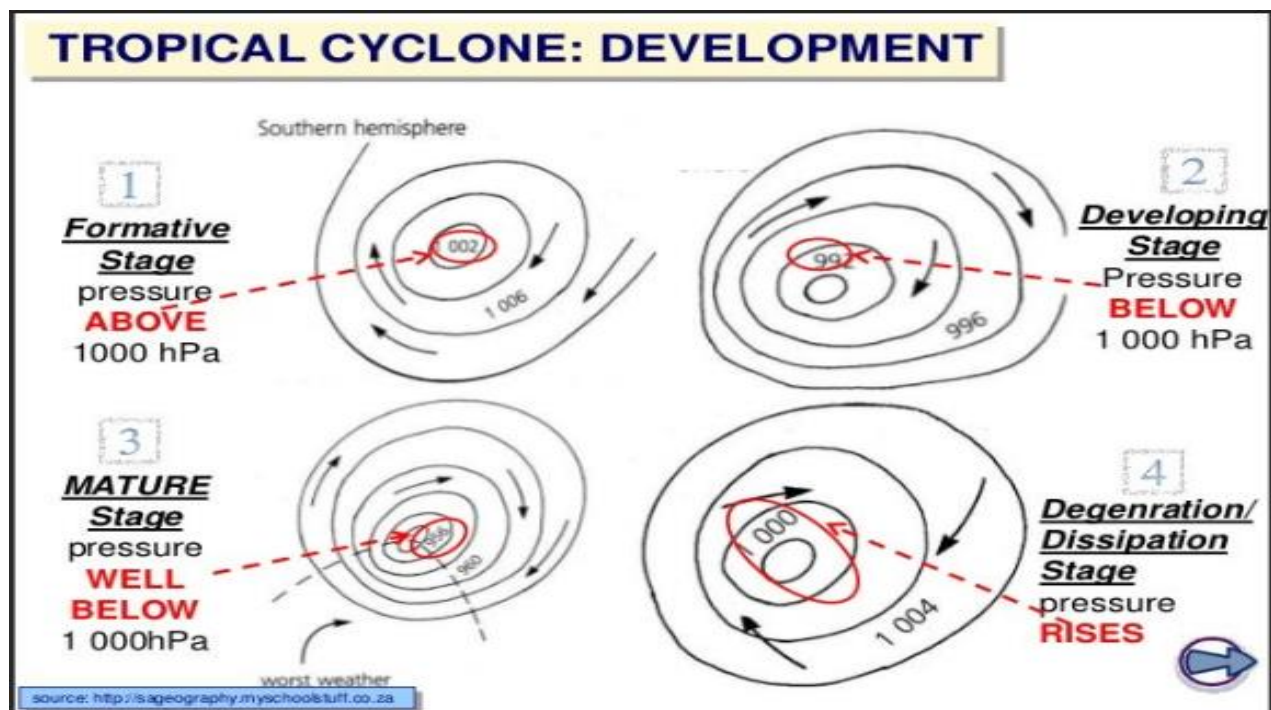


Figure 5.5.1.2 A diagram used by Mrs Cloete showing different stages of a tropical cyclone

In terms of explaining the direction in which tropical cyclones move, she used a diagram showing world map of the occurrences of the tropical cyclones and also referred the students back to the video clip that she used at the beginning of the lesson, and this symbolizes the adoption of multimedia, coherence and contiguity principles. Mrs Cloete used a world map [Refer to Figure 5.5.1.3 below] indicating the areas around the world in which tropical cyclones develop. She said:

“If you look at this map over here, you can see areas in which these systems [tropical cyclones] develop and if you pay special attention, you can see that the develop around the equator where sea surface temperatures are very high. And remember guys, that uhm.... the systems [tropical cyclones] won’t develop around the equator at around 0 and 5 degrees latitude because Coriolis force is non effective”

Mrs Cloete explained how Coriolis force is zero at the equator and tropical cyclones require Coriolis force to deflect the wind into the system thus equatorial regions won’t be affected by these systems.

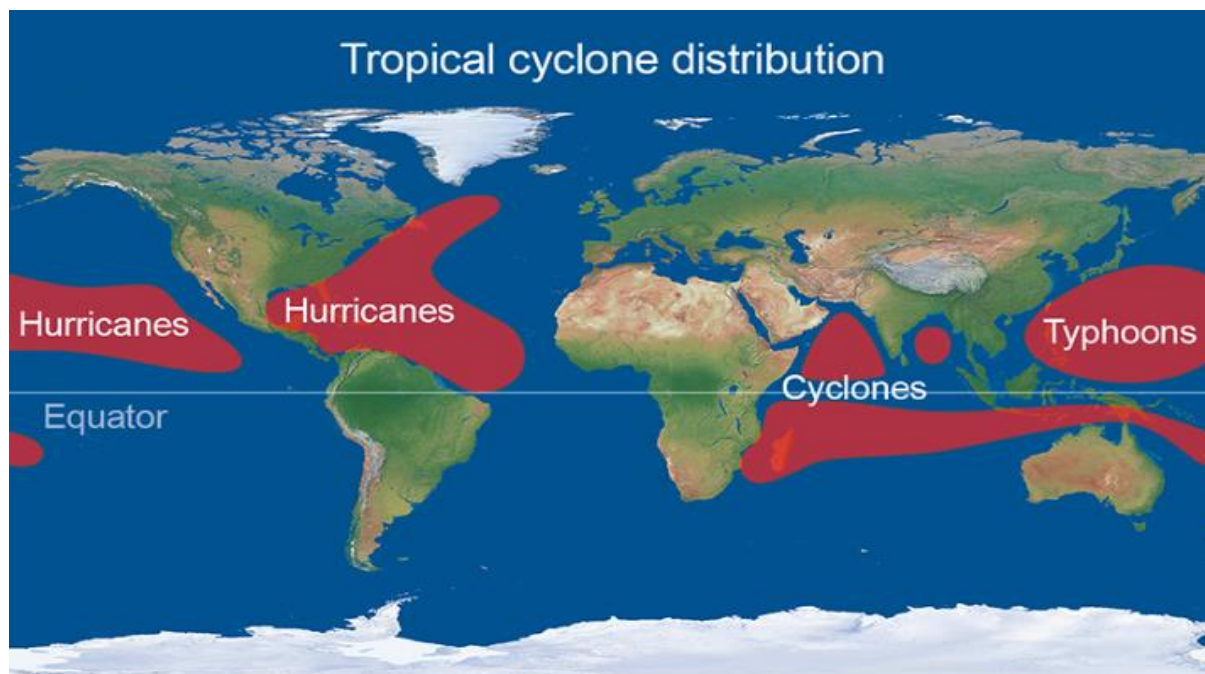


Figure 5.5.1.3 An image used by Mrs Cloete showing areas in which tropical cyclones occur.

Lastly, to explain the negative impact that tropical cyclones have on people, environment and economy, Mrs Cloete used video clip showing the devastating impact of the tropical cyclones. She played the video clip and then asked the students what negative impact the students saw on the video clip. While the students were giving responses, she then referred to the video clip and images to indicate the impact that was caused either on the environment and on people. At this part of the lesson, modality principle was applied by Mrs Cloete since the video was narrating a story about how people, environment and economy are severely affected by the tropical cyclones.

Mrs Cloete used real world examples by showing the students the impact that tropical cyclones have on developing countries around the world using video clip. Real-world connections are expected to have many benefits, such as enhancing students' understanding of concepts (De Lange, 1996). Mrs Cloete applied the modality principle in the sense that she told a story of how the destruction of people's homes will happen,

trees will be uprooted, and bridges will collapse using a series of images and video clip. She is quoted saying:

“These are some of the losses that the poorest of the poor will encounter in some of these developing countries. And, it is unimaginable to think about how long it is going to take for the governments of these people to rebuild everything that has been destroyed by these tropical cyclones.”

She then referred the students to the PPT whereby there was a tabulated summary of the impact of the tropical cyclones on the environment and people. As a conclusion to the lesson, Mrs Cloete put up the infographic that was showing all the content knowledge that was taught or revised in the lesson (Refer to annexure N). Mrs Cloete used the infographic to recap on the main concepts that were taught during the lesson.

Implementation of multimedia for teaching.

Mrs Cloete referred to all multimodal during her lesson, by switching through different multimodal. It appeared as if Mrs Cloete wanted the students to see relationship between different concepts showed in different multimodal. By allowing the students to see the relationship between different concepts, it will allow students to own the knowledge and transfer it from working memory to long term memory, which is supported by personalization principle.

In addition, it appears that Mrs Cloete wanted the students to be able to see patterns that exist with different diagrams and videos that she used in her lesson. In most part of the lesson, she used the pictures and videos interchangeably when she wanted to explain certain concepts that the students did not understand. She emphasized the importance of looking at the relationship between the text and pictures when she was using the infographic (See annexure N), which emphasizes the dual channel assumption.

On the other hand, Mrs Cloete emphasized the importance of the students going through maps/diagrams in their own time (See annexure N). This is what he had to say:

It is important guys you zoom into these maps in order to find finer details with regards to where in the world tropical cyclones have a significant impact and what are some strategies these countries put in place in order to mitigate their impact.

The amount of written text on the PPT was limited (she mostly used summaries). More emphasis was on the pictures and video clips that were used during the lesson. Mrs Cloete could have been avoiding overloading students cognitively during lesson, thus suggested the students to look at certain diagrams and pictures in their own time.

In summary, Mrs Cloete referred to the multimedia that she used on numerous occasions in order to explain the concepts that were taught in lesson (personalization principle). In addition, Mrs Cloete summarized important concepts by referring the students to the diagram in terms of the main concepts that she wanted the students to learn in the lesson to avoid overloading students cognitively (limited capacity assumption). The Mrs Cloete used infographic, pictures and video clips to ask students questions based on different concepts that she wanted to explain during the lesson which applied supported the multimedia, contiguity and coherence principles. Towards the end of the lesson, the Mrs Cloete refers students to the multimedia that she used earlier in the lesson in order to reinforce certain concepts in the lesson.

5.5.2 Mrs Naidoo's lesson observation

Mrs Naidoo delivered a lesson on Mid-latitude cyclones. Her approach was to consolidate some of the Grade 11 concepts that are important in understanding Mid-latitude cyclones. Mid-latitude cyclones is the first topic taught under climatology section at the beginning of the Grade 12 Geography academic year. Mrs Naidoo highlighted that the lesson was to reinforce the concepts taught in Grade 11 as they are important in building up for the Grade 12 content. She noted that some of the Grade 11 content is examined in the Grade 12 preliminary and final exams. Diagram 5.5.2.1 below indicates the approach that Mrs Naidoo introduced multimedia in her lesson while teaching climatology concepts.

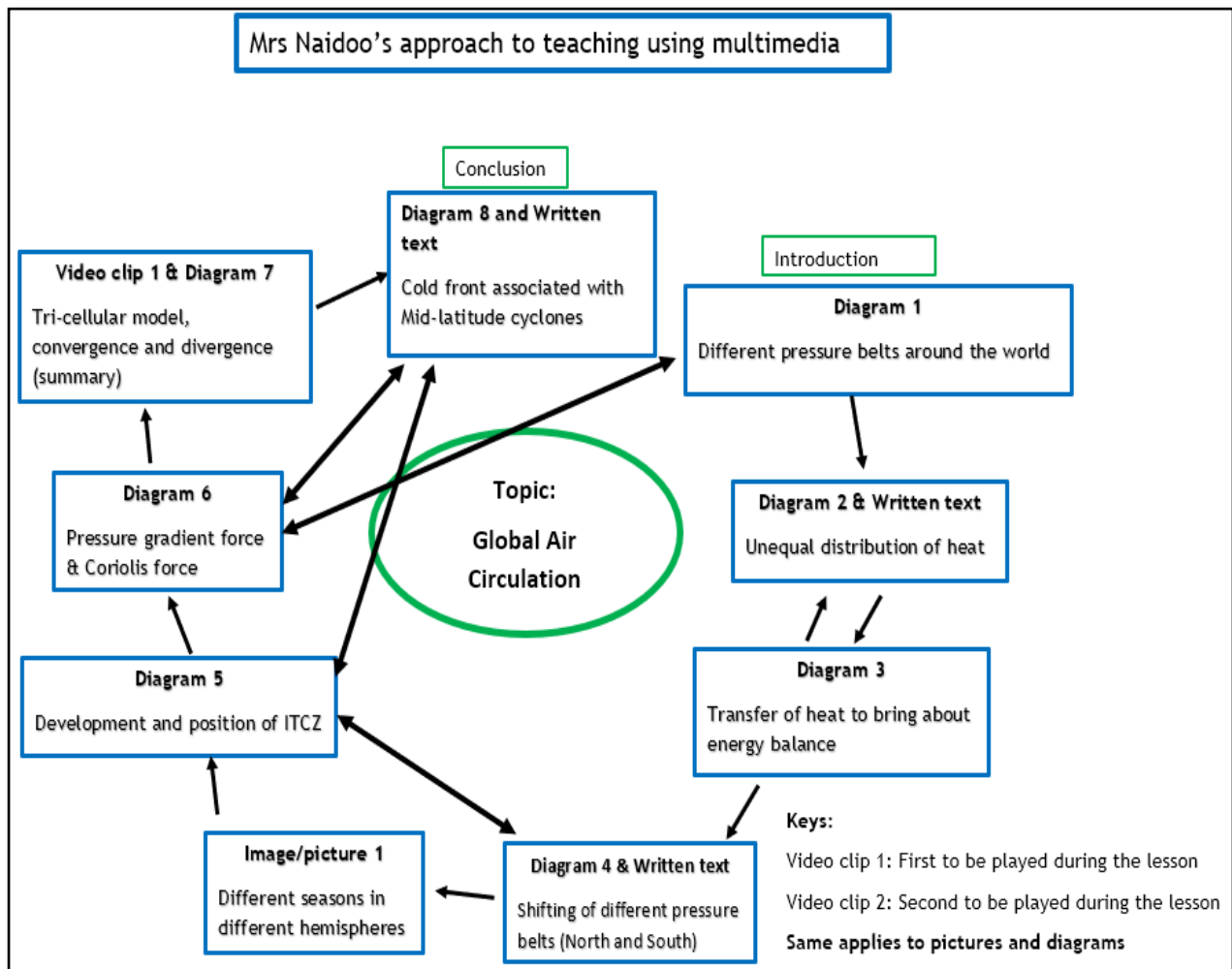


Diagram 5.5.2.1: Introduction sequence of multimedia during instruction.

The diagram above indicates the sequence in which multimedia were introduced from the introduction to the conclusion of the lesson. There were instances where the teacher will refer to the multimedia that was used earlier in order to explain certain concepts at the later stage of the lesson, hence some arrows showing back and forth. Certain multimedia were used numerous times to explain different concepts hence they appear more than once in the sequence of the lesson. Thicker arrows indicate an extended time teacher spent while referring to a diagram while thinner arrows indicate lesser time.

Design of multimedia for teaching. Mrs Naidoo introduced her lesson as one that will focus on “Global Air Circulation”. She proceeded to state that the lesson will focus on different pressure belts/cells that exist around the world and how these different

pressure cells influence the direction in which the wind blows. She stated that she would recap first the concepts taught in the previous lesson. She quoted saying:

I am going to recap what we did yesterday. You have all drawn this diagram right? This diagram (Planetary winds) is one of the most important diagrams that you need to be able to recognise and understand because this is the fundamental explanation of why we have different climates around the world.

Mrs Naidoo used different multimedia to explain different concepts. She started the lesson by putting up a diagram showing different pressure belts around the world. She used the diagram to explain how different latitudes promotes different pressure belts and ultimately climates around the world [Refer to Figure 5.5.2.1 below]. She is quoted saying:

“When we go back to climates, we learnt that latitude seems to be the main climatic criteria for each of these areas. So, latitudinal position determines the type of climate. So, generally we realise that the closer you are to the equator, the warmer the temperatures and closer you are to the poles the colder the temperatures”.

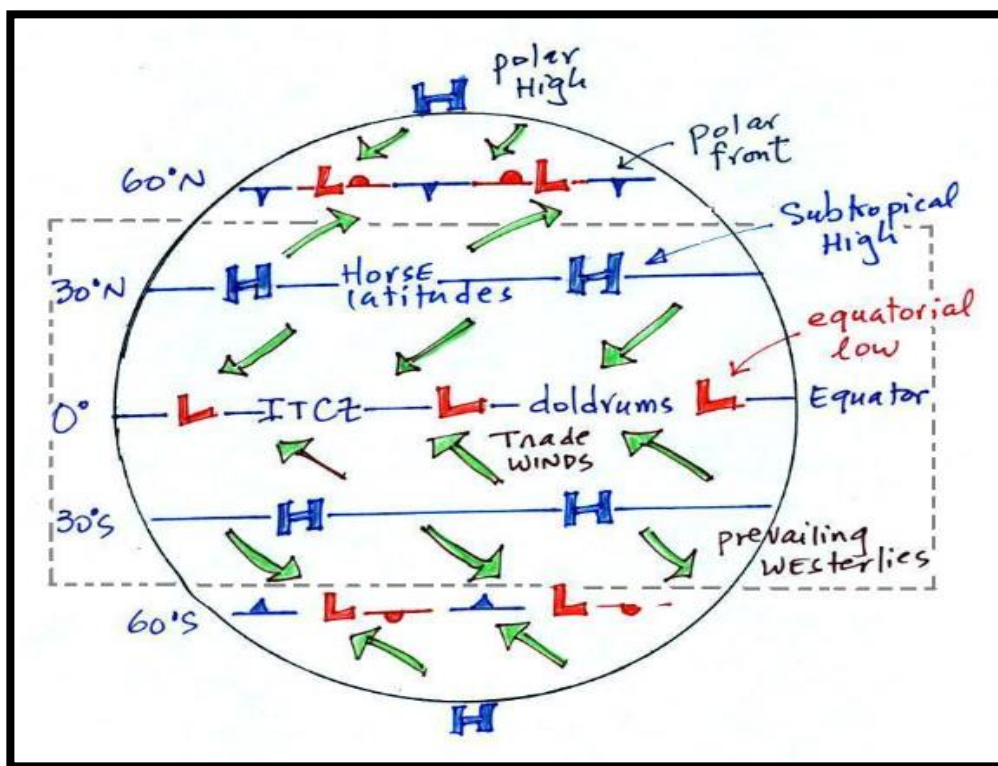


Figure 5.5.2.1 A diagram used by Mrs Naidoo showing different pressure belts around the world and associated global winds.

Mrs Naidoo highlighted the fact that equatorial regions are warmer and as a result there will be low-pressure belt around the equator. Likewise, she pointed out that polar regions are colder, thus the high-pressure belt will be around the poles.

Mrs Naidoo applied contiguity and coherence principles by explaining the concept of pressure belts using this diagram because the written text was placed on intended descriptions. In addition, there was no extraneous words which could potentially confuse the students and perhaps overload them cognitively.

Mrs Naidoo referred the students to diagram on the board and highlighted the fact that equatorial regions are warmer than polar regions, that creates unequal distribution of heat. This is what she had to say:

“Now that creates a very unbalanced temperature distribution, the places within equatorial regions will be so hot, and the places around the polar regions will be so cold, and that human life will find it so difficult to adapt. So anyway, what nature has done is it creates a distribution of heat.”

At this stage of the lesson, Mrs Naidoo used the diagram [Refer to Figure 5.5.2.2 below] and written text on the board to show the students how heat is unevenly distributed across the globe. Mrs Naidoo explained that when the northern hemisphere is tilted towards the sun, it is summer which means more insolation. She indicated that when it's summer in the northern hemisphere, it means that it's winter in the southern hemisphere because the earth is tilted away from the sun, which means less insolation. She even referred the students to the diagrams that they drew in their books and written text on the board as well as verbal explanation which signals multimedia principle.

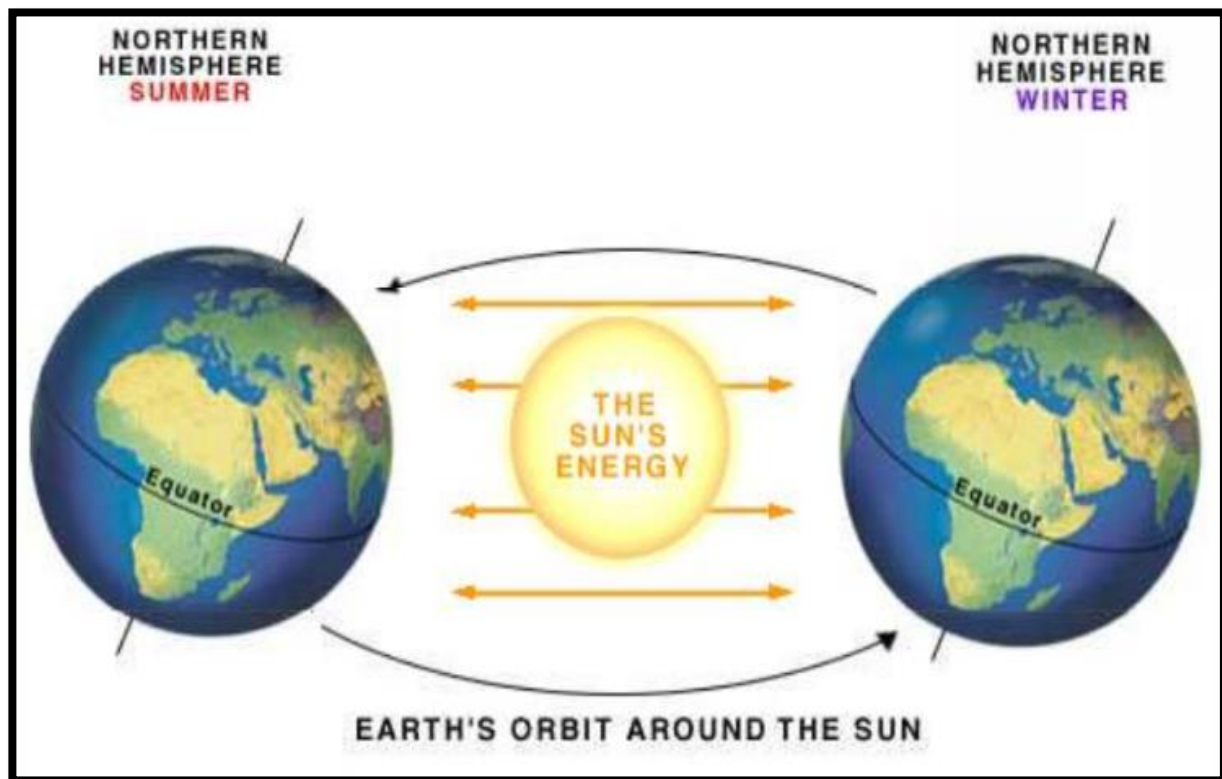


Figure 5.5.2.2 A diagram used by Mrs Naidoo showing the angle of the sun in winter and summer seasons in the northern hemisphere and southern hemisphere.

Mrs Naidoo used the diagram [Refer to Figure 5.5.2.3] on the board to illustrate for the students how the heat distribution will happen across the globe in order to bring about balance of the earth's temperatures. She is quoted saying:

"So, in reality, the warm air kind of shifts towards the poles to replace the cold air and the cold air shifts towards the equator to cool it down."

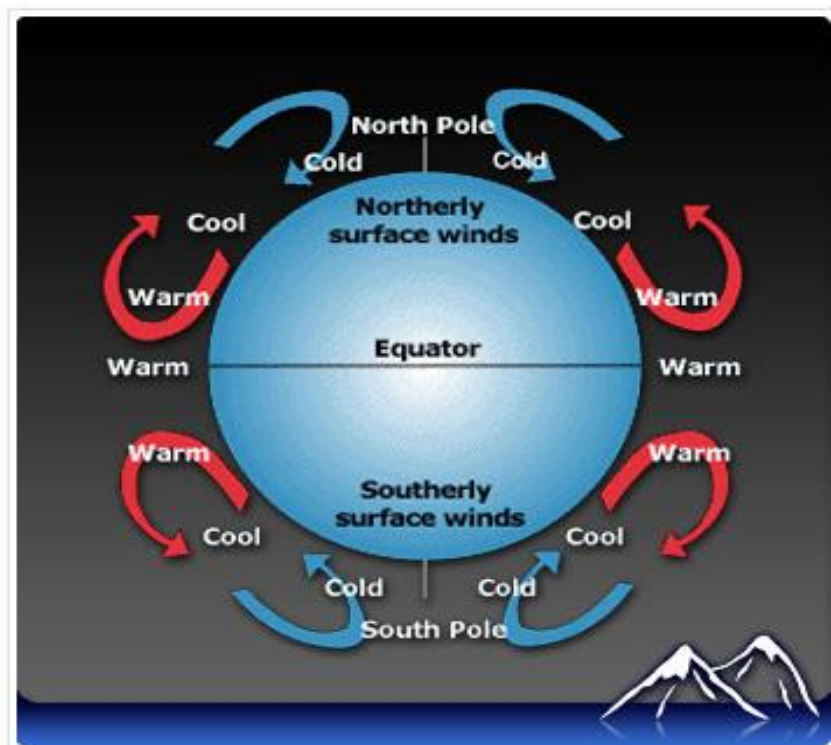


Figure 5.5.2.3 A diagram used by Mrs Cloete indicating how warmer winds blow from the equator to the poles and cold winds blow from the poles to the equator to bring about energy balance across the earth.

Mrs Naidoo annotated the diagram on the smart board showing the direction in which warm and cold air are flowing in terms of bringing earth's energy balance which indicates the application of multimedia principle.

Mrs Naidoo went on to show how wind will start blowing from high pressure belts to low pressure belt along the pressure gradient using the global air circulation diagram [Refer to Figure 5.5.2.1]. She indicated the direction in which the wind blows by using arrows from high pressure belt to low pressure belt. Alongside the global air circulation there was annotation and writings that was used to highlight different concepts in the lesson which signals contiguity principle. According to Mayer (2002) students are more likely to engage in productive cognitive processing when corresponding words and pictures are presented at the same time. Mrs Naidoo appeared to be deliberately presenting visuals and text at the same time, which will enable the students to look at the relationship that might exist between the two multimodal.

In addition, she explained using the same diagram [Refer to Figure 5.5.2.1] how the pressure belts are going to shift north and south depending on the season (whether winter or summer). She is quoted saying:

Now, the winds intersect at a particular position, that we know the winds aren't going to be set because what happens in 365 days as the Earth revolves around the sun? What is going to happen isn't Mr. D..... The student answers " They gonna shift, the low pressure is gonna move up and down" So, what makes them move up and down? The students answers " The tilt of the of the earth" the tilt of the Earth is going to be in such a way that the sun's direct rays concentration are going to shift between the equatorial region and almost shift as low as about 40 degrees, which means that this equatorial low pressure system is going to also shift.

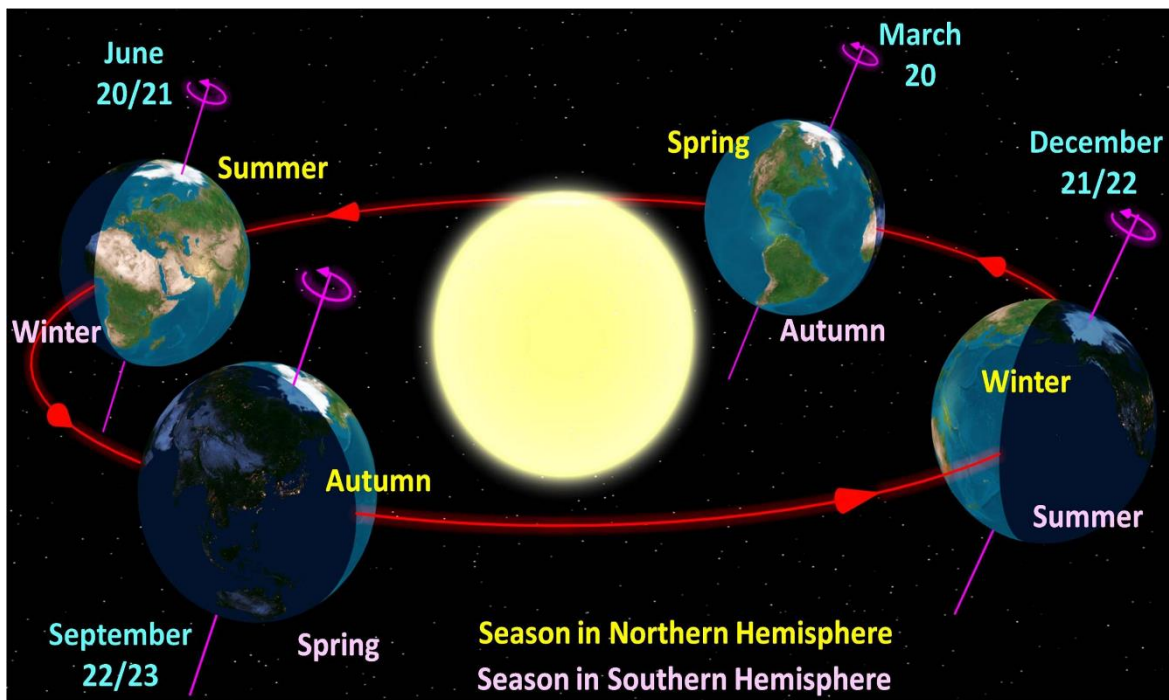


Figure 5.5.2.4 A diagram used by Mrs Naidoo showing the angle of the sun in different seasons.

Contiguity principle was applied when Mrs Naidoo illustrated how pressure belts shift up and down because of the angle that the sun strikes the earth during different seasons. Using a different diagram, Mrs Naidoo indicated the angle of the sun during different seasons [Refer to Figure 5.5.2.4], which influences the shifting north and south of different pressure belts in different seasons.

After the explanation of how different pressure belts shift north and south, a student asked a question " Maam can you please re-explain what inter-tropical convergence zone is ". Mrs Naidoo responded by stating that:

Sure! I will explain that to you. I will go to another diagram. Because what I am gonna do is to put it into context. Okay!!

Mrs Naidoo promised the student that she will switch to another diagram because it seemed like the diagram that was on the board was not sufficient to answer the student's question. It appeared as the diagram on the board was indicating global wind patterns but the student was asking about the zone where warm and cold air converge which cannot be fully explained on the diagram that was on the board. Contiguity principle and multimedia principles were applied when Mrs Naidoo put up the diagram [Refer to Figure 5.5.2.5] that showed the location of the Intertropical Convergence Zone (ITCZ) and indicated to the students that ITCZ forms when air masses from the tropics converge at a particular zone. On this diagram [Figure 5.5.2.5], ITCZ in summer and winter were indicated clearly using different colours red and blue. Mrs Naidoo indicated that ITCZ indicated by red line shifts north in July which is summer in the northern hemisphere, while the ITCZ indicated by blue line shifts south in January which is summer in the southern hemisphere.

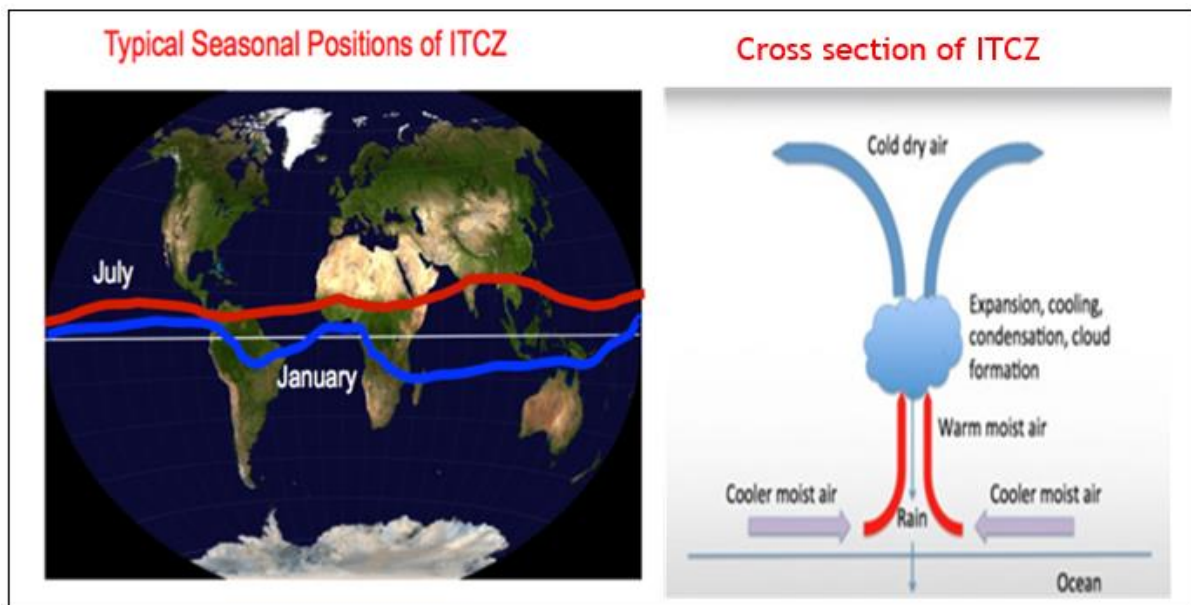


Figure 5.5.2.5 A diagram used by Mrs Naidoo showing formation of the ITCZ and its position in different seasons.

After explaining the term ITCZ, she switched back to the previous diagram showing different pressure belts [Figure 5.5.2.1] and the direction in which the wind blows. Mrs Naidoo is quoted saying:

So winds are created, but what do we call that force that results in wind or that variation between the pressures. What do we call it?

A student answers:

"pressure gradient force"

Mrs Naidoo elaborated:

Right, because we have pressure gradient force, uhm... I will show you a diagram just now...

Mrs Naidoo elaborated using another diagram and also writing additional notes on the diagram (using different colours) to indicate forces that act on the wind as it blows from high pressure to low pressure such as pressure gradient force and Coriolis force [Refer to Figure 5.5.2.6 below]. According to Mayer (2009), the dual-channel assumption states that humans possess separate channels for processing visual and auditory information, which are visual-pictorial channel and auditory-verbal channel. It appears that Mrs Naidoo understood the importance of providing students with information that can be processed using this dual channel. Explaining the impact that these two forces have on global or planetary winds, this what Mrs Naidoo had to say:

So that means my planetary winds are actually travelling. It looks like they're going left or right. So that's the perception you get. So, therefore our prevailing winds will flow either westward or eastward. So, you're only going to get westward flowing wind and eastward flowing wind and they're going to either be called south easterlies, north easterlies, south westerlies, or north westerlies. And why do we call them that? Because winds are named from where they originate, from where they flow. Therefore, if we go back to... have you all got this? If we...go back to the diagram and apply that information, I got my temperature variation forming different pressure cells. Pressure gradient force is created between the high and low. The earth is spinning. And as the air from the high to the low Coriolis force affects it...uhm because of the spinning of the earth.

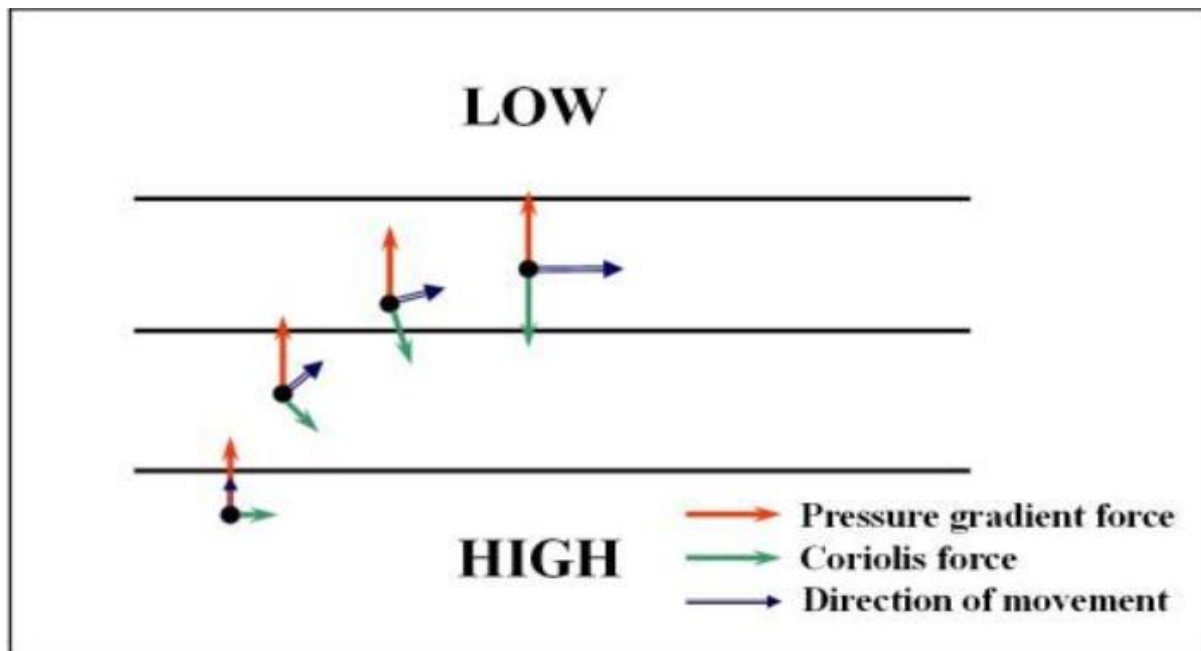


Figure 5.5.2.6 A diagram used by Mrs Naidoo showing the impact of the Coriolis force and pressure gradient force along the pressure gradient.

Mrs Naidoo referred and annotated Figure 5.5.2.1 to show how the wind blows along the pressure gradient while explaining these Coriolis force and pressure gradient force concepts and how the wind blows along the pressure gradient. Coherence and contiguity principles were applied as Mrs Naidoo indicated on the diagram the summary of forces that operate when wind blows and typical generalisations that students need to draw from the diagram.

Towards the end of the lesson, Mrs Naidoo played a video clip from YouTube as a way of summarizing the main concepts discussed in the lesson. Mrs Naidoo highlighted the fact that the introduction of a video clip is to emphasize on the concepts explained in the lesson, supposedly as a consolidation method to drill concepts taught from a different perspective using different diagrams on the video. In the video clip, there was narration done on the explanation of Global air circulation which supports the modality principle. According to Robinson (2004), Mayer's research shows that students learn more deeply from animation and narration than from animation and on-screen text. The modality principle allows the teacher to design multimedia that would narrate how the concept or scenario happened or formed.

Mrs Naidoo introduced the concept of tri-cellular model of global air circulation. Multimedia and signalling principles were evident as Mrs Naidoo explained the tri-cellular model using the diagram as well as verbal and written text where the cold air is going to sink and where warm air is going to rise linked to the different pressure cells taught at the beginning of the lesson [Refer to Figure 5.5.2.7 below]. She is quoted explaining the formation of the polar cell saying:

The next cell is going to be at the polar region. So what happens at the Polar region is because the air is very cold, the air is going to sink forming that high pressure system. Okay? As the air sinks towards the ground, the ground temperatures will be slightly warmer because even though it's cold, it'll be warmer than the air that's coming from the atmosphere. So what will happen here as it sinks, we know that sinking air diverges, okay? So the sinking air is going to diverge. And as it diverges, it moves to the latitudinal positions that are going to be much warmer. So as it moves to the latitudinal positions that are warmer, it's going to create a low pressure system. And this low pressure system is gonna result in air rising over here and as it rises, it cools and sinks, and it's gonna go back to the polar region.

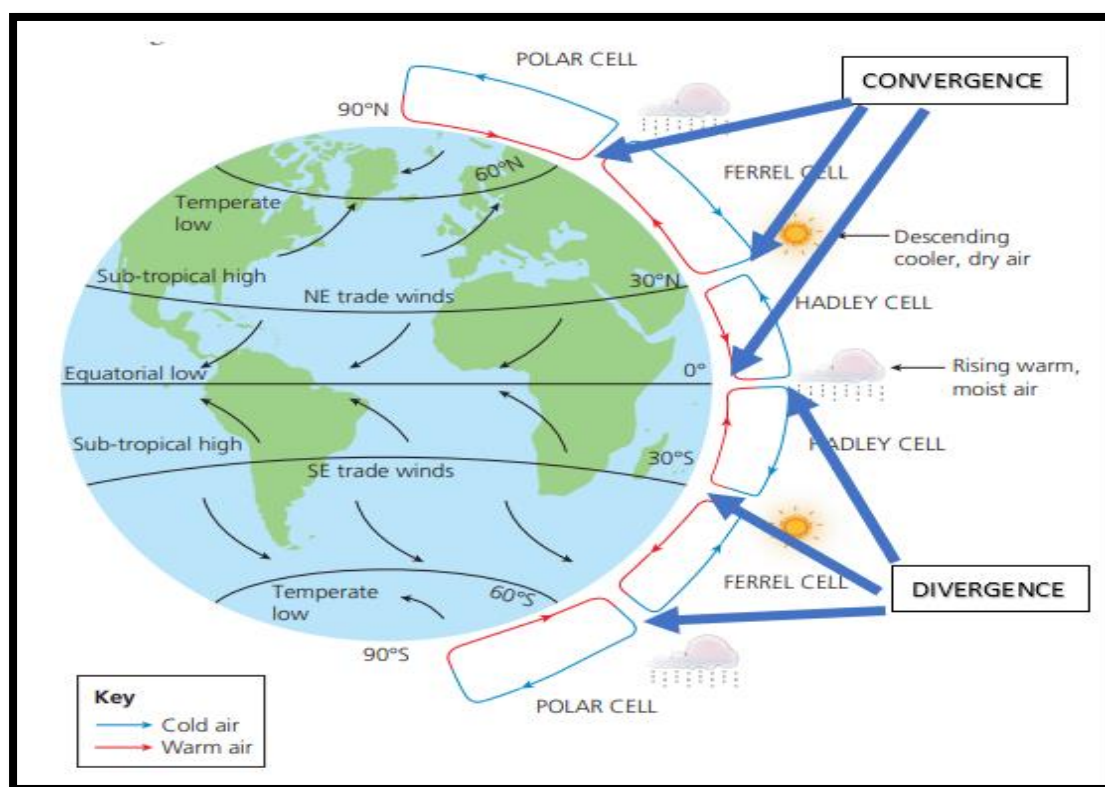


Figure 5.5.2.7 A diagram used by Mrs Naidoo showing tri-cellular model of global air circulation.

Mrs Naidoo stressed on the formation of the polar cell by indicating on diagram how the cold air sinks and what will happen to it as it sinks [it will diverge on the surface]. In addition, while the Mrs Naidoo is explaining the formation of tricellular cells, she annotated on the diagram to indicate these movements of air in terms of vertical or horizontal and convergence or divergence which indicates the application of multimedia and signalling principles. These principles were indicated by placing the written text on the concepts or term explained and by also including key narration steps on the diagram like where convergence and divergence will take place.

Mrs Naidoo introduced the concept of midlatitude cyclone by linking it with the concepts taught during the lesson such as Hadley cell, Ferrell cell and Polar cell [Refer to Figure 5.5.2.8]. She is quoted saying:

It's a converging zone, but it has a specific name. I told you yesterday. A front here, it's called the front right? And because you said this region, we call this the polar front. So we are gonna find the polar front is going to form over here. Now that is very important later on when we move up, because South Africa is going to be affected by the polar front in our winter months.

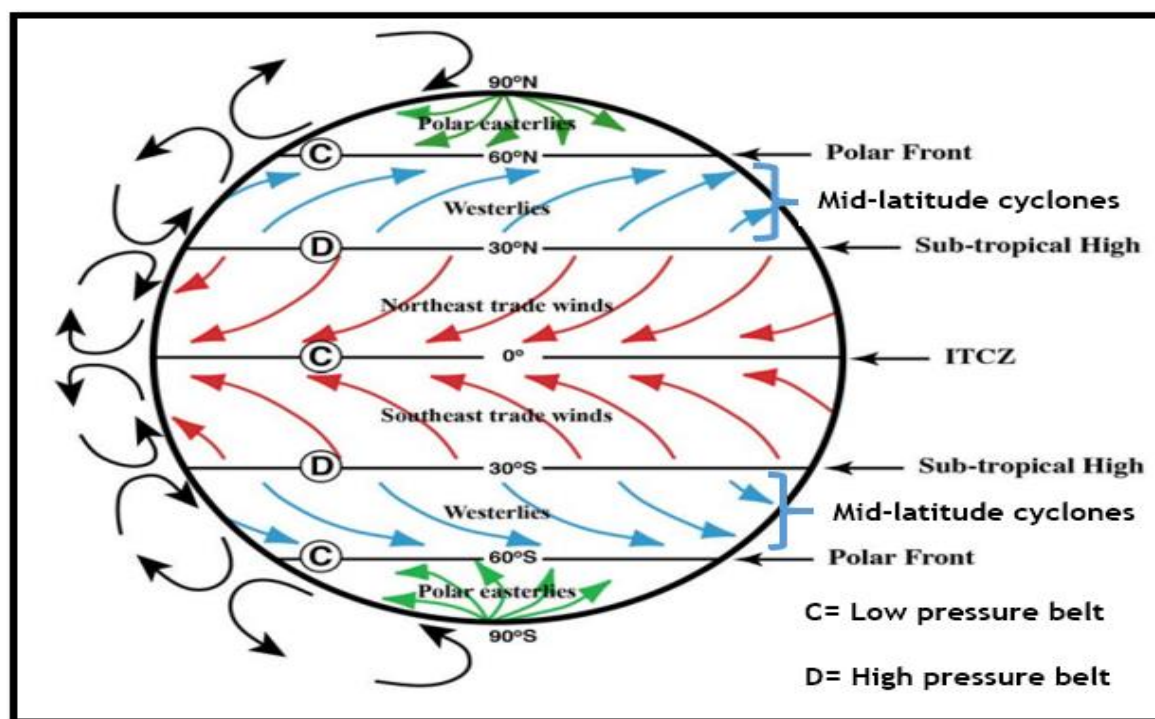


Figure 5.5.2.8 A diagram used by Mrs Naidoo showing global winds around world.

Mrs Naidoo referred to the Figure 5.5.2.8 again while explaining this concept of a cold front while showing the formation of the midlatitude cyclone along the polar front and the direction in which these systems move in the middle latitudes. Multimedia principle and coherence principles were indicated when the Mrs Naidoo brought in the practical implications of how the location of South Africa will make it prone to series of fronts that pass that area in during winter months.

Implementation of multimedia for teaching

Throughout the lesson, Mrs Naidoo has been referring the students to the annotated diagrams that were on the board. It clearly appeared that the focus of the lesson was centred on a particular diagram for the students to have a clear understanding in the lesson before she moved to the other concepts taught in the lesson. Dual channel assumption was taken into consideration as these diagrams used had text referring to the different concepts explained, which then allowed one channel to process the written text and the other channel to process visuals. Supposedly, taking the dual channel assumption into consideration allowed the students to process knowledge from sensory memory to working memory and ultimately to long term memory. When knowledge is stored in the long-term memory, according to Mayer (2002) active learning assumption has been achieved which suggest that meaningful learning has taken place and positive results should be anticipated.

Mrs Naidoo referred the students to the diagram (Global Air Circulation) multiple times to reinforce the concept that she was explaining. The diagram was free from extraneous words which suggested that limited capacity was taken into consideration. Limited capacity assumption suggests that students can only process certain amount of knowledge at a particular time. Mayer (2002) argues that if limited assumption is taken into consideration, active learning is bound to happen which will lead to information being transferred from working memory to long term memory. Mrs Naidoo also emphasized and drew student's attention to the fact that global air circulation responsible for the formation of the mid-latitude cyclones.

In summary, Mrs Naidoo referred to the diagrams repeatedly while explaining concepts taught in the lesson which supports multimedia and modality principles. She emphasized the importance of annotating the diagrams the way she did and explained to the students why they should look at certain aspect of the diagram in a particular way (signalling principle) and these diagrams considered the dual channel assumption. Moreover, Mrs Naidoo explained to the students why she chose a particular multimedia and why the multimedia is important for the purposes of the lesson. Most diagrams did not have extraneous words which supported limited capacity assumption. Both Mrs Naidoo and students were referring to multimedia when they were asking questions. Lastly, Mrs Naidoo used a video clip to make summaries of the concepts taught in a particular point in the lesson before she moves to the other concepts taught (To avoid overloading students cognitively).

5.5.3 Mrs Motaung's lesson observation

Mrs Motaung delivered a lesson on Global Air Circulation. Her approach was to consolidate some of the Grade 11 concepts that are important in understanding Mid-latitude cyclones. Mid-latitude cyclones is a first topic taught under climatology section at the beginning of the Grade 12 Geography academic year. Mrs Motaung highlighted that the lesson was to reinforce the concepts taught in Grade 11 as they are important in building up for the Grade12 content. Mrs Motaung's lesson was based on the Global Air Circulation with the emphasis on the development of different pressure cells, the impact of Coriolis force as well as tri-cellular cells around the world. The approach of Mrs Motaung was slightly different from the first two teachers, in the sense that she drew or constructed diagrams on the board herself and used diagrams on the student's textbooks. The diagram 5.5.3.1 below indicates the steps that were followed by Mrs Motaung in introducing the multimedia throughout the lesson.

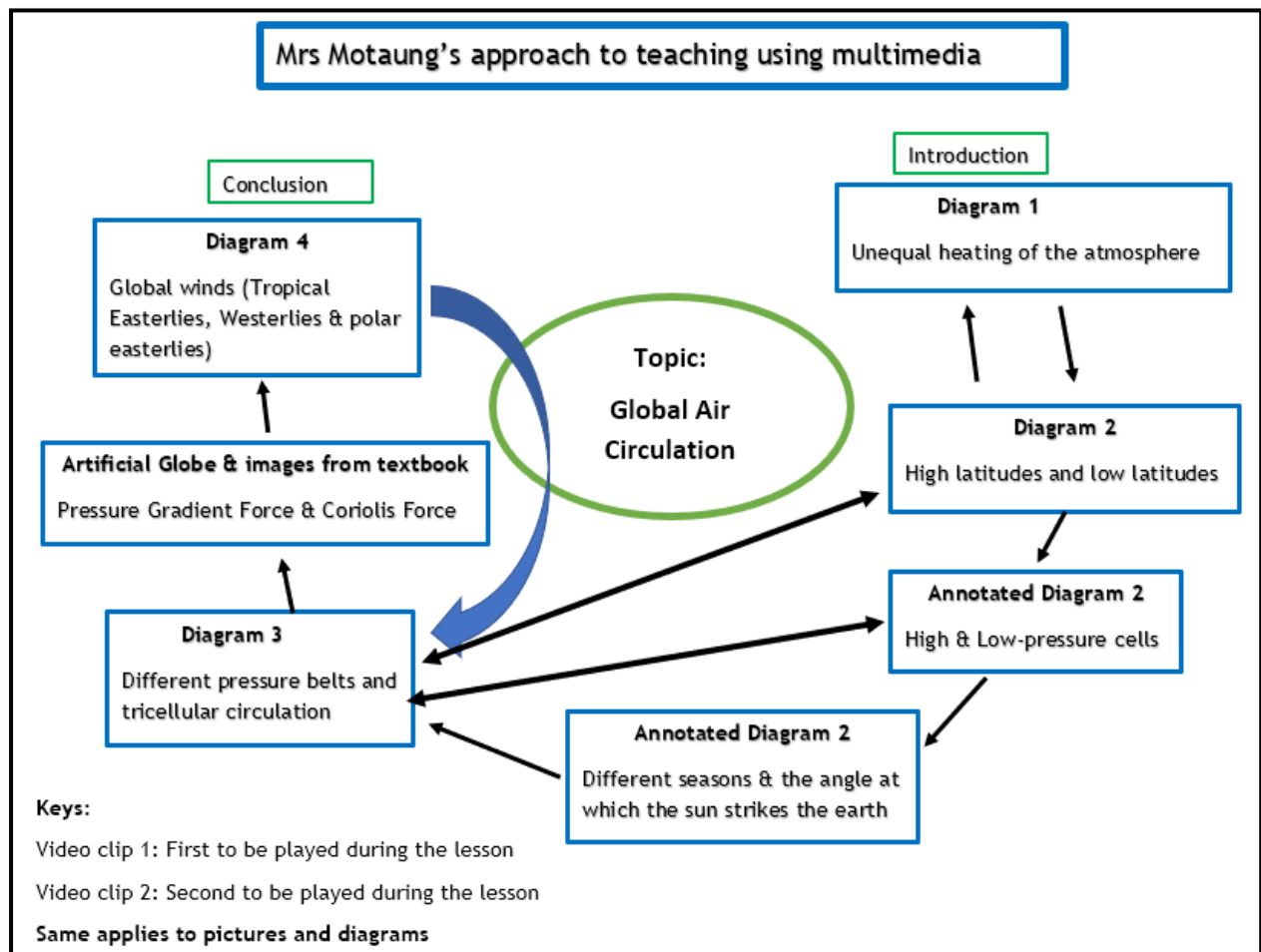


Diagram 5.5.3.1: Introduction sequence of multimedia during instruction.

The diagram above indicates the sequence in which multimedia were introduced from the introduction to the conclusion of the lesson. There were instances where this teacher will refer to the multimedia that was used earlier in order to explain certain concepts at the later stage of the lesson, hence some arrows showing back and forth. Certain multimedia were used numerous times to explain different concepts hence they appear more than once in the sequence of the lesson. Thicker arrows indicate an extended time teacher spent while referring to the multimedia while thinner arrows indicate lesser time used.

Design of multimedia for teaching.

The emphasis from Mrs Motaung was to construct diagrams from the start and have diagrams annotated throughout the lesson while she was teaching [Figure 5.4.3.1]. She started first by telling the students that she is was going to explain the unequal heating of the atmosphere and how global air circulation brings about the balance of energy/heat throughout the world. She was quoted saying:

Air moves around the globe transporting heat from the tropical regions to the polar regions. And that circulation of movement of air is what we call global air circulation. In today's lesson, we're going to take a look at how the earth's atmosphere works on a more complex level.

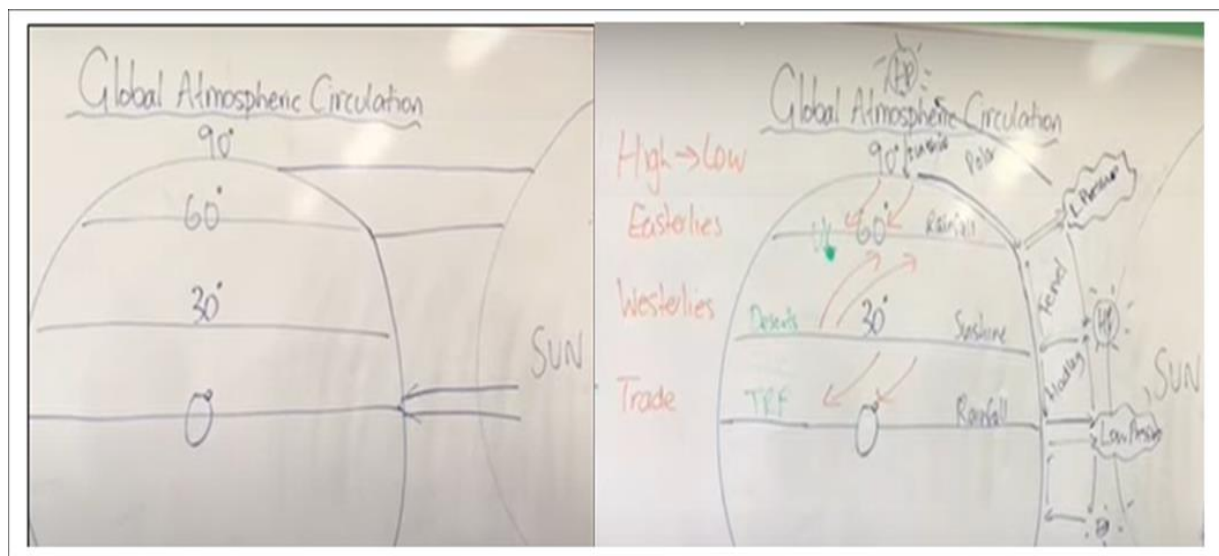


Figure 5.5.3.1 An annotated diagram used by Mrs Motaung showing global pressure belts

Mrs Motaung then explained that main factors that are at play with the distribution of heat across the world were the shape of the earth and its tilted position in space as well as the earth's rotation (which brings the deflection of the wind). She drew the diagram of the globe showing different latitudes [Figure 5.5.3.1] and she said:

The first thing we're going to look at is on the board, okay. We gonna look at the latitude. Okay. We find the equator. If you move north or south away from the equator, we move into it what we call the higher latitude and you will be able to recognize it or you will see it like this.

Mrs Motaung explained by indicating on the drawn diagram that there are low latitudes around the equator and there are high latitudes around the poles. She indicated for the

students that polar regions will have cold temperatures because they are far away from the sun and as a result, a high-pressure cell will develop. She then told the students that equatorial areas will have higher temperatures since they are close to the sun and a low-pressure cell will develop. She indicated to the students that when warm air rises, it leaves less pressure on the surface which will be interpreted as a low-pressure cell, while when cold air sinks, it will put more pressure on the surface and that will be interpreted as high pressure cell [Refer to Figure 5.5.3.2 below]. As she was talking through these pressure cells, she was showing it on the diagram on the board. It appears that Mrs Motaung applied multimedia and contiguity principles as she was using both written and spoken text, and diagrams were placed next to each other.

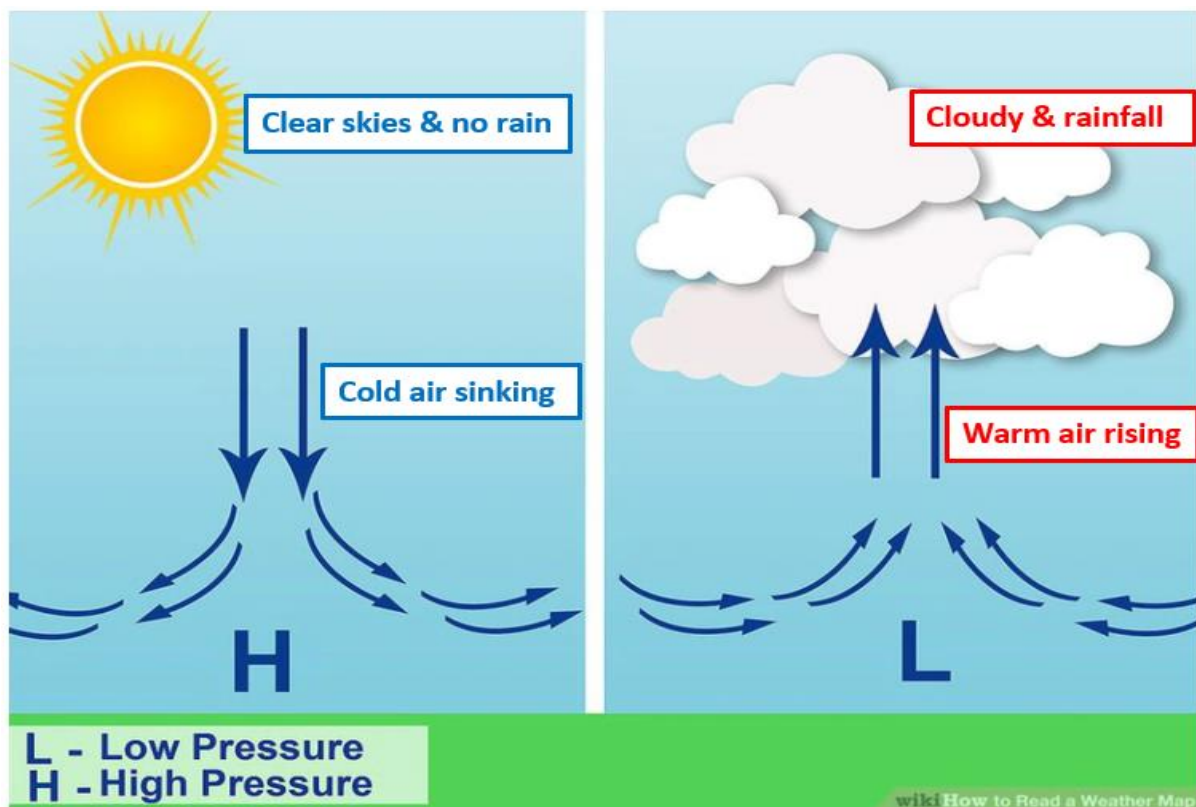


Figure 5.5.3.2 A diagram used by Mrs Motaung showing the formation of low and high-pressure cells.

Mrs Motaung moved from one diagram [Figure 5.5.3.1] illustrating the differences between the location of different pressure cells (High pressure at the poles and low

pressure at the equator) to a diagram [Figure 5.5.3.2] showing rising warm air and sinking cold air. In both diagrams Mrs Motaung illustrated the characteristics of high- and low-pressure cells. She went on to say that:

Another thing that we should remember and keep in mind guys, is that the latitudes are different. Uhm...with the latitudes, the earth heats differently at different latitudes. Isn't it? Remember what we said, the earth is spherical, okay?

Mrs Motaung complimented the diagram [Figure 5.5.3.1] on the board to add the sun so as to show the students the relationship between the sun at its location in relation to different latitudes around the world, and how low latitudes will be warmer as compared to the higher latitudes, which resembles multimedia principle.

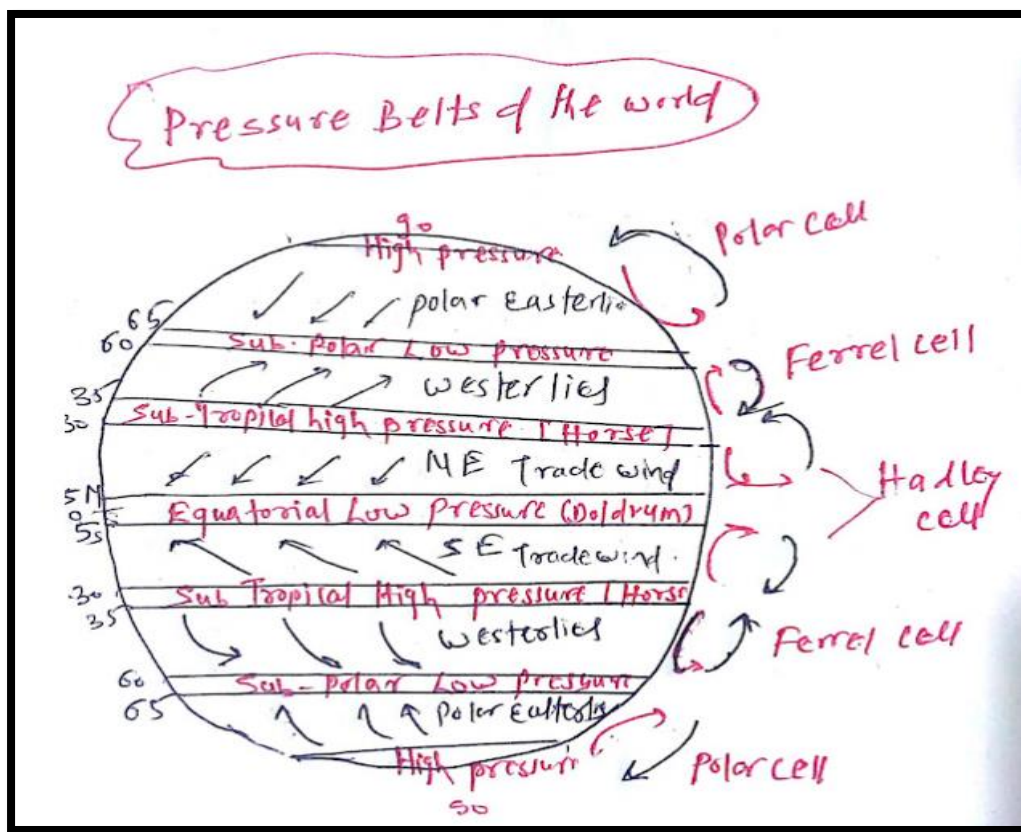


Figure 5.5.3.3 A diagram used by Mrs Motaung showing different pressure belts around the world.

While the diagram [Figure 5.5.3.3] of the global air circulation with different pressure belts was on the smart board, she introduced the concept of how different cells are going

form to complete the tri-cellular model of global air circulation. Mrs Motaung used horizontal and vertical air movements to explain and illustrate the formation of these cells. She is quoted saying:

So, if we can just stop here for a minute. Guys, here we have warm air that is rising, as it is rising it will diverge. We call air that is moving apart from each other as divergence. Divergence, okay? Meaning it's moving apart and because it's cold it's going to sink. As it's coming down back towards the surface, the earth's surface and it's going to start heating up again and move towards each other.

Mrs Motaung explained the concepts of convergence and divergence by showing the students where these two processes take place on the diagram [Figure 5.5.3.3] on the board. While she was explaining the two processes, it was clear that she wanted the students to recognise the vertical and horizontal air movements that will ultimately complete the tri-cellular model of global air circulation. Multimedia and contiguity principles were applied to the lesson at this stage as both written and spoken text were used together with the diagram to explain the tri-cellular model of global air circulation using vertical and horizontal air movements as well as the convergence and divergence of air masses. Thus, she completed explaining the tri-cellular model of global air circulation by saying:

So, let's complete this cell quickly. We have warm air rising, getting cold and heavy so it's sinking again and then moving back towards the equator. And then this circulation, guys, forms one of our 3 cells in our tri-cellular circulation. Known as the? Do you still remember? Known as the Hadley cell.

All these explanations were done with verbal and written texts with an aid of a drawn diagram for the students to visualise what is happening in both hemispheres, which qualifies the multimedia and contiguity principles.

After explaining the tri-cellular model of global air circulation, Mrs Motaung went on to explain the formation and the impact of the Coriolis force on the direction in which wind blows. She introduced the concept by saying:

Now let's look at the rotation of the Earth. Okay? What do you know about the rotation of the Earth? The earth rotates from which direction to which direction? The earth rotates from west to east...so this way around (showing the students by spinning in that direction) like so...from west to east that is quite important to remember and then let's look at Coriolis force, what is the Coriolis force again?

Mrs Motaung used both an artificial globe and the picture in student's textbook [Refer to Figure 5.5.3.4] to explain the formation of Coriolis force and the impact it has on the wind on both hemispheres. She started first by using an artificial globe and she indicated to the students that the high-pressure cell will dominate the polar regions and low-pressure cell will dominate the equatorial regions. She then reminded the students that wind blows from a high-pressure cell to a low pressure, which meant that wind would blow from the poles to the equator. Mrs Motaung illustrated for the students that because the earth rotates, so as the wind blows from the poles to the equator, it will not blow straight along the pressure gradient, but it will be deflected to the right in the northern hemisphere and to left in the southern hemisphere. Mrs Motaung emphasized on the position that you should standing when you look at the deflection of the wind in both hemispheres. She is quoted saying:

Guys, if you are standing at North pole looking down at the equator, the wind is supposed to blow straight down from the north pole to the equator, but look now....because the earth is rotating from west to east, the wind now... uhmdeflect to the right. Can you see that?

Mrs Motaung explained the formation of the wind which was from the high-pressure cell to a low-pressure cell along the pressure gradient using an artificial globe. The spoken words as well as annotation on the artificial globe were used to explain the deflection of the wind to the left in the southern hemisphere and to the right in the northern hemisphere which indicates the application of the modality and multimedia principles.

To consolidate the concept of Coriolis force, Mrs Motaung referred the students to a picture in their textbook elaborating on the deflection of the wind in both the southern and northern hemispheres [Figure 5.5.3.4]. This could be because textbooks in general, for many years, were used to integrate discipline knowledge and support teachers in developing students' learning outcomes (Fasso, Knight & Knight, 2014). There was written text next to the picture in the textbook showing the deflection of the wind in both hemisphere, which promotes multimedia principle. According to Mayer (2003), multimedia principle proposes that the multimedia design must include both words and images, as information is better transferred and processed when the teacher uses these two elements together.

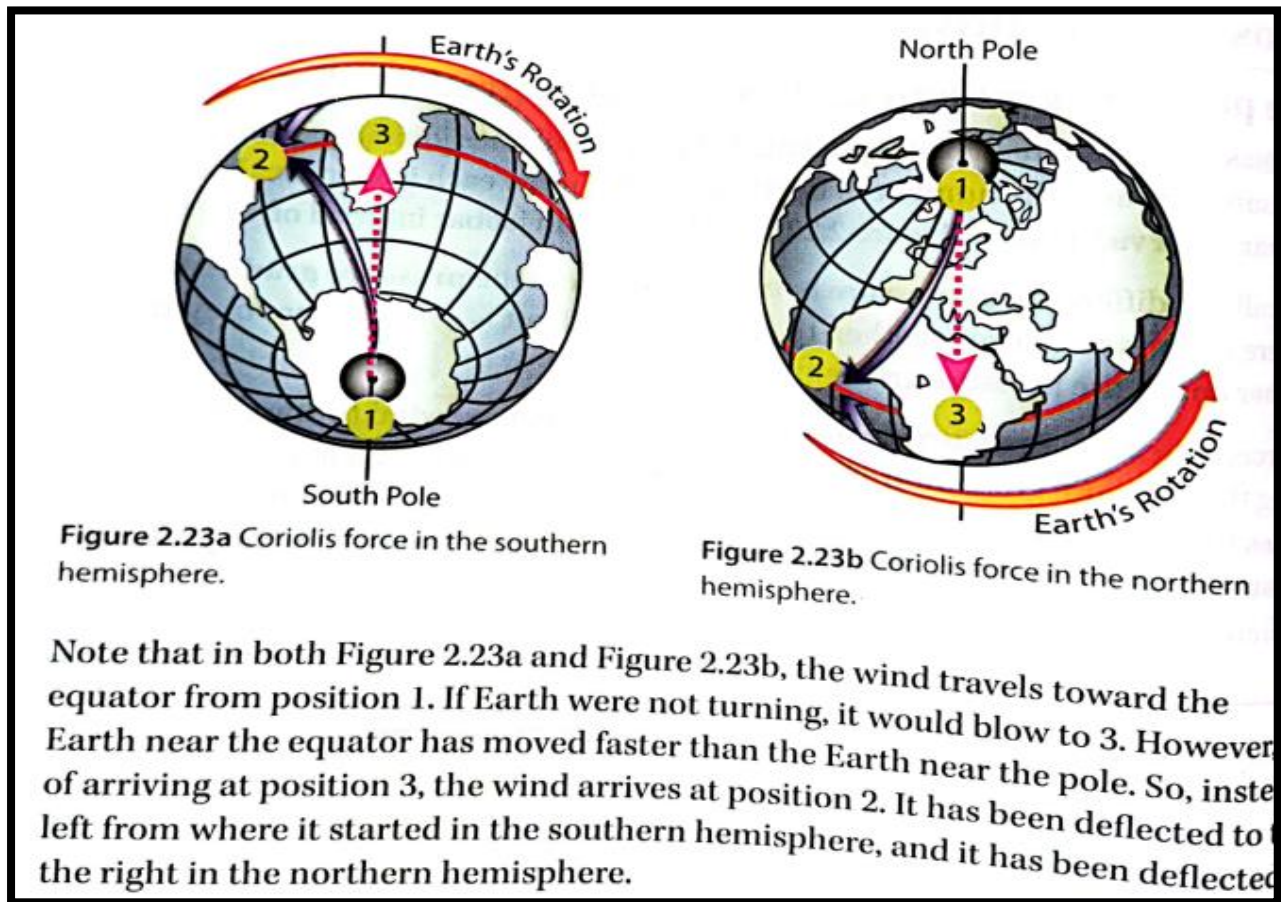


Figure 5.5.3.4 An extract from students' platinum textbook showing the direction in which the wind is deflected in the southern hemisphere and northern hemisphere.

Mrs Motaung went on to explained how different global winds are named and whether they are warm or cold winds. She reminded the students that in geography we name winds according to where they come from. She indicated that if the wind is coming from the east, it is called easterlies and if it is coming from the west, it is called the westerlies. She is quoted saying:

Polar easterlies are coming from the east. Westerlies are coming from the west. Ok? Are you fine? Let's look in the northern hemisphere. Let me change the colour, you have high pressure and low pressure. So, uhm... this wind here will blow from the high pressure to a low pressure, but now look... from easterly direction. Now there two things to look at here. The wind is coming from the east and it is also from the tropics, and tropics are warm. That's why then we call them warm tropical easterlies.

While explaining these concepts using a diagram on the board, Mrs Motaung used different colours to indicate the direction in which the wind was blowing and the temperature of the wind (warm or cold). Winds blowing from the equatorial regions are generally warmer indicated by the red arrows while winds blowing from the poles are generally cooler indicated by blue arrows [Refer to Figure 5.5.3.5 below]. By annotation of diagrams indicating the direction of the wind and the temperature of the wind, it supported the personalization and multimedia principles.

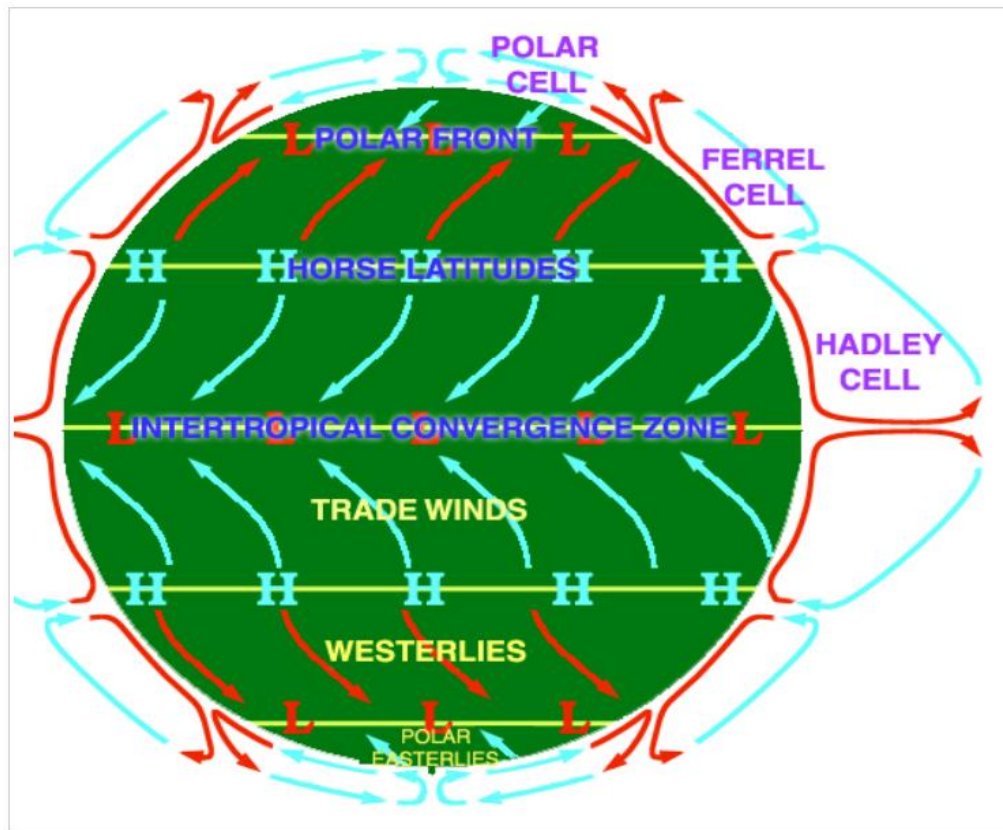


Figure 5.5.3.5 A diagram used by Mrs Motaung showing pressure belts and global winds.

Implementation of multimedia for teaching.

The usage of diagrams, written and spoken text used helped her to explain many concepts in details and it appeared that Mrs Motaung did not want to overload students cognitively in terms of adding and using other materials besides the diagram drawn on the board and the ones on the textbook. According to Rudolph (2017), limited capacity assumption

alludes to the fact that there is a limit to the amount of information either verbal or visual channel can process at a time. Cognitive Load Theory (CLT) defines how the brain can only process selective incoming sensory data into working memory.

In summary, it appears that Mrs Motaung adopted a different approach in teaching climatology concepts using multimedia. She drew and annotated diagrams and sketches on the board to explain the work and referred the students to the diagrams and pictures in their textbooks as well (multimedia principle and coherence principle). This was a different approach from the other two teachers, since they used numerous multimodal in different parts of their lessons and even to the extent whereby, they will explain one concept using different multimodal. She also taught specific concepts that she wanted the students to understand using specific multimedia (to avoid overloading students cognitively).

5.5.4 Mrs Mkhwanazi's lesson observation

Mr Mkhwanazi was teaching a lesson on Mid-latitude cyclones, which is the first topic, taught in Grade 12 syllabus under the climatology section. Mr Mkhwanazi was using the videos downloaded on YouTube of someone teaching the mid-latitude cyclone section. His approach was to pause along the video and explain certain concepts using other multimodal like pictures and diagrams. He made it clear from the beginning that the purpose of the lesson was to reinforce certain concepts taught earlier in the year and he used this lesson as a revision session for the preliminary examinations. The diagram 5.5.4.1 indicates Mr Mkhwanazi approach to teaching climatology concepts using multimedia. The diagram below outlines all steps follow by Mr Mkhwanazi in introducing multimedia during the lesson.

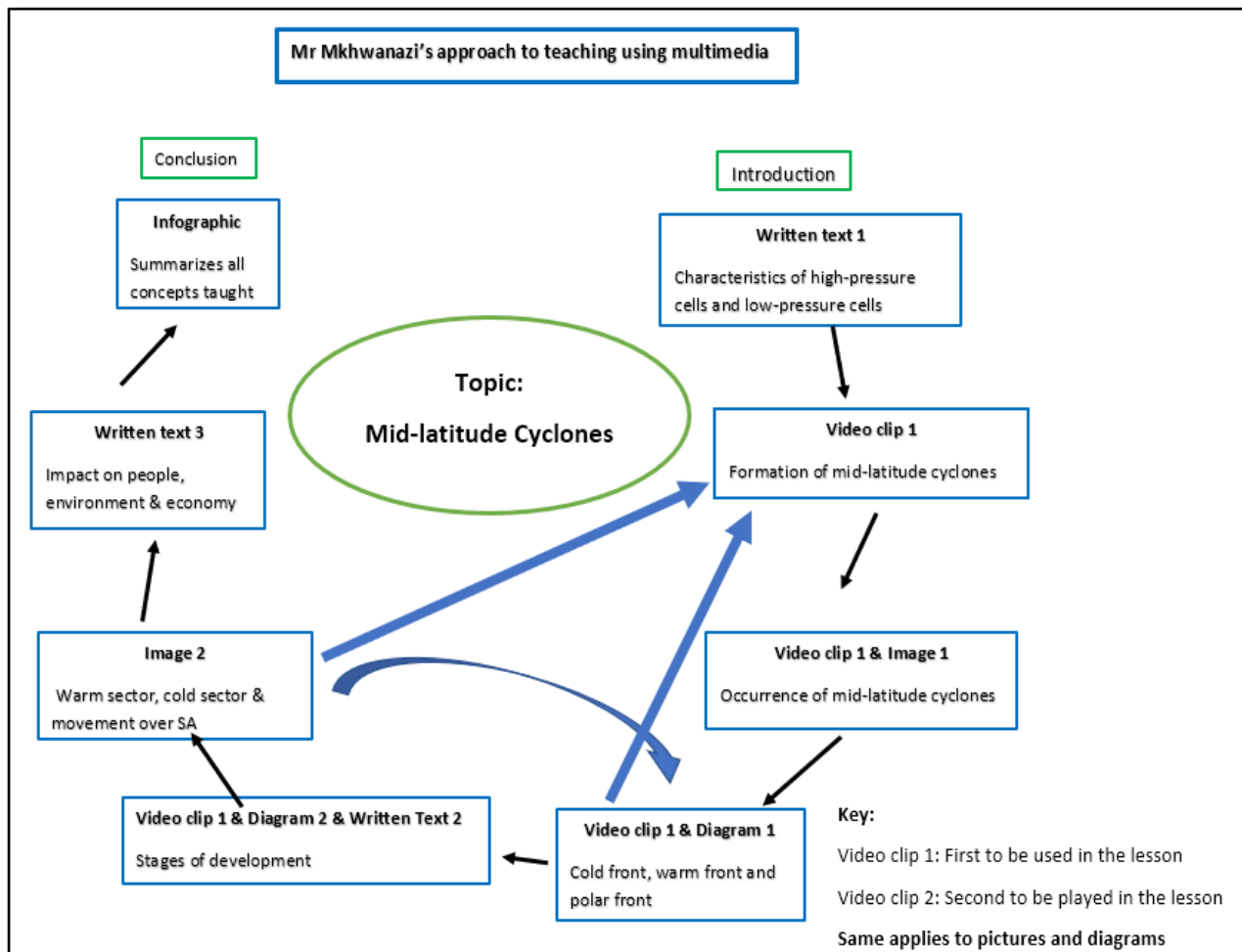


Diagram 5.5.4.1: Introduction sequence of multimedia during instruction.

The diagram above indicates the sequence in which multimedia were introduced from the introduction to the conclusion of the lesson. There were instances where the teacher will refer to the multimedia that was used earlier in order to explain certain concepts at the later stage of the lesson, hence some arrows showing back and forth. Certain multimedia were used numerous times to explain different concepts hence they appear more than once in the sequence of the lesson. Thicker arrows indicate an extended time teacher spent while referring to the multimedia while thinner arrows indicate lesser time.

Designing multimedia for teaching.

Mr Mkhwanazi started the lesson by asking the students to distinguish the difference between low-pressure systems and high-pressure systems. While the students were giving Mr Mkhwanazi the characteristics of these pressure systems, he drew the table on the

board, and he was classifying the characteristics of low-pressure cells and high-pressure cells as the students were telling him. He said the following as the introduction to the lesson:

Our focus today is the characteristics of low-pressure cell because the mid-latitude cyclones are classified as intense low-pressure system which moves from west to east and occur in the middle latitude.

Mr Mkhwanazi asked the students to pay attention to the video clip that he was going to play, and he instructed the students should stop him if there is anything that they do not understand as the video plays. He indicated he would pause the video to elaborate on what the video was explaining or even ask the students questions based on the topic. Before he played the video, he indicated that:

There are various concepts that will be explained in this video, starting with general characteristics of mid-latitude cyclones and areas of formation as well as conditions necessary for the formation.

On the video, the presenter explained that mid-latitude cyclones are low pressure systems, that develop in the middle latitude between 40 and 60 degrees north and south of the equator. The presenter highlighted that the system in the mature stage is made up of two fronts namely cold and warm front. He went on to indicate on the diagram that he was using that the warm front and cold front separate the system with the warm and the cold sectors. The presenter highlighted the fact that these systems travel from west to east pushed by planetary winds called westerlies.

The presenter appeared to be applying multimedia and contiguity principle because he used a synoptic weather map to describe the characteristics of mid-latitude cyclone [Refer to Figure 5.5.4.1 below]. On the synoptic weather there was a cold and warm front, warm and cold sectors, circulation of air and pressure difference using isobars. All these characteristics were indicated using a diagram [Figure 5.5.4.1] as well as written text next to it and this clearly indicates multimedia and contiguity principles. In addition, on the diagram that the presenter used there was limited text, which applies the coherence principle and avoiding to cognitively overload the students.

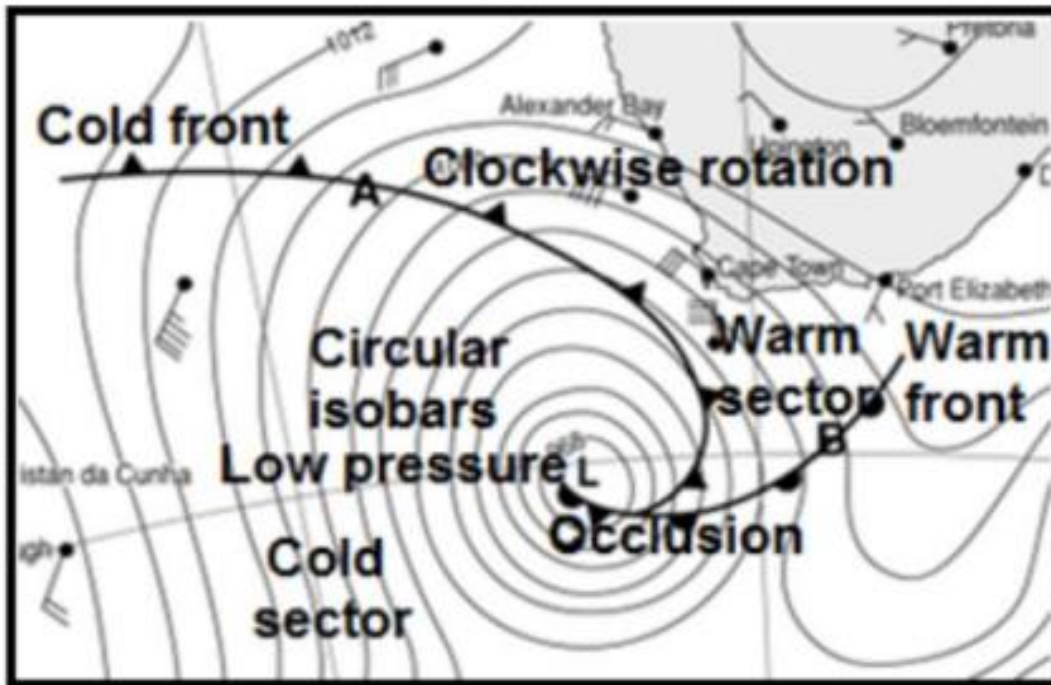


Figure 5.5.4.1 A synoptic weather extract used by Mr Mkhwanazi showing mid-latitude cyclone passing over South Africa.

Mr Mkhwanazi paused the video to remind the students that mid-latitude cyclones are low pressure systems and as a result they will be associated with cloudy conditions and heavy rainfall.

The presenter on the video went on to show the students on the world map the areas in which the mid-latitude cyclones occur. He indicated that mid-latitude cyclones occur in middle latitude between 40 and 60 degrees north and south of the equator. The presenter used the world map [Figure 5.4.4.2 below] and highlighted the regions where mid-latitude cyclones develop using a different colour. Coherence and contiguity principles were applied when explaining the areas in which mid-latitude cyclones develop because there were no extraneous words used and the text was placed next to the areas in which these systems occur.

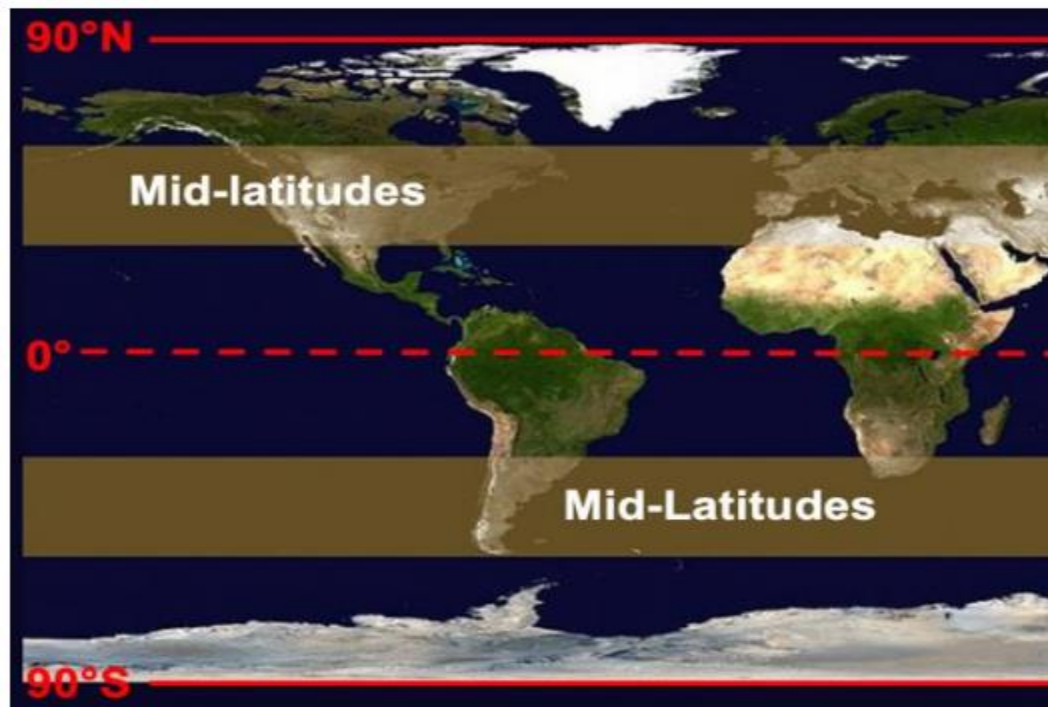


Figure 5.5.4.2 A diagram used by Mr Mkhwanazi showing areas in which mid-latitude cyclones occur.

Mr Mkhwanazi paused the video to highlight that mid-latitude cyclones occur in the middle latitudes along the polar front. He emphasized that along the polar front, warm subtropical air mass from equatorial region will meet with cold polar air mass from the poles. He went on to say:

When these two air masses of different temperature meet, we will have a polar front. Uhm, guys remember when cold and warm air masses meet, they can't mix up, but warm air is going rise because it is lighter and cold air is going to wedge underneath it because it is heavier.

While explaining this concept of the polar front, Mr Mkhwanazi switched to another diagram [Refer to Figure 5.5.4.3 below] where he indicated how warm is going to rise. He went on to say:

When this warm lighter air mass rises, Jet streams will blow them away in the opposite direction and this is the condition that is necessary to form a bend along a polar front... uhm ... this bend is necessary for the formation of the cold and warm fronts which are integral part of the whole system.

On the diagram [Figure 5.5.4.3] that Mr Mkhwanazi used there were extraneous words were limited and the text was placed next to the concept explained and this takes into account the multimedia, coherence and contiguity principles. In addition, the diagram used was a 4D shape which allowed students to visualize like in reality, which indicates the personalization principle of the multimedia effect in teaching and learning.

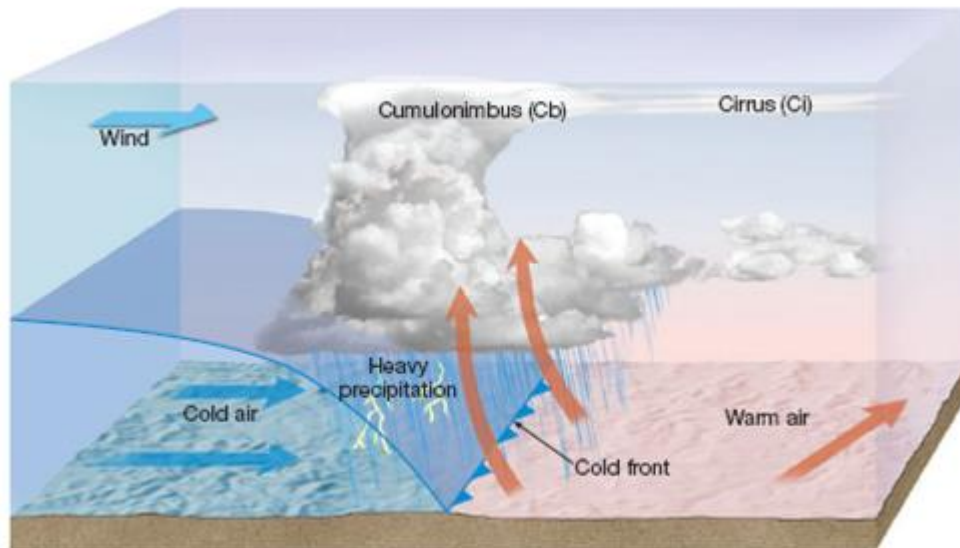


Figure 5.5.4.3 A diagram used by Mr Mkhwanazi showing a cold front

Mr Mkhwanazi continued playing the video, at this stage the presenter in the video was explaining the stages of development in the mid-latitude cyclones. He started first by explaining that at the initial stage, the warm air masses meet with cold polar air mass along the polar front. He indicated using a diagram [Figure 5.5.4.4] that at the development stage, the bend along the polar front has formed and warm and cold fronts start developing. At mature stage, the presenter indicated that cold and warm fronts are clearly visible because the bend has deepened. He added that there is a well-developed warm and cold sector. At the occlusion stage, he highlighted the fact that the warm sector has become narrower because of the cold front that is catching up with the warm front. All these stages of mid-latitude cyclones were explained using a diagram [Refer to Figure 5.5.4.4 below] with the text written next to each diagram at each stage. It appears that the presenter applied multimedia, coherence and contiguity

principles. There was limited amount of text written on the diagram, and the text was placed below each stage of development explaining what was happening in each stage of development of mid-latitude cyclones [Refer to the Figure 5.5.4.4 below].

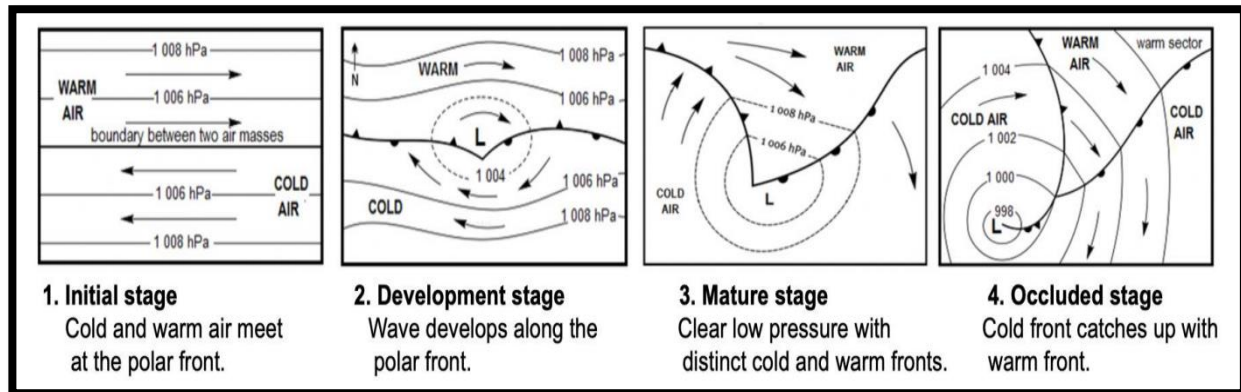


Figure 5.5.4.4 A diagram used by Mr Mkhwanazi showing different stages of a mid-latitude cyclone.

Mr Mkhwanazi paused the video after all stages have been explained and he added that the students need to be able to identify all stages of midlatitude cyclones by simply looking at the cold and warm fronts as well as the cold and warm sectors. He indicated that the mid-latitude cyclones normally die when they pass through the land because of the friction on the land. He highlighted the fact that in South Africa only the southwestern cape will be affected by the cold front of the system as it moves over. He stated that the warm front does not affect South Africa's weather since it is bent southwards away from the country. He used another diagram to explain what he meant [Refer to the Figure 5.5.4.5 below].

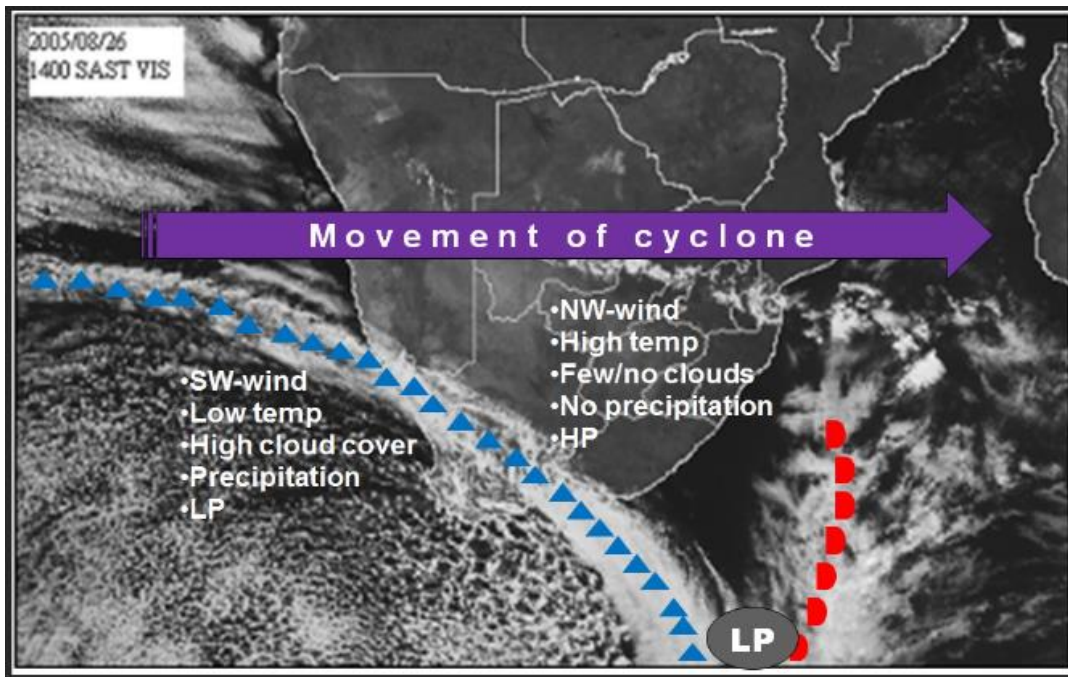


Figure 5.5.4.5 An aerial photograph used by Mr Mkhwanazi showing a mid-latitude cyclone passing SA.

On the diagram [Figure 5.5.4.5] that Mr Mkhwanazi used to explain how cold front affect southwestern cape of South Africa and warm front does not, it was apparent that this teacher applied multimedia, coherence and contiguity principles. There was limited amount of written text on the diagram and the text was placed next to the concept it was intended to explain. He took into consideration the dual channel assumption into consideration in the sense that diagrams and pictures were always presented together, so that each channel will process its information from working memory to long term memory. In addition, the warm front was indicated with the red (warmer) and cold front was indicated with the blue (Colder) which applies personalization principle because students can associate red with warmer conditions and blue with colder conditions.

Mr Mkhwanazi explained the positive and negative impact that mid-latitude cyclones have on people, environment and the economy. He used written text to make clear connections to the real world by telling the students how rain will lead to flooding of settlements and drowning of crops. In addition, he explained how cold front is going to affect the South-Western Cape in winter, he indicated how people who live in informal settlements will be affected by cold conditions, heavy rainfall and possibly snowfall. He explained to the

students how the government could assist the poor communities and farming communities during these cold and wet weather conditions. In terms of the positive impact that mid-latitude cyclones will have on people, environment and economy, he indicated that:

Guys, because mid-latitude cyclones are associated with heavy rainfall and snow, this will contribute significantly to amount of water inside the dams. Uhm... this water will be used by people in their household, but it can also be used by farmer to water their crops and for livestock to drink.

Implementation of multimedia for teaching.

Mr Mkhwanazi then showed the students a table on the whereby the positives and negatives of mid-latitude cyclones were summarized. And he took the students through all the points that were indicated on the table. As a conclusion and summary to the lesson. This indicates that limited capacity assumption was taken into consideration because students' attention was drawn to the most important concepts of lesson which possibly avoided cognitively overloading students. Limited capacity assumption promotes students being able to process adequate information from working memory to long term memory, which is then assumed that active learning has taken place and meaningful learning has occurred.

Mr Mkhwanazi brought up an infographic [Refer to appendix M] that summarize the whole section and told the students that they need to go through that infographic in their own time in order to consolidate the concepts taught in the lesson, since the lesson was over. It appears that when the infographic was designed, multimedia, contiguity and coherence principles were considered. But also on the infographic, there was no extraneous words and information, few summaries were used with relevant images. Students could not be overwhelmed by the information on the diagram as the information was presented in a coherent manner and students could easily relate to the presentation style where headings and subheadings were used. The presentation of images next to the text took into consideration the dual channel assumptions that words and visuals are processed separately.

In summary, Mr Mkhwanazi used multimedia to capture student's attention for most part of the lesson, because most of the students focused on the screen where the video clip and pictures were presented. On the video and pictures that were used, multimedia, coherence and contiguity principles were applied, and it appeared that the students could easily follow. Mr Mkhwanazi used variety of real-life examples that he engaged the students into the lesson, which students could easily find real world connections. He referred to the multimedia in most part of the lesson and illustrated certain concepts on the same multimedia.

5.6. CONCLUSION

The above-mentioned findings reveal that the participants under investigation share many similar practices concerning how they approach their teaching using multimedia. These findings seem to suggest that participants view multimedia as a tool used to enhance the teaching of climatology concepts and to reinforce some of the concepts that appears to be more abstract, and students find difficult to understand. Various principles of multimedia learning were evident during lesson observations and during the interview. During interviews, dual channel assumption was generally considered by the teachers, whereas limited assumption capacity became evident during the interviews when teachers spoke about how they avoid cognitively overloading students with content knowledge.

CHAPTER SIX

DISCUSSION OF FINDINGS

6.1. INTRODUCTION

The main objectives of this study were to examine how Grade 12 Geography teachers use multimedia to teach climatology concepts and to determine the pedagogical value that multimedia bring when teaching climatology concepts. This section of the study will unpack ways in which geography teachers in the study integrate the use of multimedia in teaching abstract climatology concepts. The study will then unpack pedagogical value that selected multimedia bring during the teaching of climatology concepts. Lastly, I will discuss ways that teachers in the study use multimedia to enhance the teaching of Grade12 climatology concepts. The findings from both the lesson observations and interviews will be presented simultaneously since they are a lot of discussions that are overlapping from the data collected using these two data methods.

As already been indicated in the conceptual framework, the theoretical framework adopted in this study is based on Mayer's Framework for multimedia learning. Teachers play a crucial role in promoting effective teaching and learning with the usage of multimedia. Mayer's (2012) framework of multimedia learning and conceptual framework of this study have made it possible to see how teachers design and implement multimedia for teaching and learning within geography classrooms. Mayer's principles of multimedia learning are used as lenses and language to describe the processes that unfold while geography teachers teach using multimedia. With multimedia principles in mind, this study seeks to understand how geography teachers integrate the use of multimedia in the teaching of climatological concepts in geography classrooms. The study also wants to determine the pedagogical value that multimedia bring during the instruction of teaching climatology concepts.

6.2. DISCUSSIONS OF MAIN FINDINGS

6.2.1. How do teachers integrate the use of multimedia in the teaching of climatological concepts?

This sub-section of the study will unpack general practices followed by teachers in teaching climatology concepts. Firstly, the study will look at the way in which teachers design their multimedia and then the study will look at the practices that are followed during the implementation of the multimedia in teaching and learning. Designing of multimedia is an essential process that is necessary for teachers to plan and execute accordingly. Effective design of multimedia informs the way in which implementation of multimedia should be done. Well-designed multimedia tends to lead to effective implementation which helps the teachers with the successful integration of multimedia during instruction (Mayer, 2002).

Designing of multimedia for teaching purposes

Some teachers mentioned that they prefer using text in conjunction with the images in order to demonstrate concepts taught effectively and efficiently. Presentation of written text next to the images was also evident in the lesson observation which promotes multimedia principle. Mayer (2006) asserts that words and graphics should be located near each other so it is clear that they are connected. He argues that otherwise, it is more difficult for students to process them together, which then increases memory load. Geography teachers in the main prefer presenting words and visuals next to each other for the students to process the knowledge effortlessly, from working memory to long term memory. Thus, Robinson (2004) asserts deeper understanding occurs when students mentally connect pictorial and verbal models of the explanation. He argues that this process is more likely to occur for multimedia presentations involving words and pictures than for presentations in words alone.

In addition, during lesson observations some teachers annotated diagrams and pictures, by adding notes on the side of the images or indicating a specific point of the concept illustrated. The reason why teachers annotate multimedia during teaching could be that

certain multimedia lack details in terms of the concept being explained. Consequently, in order to promote multimedia principle, words with specifics can be added on the multimedia in order to enhance understanding of the students. Deeper learning occurs from words and pictures than from words alone (Mayer, 2006). “Many students have an improved ability to learn and remember when offered multimodal content that includes text and visual” (Yarbrough, 2019, p.1). Thus, Robinson (2004, p.10) speaking about dual channel assumption states that the auditory-verbal channel processes verbal representations of words that enter the cognitive system through the ears. The visual-pictorial channel processes pictorial representations of pictures that enter the cognitive system through the eyes. Effective and meaningful learning occurs when students are presented with knowledge in the form of words and visuals at the same time and preferably the text and visuals should be next to each other.

3 of 4 teachers argue that they avoid using multiple multimedia in one lesson. Generally, they argue that using a lot of multimedia at once can confuse students and possibly overload them cognitively. According to Robinson (2004) prior research shows that adding interesting but irrelevant text to a passage does not enhance learning and sometimes hinders it. Robinson (2004) argues that adding interesting but irrelevant material to a multimedia presentation can overload one or both of the processing channels and disrupt the integration of pictorial models, verbal models, and prior knowledge. A limited amount of thoroughly planned and prepared multimedia is always better than limitless amount of disorganised multimedia during instruction. The latter, according to Mayer (2006) happens to overload students cognitively.

Furthermore, teachers seem to suggest that in order to avoid overloading students cognitively, designing multimedia plays a key role which then ultimately affects how the multimedia is presented. Summaries in the form of table and infographics were some of the techniques that teachers used to avoid extraneous material in their presentations. Infographics are tools that combine pictures and text to succinctly frame information and ideas (Yarbrough, 2019). Dunlap & Lowenthal (2016) highlight how teachers should ensure

that the content conveyed by the infographic is accurate, complete, and relevant. Teacher's responsibility is to add additional information on the multimedia that will help the students to understand the concepts better. Planning extensively and knowing what needs to be achieved by the multimedia in the form of infographics is an essential requirement of an effective multimedia teaching. Comprehensive planning and knowing what needs to be achieved by multimedia is key in effective teaching and learning.

In addition, lesson observations indicate that some teachers preferred to use infographics in order to deliver their lessons. Generally, infographics uses collection of images such as charts and bar graphs and brief description of text that gives an understanding to the students. It appears that some teachers chose infographics in order to allow students to comprehend content taught without cognitively overloading the students. Thus, Holsanova, Holmberg & Holmqvist (2009) argue that with the use of infographics in lessons for instructional purposes, different dimensions of knowledge can be transmitted by explaining the processes and events, establishing connections between concepts and concretizing abstract notions. In addition, Dunlap & Lowenthal (2016, p.42), "People learn and remember more efficiently and effectively through the use of text and visuals than through text alone". Multimedia in the form of infographics seem to be generally used inside geography classrooms, perhaps teachers want students to see relationships that exist between different concepts and how different concepts are linked with each other. Some climatological concepts in geography are associated with stages of development (like mid-latitudes and tropical cyclones) which are ideally presented in an infographic.

Implementation of multimedia during instruction

Some teachers in the study indicate that it is essential to take into consideration the amount of content knowledge and concepts that you teach in a lesson. These teachers suggest that there should be limited amount of content that students can comprehend and thus store in the long-term memory. However, this was contradictory with what was observed during the lessons. In all four lessons that were observed there were numerous

concepts that were taught. Perhaps, the reason why so many concepts were taught was because it was the revision lessons as it was indicated by some teachers that the lessons were to prepare the students for the preliminary examinations. According to Rudolph (2017) cognitive theory of multimedia learning (CTML) is an important theory because it outlines ways in which multimedia and instructional designers must follow when designing instructional multimedia. Taking into consideration the fact that students can only process a limited amount of information at a time, the information presented to the student should not contain any unnecessary content. If reasonable amount of content is taught at a time, then we should anticipate that their working memory will be able to process information adequately and ultimately such knowledge will be stored in the long-term memory.

There is consensus amongst the teachers in the study that planning and designing instructional materials using multimedia is of paramount significance. Thus, it is imperative that teachers find creative ways of presenting multimedia to the students so that the process of effective comprehension from the student's side is not prohibited or limited in any way. According to Oud (2009) when planning a multimedia instruction project, teachers need to choose activities and interactions based on the desired type of student learning and try to integrate the steps and activities into a broader conceptual framework for students. Shank (2005) argues that even though there are benefits of using multimedia, however, "the first consideration is whether you have the resources and skill sets needed to do it well. Designers need to select media only when it supports a learning need". It is paramount for the teachers to have skills of knowing when and how to introduce the multimedia.

Multimedia such as graphs and diagrams can be used as a summative technique to highlight all important aspects or concepts taught during the lesson or topic. Thus, Scrimshaw (1997) examining the teacher's role in classrooms using multimedia, argues that teachers need to teach the process of learning rather than its products by locating, collating and summarising information, also identifying connections and contradictions within a body of information.

While teachers locate, collate and summarize content knowledge for the purposes of teaching using multimedia they should consider Mayer's cognitive theory of multimedia learning which is based on three assumptions which are dual channel assumption, limited capacity assumption and active learning assumption. Lesson observations and interviews indicate broadly that geography teachers consider some of these assumptions during the planning and implementation stages of their teaching. As indicated in the earlier discussions in this section, geography teachers generally present written text next to the visuals when teach using multimedia which supports the dual channel assumption. Dual channel assumption presupposes that there are two channels in the student's brain which process knowledge presented as words and visuals separately. Each channel in the human cognitive system has a limited capacity for holding and manipulating knowledge (Baddeley, 1999; Sweller, 1999). In addition, Mayer (2002, p.60) asserts that when a lot of pictures (or other visual materials) are presented at one time, the visual-pictorial channel can become overloaded. Likewise, when a lot of spoken words (and other sounds) are presented at one time, the auditory-verbal channel can become overloaded. The key with the teachers is balancing the number of visuals with written words used in the presentation while teaching.

While teachers in the study highlight the fact that they limit the amount of content that is presented to the students at a time, it is also teacher's responsibility to promote interactive teaching and learning. According to Mayer (2001) meaningful learning occurs when students engage in active processing within the channels, including selecting relevant words and pictures, organizing them into coherent pictorial and verbal models, and integrating them with each other and appropriate prior knowledge. Even though for this study it is impossible to determine or establish if students were selecting, organizing and integrating knowledge into long term memory, however, it is evident that students are engaged in active and meaningful learning. The types of questions that students ask illustrated some level of understanding of the concepts taught in the lessons that were observed. The students asked questions by referring the teachers to the multimedia that they used in teaching the concepts in the lesson. Thus, Mayer (2002, p.60) asserts that active learning processes are more likely to occur when corresponding verbal and pictorial representations are in working memory at the same time.

6.2.2. What pedagogical value does multimedia bring during the instruction in teaching climatology concepts?

This sub-section of the study discusses the pedagogical value that multimedia brings during the teaching of climatology concepts. There are four pedagogical values that became apparent during the lesson observations and interviews namely: multimedia used as a reference point of discussions, multimedia used to reinforce climatology concepts, multimedia used summarize climatology concepts [infographics] and lastly multimedia used to introduce and conclude the lessons.

Multimedia as a reference point

Teachers in the study referred to the multimedia that they were using throughout the lesson. It appears that climatology lessons are generally centred around multimedia. “The multisensory nature of multimedia makes it to stimulate multiple senses of the audience at a time” (Kareem, 2018, p.158). Mrs Cloete was quoted saying: “look at the pressure cell that develops around the equator”, “Observe how the pressure belt changes in different seasons”, “Can you see how the wind is deflected in both hemispheres due to Coriolis force”. The emphasis from teacher’s perspective is on the students observing and paying attention to the illustrations indicated on the various multimedia. Thus, Kareem (2018) asserts that multimedia should stimulate students’ senses in the classroom and allow interactions between the students and teachers. Consequently, she argues that teaching could be more attractive and interesting to students and enhance students’ motivation and understanding thereby making learning meaningful and authentic. It appears that teacher’s focus is to refer to the multimedia repeatedly in order to stimulate students’ senses and thus enhancing comprehension and understanding of the content. Teachers annotate diagrams that they use while explaining climatology concepts, which is some form of reference to the multimedia used. Some teachers argue that the diagrams that they use sometimes lack certain details and consequently it is necessary to add some details on the multimedia in order to enhance understanding of the students.

In addition, most teachers argue that multimedia help them to pace their lessons by referring to different concepts in one multimedia like a diagram. These teachers highlight the fact normally just one image or picture will explain multiple concepts or show how those concepts relate to each other. Structure of the lesson takes a different shape when teachers use multimedia, in the sense that one infographic can have an image, written words & graph/ diagram to illustrate a particular concept. “Arranging instructional content in logical sequences also helps students to process information better” (Oud, 2009, p.167). Consequently, the structure of the lesson will be different and such minimal illustration will help teachers to save time and drill the content knowledge they want the students to acquire. Thus, Oud (2009, p.168) argues that reducing extraneous load involves simplifying and removing as much as possible that is not necessary to the content. Subsequently, he claims that when unnecessary content/media is reduced, it is less likely that students’ attention will be distracted from the content, and more likely that they will understand and learn meaningfully. Mayer (2006) qualifies that all unnecessary graphics, text and audio should be removed, since graphics and words that do not directly contribute to the main points distract the student’s attention away from the main instructional messages. This argument is also highlighted by Clark & Lyons (2004) when they argue that teachers should watch out for and remove any graphics or visuals that are merely decorative or generate associations that are interesting but not related to the main point or concept.

Some teachers in the study responded to the student’s questions by referring them the multimedia either used in previous lessons or current lesson to address misconceptions that some students might have. Some teachers contend that teacher’s attention should be focused on questions asked by students rather than on teachers’ questions (Carner, 1963; Wellington & Wellington, 1962). Teachers should focus their attention on how they should respond the student’s questions effectively. In this study, it is evident that teachers used multimedia to answer the questions students had during the lessons. It appears that geography teachers navigate through various multimedia in order to address student’s questions and thus encourage them to ask questions if they do not understand certain content taught in the lesson. Thus, Shank (2005, p.11) teachers should use multimedia to help students find their way around multimedia. If multiple types of media

and content are required, then use position and prominence to direct students' attention to the most important information.

“Another classroom situation in which student questions should probably be elicited occurs when a teacher has explained a new subject. Students should be queried about possible lack of understanding. In fact, one might offer the hypothesis that students encouraged to ask questions in this type of situation will learn more than a group of students deprived of this opportunity” (Gall, 1970, p.716). To illustrate that some teachers in this study encourage students to ask questions, because even though the question raised by the students were not necessarily speaking to the diagram the teacher was using, the teacher referred to the diagram that he had already used in the lesson or topic to answer the student's question adequately. Shank (2005, p.11) asserts that teachers should be consistently looking for how they can help the students with multimedia or by consistently placing navigation elements to clarify what to do next.

Reinforcement of climatology concepts

Some teachers in the study comment that multimedia help them to achieve required outcomes at the end of each lesson by reinforcing certain concepts. These teachers suggest that using visuals in a lesson is a powerful tool that will not be easily replaced by any teaching aid particularly teaching climatology concepts. Zhang (2011, p.580) asserts that introducing multimedia technology to geography teaching and taking advantages of various software can make boring classes to be vivid and consequently these attract students' attention to learn geography. Some teachers argue that multimedia help to reinforce certain concepts and to also show different sides of a particular topic or concept.

In addition, 2 of 4 teachers in the study argue that it is essential to avoid using different multimodal with the same concept as this will lead students overloaded cognitively or confused and prohibit the reinforcement of climatology concepts. “In fact, research has revealed that cognitive overload, as result of too much visual and audio information processing, does not affect only low-ability students.” (Schmid, 2008, p.1556) but also

the high-ability students equally. Teachers should rather choose one multimedia to reinforce and explain each climatology concept in detail. Teachers avoid using multiple multimodal to explain one concept due the fact that multiple multimodal might confuse the students and consume a lot of time during the lesson.

Teachers in the study highlights the fact that multimedia provides teachers with the ability to make the geographical content practical and therefore the students can respond to it immediately. “In geography teaching, some animation and audio information can be used to increase students’ understanding and memory in learning geography when abstract contents are involved” (Zhang, 2011, p.581). It seems like multimedia allows teachers to bring abstract knowledge that is hardly to visualise on the outside world into tangible knowledge that students can visualise. One teacher uses an example of how Tropical Cyclones can be visualized by the students as the system of a low-pressure cell which is associated with tall cumulonimbus clouds that are circulating in the clockwise direction normally located in the eastern side of the continents.

In addition, Zhang (2011) asserts that abstract concepts of space represented by earth movement and formation of eclipse, three-dimensional animation can be adopted to solve the problem. It is highly unlikely that a concept could be made relevant to the students if they are not seeing it to make a mental image of it. Multimedia elements have paramount importance in teaching of science since it helps to present different phenomenon and process vividly, simulate complex contents and present different levels of abstraction Altherr, Wagner, Ecker & Jold, (2004) and De Sousa, Richter & Nel (2017). Thus, Kareem (2018, p.158) argues “Some concepts which appeared abstract to students may become clearer and better retained. This may have positive effects on students’ academic achievement and attitude to learning of the subject. It is teacher’s responsibility to present multimedia in such a way that concepts taught can be reinforced effortlessly.

It is significant that teachers find creative ways of presenting multimedia to reinforce abstract climatology concepts so that the process of effective comprehension from the

student's side is not prohibited or limited in any way. So, it is evident that the planning of lessons is paramount importance in order to deliver the lesson. According to Oud (2009) when planning a multimedia instruction project teachers need to choose activities and interactions based on the desired type of student learning and try to integrate the steps and activities into a broader conceptual framework for students. Thus, Shank (2005) argues that even though there are benefits of using multimedia, however, "the first consideration is whether teachers have the resources and skill sets needed to do it well. Designers need to select media only when it supports a learning need". It paramount for the teachers to have skills of knowing when and how to introduce the multimedia so that they can reinforce concepts adequately.

Teachers in the study agree that multimedia helps to reinforce the concepts by providing a visual content of the topic. One teacher highlight "Many students are not able to visualise global concepts as they have not travelled, and this medium provides them with a structured, visual and oral representation". Thus, Pea (1991, p.65) asserts at first, students often have difficulty comprehending the spatial representation of temporal media and distinguishing 'plans' for compositions (that is, the live storyboard) from the compositions themselves. Therefore, it is believed that the usage of multimedia would bring abstract spatial representation to concrete representation that students can easily relate to.

Some teachers state that multimedia makes learning and teaching to be more dynamic and more applicable to the world outside the classroom. It seems like there is consensus amongst the teachers in this study that outside complex concepts are brought effortlessly into the classroom by multimedia such as images and video clips, which then allows students to visualize such concepts in reality. Something that resonates with many teachers and students is the importance of 'seeing' something to understand it and remember it (Wallace, 2011). In addition, Zull (2002) states that research has shown that people are capable of recalling hundreds to thousands of pictures, even when having seen the pictures for only a few seconds. Teachers should refer and draw students' attention

to the most important aspects of the multimedia that is being used. Thus, Medina (2008) asserts that the more visual an instructional or informational message is, the more likely to be recognized and recalled by the students.

Multimedia used as summaries [Infographics]

Generally, teachers believe that students understand and retain knowledge better with the usage of images, video clips and infographics. One teacher quoted saying, “The modern student is much more receptive to digital information as it is the most widely used platform of communication”. Pea (1991, p.65) approves by arguing that “the capacity for students to use devices to capture live media such as audio and video is quite novel. These media distinguish multimedia compositions from writing and spur students’ imaginations in ways uncommon in text-centered composition”. The teacher quoted further arguing, “When teaching abstract concepts, multimedia provides the students with an idea of the concept in reality”. Most of the concepts taught in climatology are abstract concepts and students need to visualize them first before they can comprehend them in order to be processed into the long-term memory. “It makes intuitive sense that there should be an advantage of dynamic over static media, especially for teaching students about dynamic phenomena” (Hegarty, 2004, p.344). Thus, Mrs Cloete argues that some students have never seen the ocean or sea and for students to understand the concepts of where tropical cyclones develop, they need to visualize it in order to understand the concepts behind their formation.

Most teachers believe that multimedia help in using time effectively and integrating multiple concepts in one topic. Infographics allows the teachers to put various information in the form of text, diagram and graphs and consequently the teachers are able to summarize one concept or topic in few pages or slides. “But the power of infographics is that they are a way of delivering the maximum amount of content in the least amount of space while still being precise and clear; because they are visual presentations as opposed to oral or text presentations, they can quickly tell a story, show relationships, and reveal structure” (Dunlap & Lowenthal, 2016, p.42). For example, when teaching Mid-latitude Cyclone, the whole section can be summarized in one page

using multimedia in the form of infographic whereby teachers will be able to highlight important aspects of the topic within a very short space of time [Refer to Annexure M]. Miller & Barnett (2010) conclude that infographics can synthesize information creating benefits to both educators and students alike. Teachers can use infographics to present core ideas of a lesson, and students can also create infographics to summarize valuable facts presented in the lesson.

In addition, some teachers highlight the fact that multimedia empowers the educational process by means of increasing interaction between teachers, students and the content knowledge. Thus, Dunlap & Lowenthal (2016) assert that multimedia in the form of an infographic can establish malleability by encouraging students to interact with the content. They give an example whereby in an infographic, students are asked questions that encourage reflection, allowing students to peruse the infographic in more than one way. The students can visualize the concepts taught and consequently, it allows them to ask questions in relation to what they can see. Thus, Vanichvasin (2013) argues that some of the learning benefits associated with infographics include improved comprehension of information, ideas and concepts, enhanced ability to think critically and develop an organized ideas and improved retention and recall of information.

Multimedia used to introduce and conclude lessons

Three out of four teachers in the study introduce the lesson by bringing up a multimedia on the board that students needed to refer to during the lesson. Of these three teachers, two of the teachers explained to the students why they chose that a particular multimedia for that lesson. “Educators need to ensure that all the visual elements are contributing to the conveyance of the instructional message and eliminate those that only function as decoration”. (Dunlap & Lowenthal, 2016, p.44) If the educators are able to ensure that multimedia contribute to the lesson, then, the educators should be able to explain to the students how and why a particular multimedia is important for that specific lesson. Multimedia such as graphs and diagrams can be used as a summative technique to highlight all important aspects or concepts taught during the lesson or topic. Thus,

Scrimshaw (1997) examining the teacher's role in classrooms using multimedia, he argues that teachers need to teach the process of learning rather than its products by locating, collating and summarising information, and identifying connections and contradictions within a body of information.

Most teachers highlight the fact that they use different multimodal for different topics in the geography syllabus. Due to the access of information that most students have in the internet, Güler (2008) points out that teachers “require a careful selection of useful information” that will enhance the teaching and the learning inside geography classroom. It appears that some teachers prefer to design the material that they can use mostly as an introduction and perhaps conclusion. Planning different lessons adequately is highlighted by the teachers in the study. Mayer (2001) asserts that studying, analysing and selecting different multimodal is essential in preparing and delivering a successful lesson with multimedia in Geography.

In addition, teachers highlight the importance of the using video clips and animated videos either to introduce or conclude the lesson. Teachers argue that video clips must be short and relevant to the concept intended to explain. Furthermore, they point out the importance of the teacher pausing the videos and explaining certain points and allowing the video to continue again. Thus, Zhang (2011) states that animations showing the formation of acid rain and greenhouse effect caused by plant emissions are real and vivid, and for some students, they have never imagined their seriousness. Consequently, “By watching these videos, students have better understanding on the issue, which can save much time in learning the content” (Zhang, 2011, p.581). Teachers should avoid using multimedia as a teaching object but rather as a teaching aid to help introduce the lesson, facilitate the discussions, reinforce concepts and ultimately conclude the lesson.

In answering the main research question of the study, I will highlight some of the key answers that came from the research sub-questions. Teachers need to invest time in planning and designing multimedia to use in teaching climatology concepts in Grade 12. Multimedia principle, coherence principle, contiguity principle and modality principles

need to be applied during the design of the multimedia for effective teaching and learning. Multimedia material should be free of any extraneous and unnecessary information so that teachers avoid overloading students cognitively. Lastly, teachers need to use multimedia as a reference and summary tool to help concretize climatology concepts for easier comprehension and understanding.

CHAPTER SEVEN

RECOMMENDATIONS AND CONCLUSIONS

7.1. INTRODUCTION

This section of the paper presents the summary of the findings, conclusions and recommendations based on the data discussed on the previous section. Some limitations of the study have also been elaborated upon.

7.2. SUMMARY OF FINDINGS

This study was set out to investigate how Grade 12 Geography teachers use multimedia to teach climatology concepts. The study assumed that since the teachers were experienced and have been performing exceptionally well in previous years on the NSC results, it can document some good practices that are happening in their classrooms. Furthermore, this study's aim was to determine the pedagogical value that multimedia brings when teaching climatology concepts. This was done by analysing lessons the researcher observed and interview questions answered by the teachers.

This study discovered that there is no linear way in which Geography teachers use multimedia to teach abstract climatology concepts in their classrooms. However, there were some similar approaches and techniques that the teachers used in delivering their lessons using multimedia. Geography teachers in the study highlighted the importance of planning adequately and substantively, to know when and how to introduce the multimedia. Most teachers in the study used multimedia throughout the lesson, but the difference with some teachers was how they used the multimedia. In general, teachers indicated multimedia and coherence principles when presented visuals and written text together (next to each other) in order to allow students look at the relationship that exist and to allow both sets of information to processed in the student's own channel accordingly as dual channel assumption presupposes. By presenting content knowledge that can be processed through separate channels, teachers avoided cognitively overloading students and thus students becoming confused during the lesson.

With the lesson observations, teachers in the study referred to the multimedia that were used in the lessons, various times. These teachers used multimedia as the point of reference throughout the lesson. Multimedia were used as a reference point of the lessons as teachers continuously made reference to the multimedia during the lesson. With the multimedia used during the lessons, multimedia principle, coherence principle and modality principle were visible. Teachers in the study presented diagrams and pictures with explanatory text next to them. In addition, teachers used multimedia in the form of video clips as a way of narrating a story about the concepts that were taught during the lesson. Teachers in the study also avoided using extraneous text and pictures in their presentations instead they used summaries in form of tables and infographic.

In addition, teachers argued that multimedia when used accurately help to reinforce certain abstract concepts that students find difficult to understand. Thus, teachers agreed that multimedia help students to visualize abstract concepts and see them as they are in real life. Teachers argued that using multimedia such as infographic is less time consuming since the whole lesson or topic can be summarized in one slide or page and students can easily relate to information in that manner.

Looking at the findings from the interviews, it was apparent that teachers agree on carefully and purposefully choosing multimedia used to teach different concepts or topics. Teachers argued that multimedia used should serve a particular purpose in a lesson and that purpose should be clear from the teacher using the multimedia. All teachers emphasized the importance of thorough and extensive lesson planning so that the teacher will know exactly how and when to introduce the multimedia in the lesson. Thus, some teachers highlighted the significance of using few multimodal carefully chosen to accomplish a particular purpose in the lesson. Limited capacity assumption was taken into consideration as some teachers in the study indicated that multimedia should be carefully chosen and integrated in order to avoid overloading students cognitively.

7.3. LIMITATIONS OF THE STUDY

Like any one study, this study also had its own limitations that prohibited full potential to document good practices that Geography teachers envisage when using multimedia. According to Marshall and Rossman (2006) all academic studies have limitations that arise of their research design, conceptual framework and other factors. It must be noted that while there are volumes of literature written on the benefits of multimedia and instructional design methods, there is limited literature on how multimedia in particular help to teach abstract climatology concepts within Geography classrooms.

Furthermore, the small sample size of teachers under this study was another limitation, which meant that the data collected was limited to that small number of teachers and their experiences. If the sample was bigger, then it means that additional pedagogic strategies could have been discovered. The study could have been better if we could have interviewed the students to hear their views about the impact that multimedia has in understanding the concepts and merge their views with those of the teachers.

Lastly, even though the teachers were experienced and achieved good results from previous years, it is possible that during the lesson that was observed they did not show all the skills that they have of using multimedia in their normal lessons because of limited time the researcher spent with the teachers. The research could be strengthened by spending more time with teachers and observe series of lessons to conclude on how teachers use multimedia for effective teaching and meaningful learning.

7.4. RECOMMENDATIONS

Even though, this current study is a small examination of how 4 teachers in Northern Johannesburg district use multimedia in teaching of climatology concepts. Other researchers may take these findings and continue the job of making geographical studies comprehensive and meaningful (That is to include a bigger sample and use both qualitative and quantitative data methods).

Future studies will perhaps want to look at the students' perspective in terms of what makes them process and comprehend climatology concepts better when multimedia is used in teaching. This will enhance the understanding of the key significant aspects of multimedia teaching and thus helping teachers in designing multimedia material aligned to the students' preferences. In addition, other researchers would want to do a comparative study whereby they compare ways in which geography teachers use multimedia to teach abstract climatology concepts from schools that are performing and those that are underperforming or from schools in rural areas to schools in urban areas.

REFERENCE LIST

- Aitken, S.C. (1994) *I' d rather watch the movie than read the book*, Journal of Geography in Higher Education, 18(3), pp. 29-30
- Akkoyunlu, B., & Yılmaz, M. (2005). *Türetimci çoklu ortam öğrenme kuramı. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 28, 9-18.
- Alharahsheh, H. H., & Pius, A. (2020). *A review of key paradigms: Positivism VS interpretivism*. Global Academic Journal of Humanities and Social Sciences, 2(3), 39-43.
- Altherr, S., Wagner, A., Eckert, B., & Jodi, H. J. (2004). *Multimedia materials for teaching physics (search, evaluation and examples)*. European Journal of Physics. 25.
- Baddeley, A. D. (1999) *Human Memory*. Needham Heights, Mass.: Allyn & Bacon.
- Byron, M. (1993). Using audio: *Visual aids in geography research: Questions of access and responsibility*. Area, 379-385.
- Carner, R. L. (1963). *Levels of questioning*. Education, 83(9), 546-550.
- Clark, R. C., & Lyons, C. (2010). *Graphics for learning: Proven guidelines for planning, designing, and evaluating visuals in training materials*. John Wiley & Sons.
- Clements, K. (1983). *The question of how spatial ability is defined, and its relevance to mathematics education*. Zentralblatt fur Didaktik der Mathematik, 1(1), 8-20.
- DaSilva, E. B., & Kvasnak, R. N. (2012). *Multimedia technology and students' achievement in geography*. The Geography Teacher, 9(1), 18-25.
- De Jong, T. (2010). Cognitive load theory, educational research, and instructional design: Some food for thought. *Instructional science*, 38(2), 105-134.
- De Lange, J. (1996). Using and applying mathematics in education. *International Handbook of Mathematics Education: Part 1*, 49-97.
- De Sousa, L., Richter, B., & Nel, C. (2017). The effect of multimedia use on the teaching and learning of Social Sciences at tertiary level: A case study. *Yesterday and Today*, (17), 1-22.
- Dunlap, J. C., & Lowenthal, P. R. (2016). Getting graphic about infographics: design lessons learned from popular infographics. *Journal of Visual Literacy*, 35(1), 42-59.

- Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American journal of theoretical and applied statistics*, 5(1), 1-4.
- Fasso, W., Knight, B.A., & Knight, C. (2014). *Development of individual agency within a collaborative, creative learning community*. In M. Khosrow-Pour (ed). *Encyclopaedia of information science and technology* (3rd ed) (pp.7519-7528). Hershey: PA: IGI Gl.
- Frank, M., & A. Barzilai. 2006. *Project-based technology: Instructional strategy for developing technological literacy*. *Journal of Technology Education*, 18(1), 43.
- Gall, M. D. (1970). *The use of questions in teaching*. *Review of educational research*, 40(5), 707-721.
- Gates, P. (2018). The importance of diagrams, graphics and other visual representations in STEM teaching. *STEM Education in the Junior Secondary: The State of Play*, 169-1
- Harp, S. F., & Mayer, R. E. (1998). How seductive details do their damage: A theory of cognitive interest in science learning. *Journal of educational psychology*, 90(3), 414.
- Hegarty, M. (1992). Mental animation: Inferring motion from static displays of mechanical systems. *Journal of experimental psychology: learning, memory, and cognition*, 18(5), 1084.
- Hegarty, M. (2004). Dynamic visualizations and learning: *Getting to difficult questions*. *Learning and Instruction*, 14, 343-351.
- Hofstetter, F. 2001. *Multimedia Literacy*. New York: McGraw-Hill Irwin.
- Kareem, A. A. (2018). The use of multimedia in teaching biology and its impact on students' learning outcomes. *The Eurasia Proceedings of Educational and Social Sciences*, 9, 157-165.
- Kharbach, M. (2012). Ways to teach using infographics. *Retrieved April, 3, 2014*.
- Krygier, J. B., Reeves, C., DiBiase, D., & Cupp, J. (1997). Design, implementation and evaluation of multimedia resources for geography and earth science education. *Journal of Geography in Higher Education*, 21(1), 17-39.

- Lai, S. L. (2000). Increasing associative learning of abstract concepts through audiovisual redundancy. *Journal of Educational Computing Research*, 23(3), 275-289.
- Lean, G., & Clements, M. A. (1981). Spatial ability, visual imagery, and mathematical performance. *Educational Studies in Mathematics*, 12(3), 267-299.
- Lefevre, W. (2004). *Picturing machines 1400-1700*. Cambridge, MA: MIT.
- Li, Q. (2007). Student and teacher views about technology: A tale of two cities?. *Journal of research on Technology in Education*, 39(4), 377-397.
- MacQuarrie, A. S. H. L. E. Y. (2012). Infographics in education. *Think Tank*. Retrived from <http://blog.k12.com/2012/07/10/infographics-education>.
- Maluleka, P. (2018). *The construction, interpretation and presentation of King Shaka: A case study of four in-service history educators in four Gauteng schools* (Doctoral dissertation, University of the Witwatersrand, Faculty of Humanities, School of Education).
- Mayer, R. E. (2002). Cognitive theory and the design of multimedia instruction: an example of the two-way street between cognition and instruction. *New directions for teaching and learning*, 2002(89), 55-71.
- Mayer, R. E. (2005a). *Cognitive theory of multimedia learning*. In R.E. Mayer (Ed.), *The Cambridge Handbook of Multimedia Learning*. New York: Cambridge University Press.
- Mayer, R. E. (2006). Ten research-based principles of multimedia learning. *Web-based learning: Theory, research, and practice*, 371-390.
- Mayer, R. E. (2008). Applying the science of learning: evidence-based principles for the design of multimedia instruction. *American psychologist*, 63(8), 760.
- Mayer, R. E. (2014). Multimedia instruction. *Handbook of research on educational communications and technology*, 385-399.
- Mayer, R. E., & Moreno, R. (2002). Animation as an aid to multimedia learning. *Educational psychology review*, 14, 87-99.
- Mayer, R. E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. *Journal of educational psychology*, 93(1), 187.
- Mayer, RE 2001. *Multimedia learning*. Cambridge: Cambridge University Press.

Mayer, RE 2002. *Cognitive theory and the design of multimedia instruction*: An example of the two-way street between cognition and instruction. *New Directions for Teaching and Learning*, 89:55-71.

McKendrick, J. 1999. *Something for everyone? An evaluation of the use of audio-visual resources in geographical learning in the UK*. *Journal of Geography in Higher Education*, 23(1), 9-19.

Medina, J. (2008). *Brain rules: 12 principles for surviving and thriving at work, home, and school*. Seattle, WA: Pear Press.

Mikropoulos, T. 1996. *Virtual Geography*. Paper presented at the Virtual Reality in the Schools Online, East Carolina University, Greenville NC.

Neo, M., & Neo, K. T. (2001). Innovative teaching: Using multimedia in a problem-based learning environment. *Journal of Educational Technology & Society*, 4(4), 19-31.

Nieuwenhuis, J. (2007). Qualitative research designs and data gathering techniques. In K. Maree (Ed.), *First steps in research* (First ed. pp 70-79). Pretoria: Van Schaik Publishers.

Noor, K. B. M. (2008). Case study: A strategic research methodology. *American journal of applied sciences*, 5(11), 1602-1604.

Oppermann, M. (2000). Triangulation—a methodological discussion. *International Journal of Tourism Research*, 2(2), 141-145.

Pailliotet, A. W., and Mosenthal, P. B. (eds.). *Reconceptualizing Literacy in the Media Age*. Greenwich, Conn.: JAI Press, 2000.

Pea, R. D. (1991). Learning through multimedia. *IEEE computer graphics and applications*, 11(4), 58-66.

Rich, D. C., Pitman, A. J., & Gosper, M. V. (2000). Integrated IT-based geography teaching and learning: A Macquarie University case study. *Journal of Geography in Higher Education*, 24(1), 109-115.

Ritchie, J., Crooks, R., & Lankow, J. (2012). *Infographics: The Power of Visual Storytelling*. John Wiley & Sons.

Robinson, W. R. (2004). *Cognitive theory and the design of multimedia instruction*.

- Rose, G. (1996). Teaching visualised geographies: towards a methodology for the interpretation of visual materials. *Journal of Geography in Higher Education*, 20(3), 281-294.
- Shank, P. (2005). *The value of multimedia in learning*. Adobe Motion Design Center.
- Smiciklas, M. (2012). *The power of infographics: Using pictures to communicate and connect with your audiences*. Que Publishing.
- Smith, J., & Firth, J. (2011). *Qualitative data analysis: the framework approach*. Nurse researcher, 18(2).
- Sorden, S. D. (2012). The cognitive theory of multimedia learning. *Handbook of educational theories*, 1(2012), 1-22.
- South Africa. Department of Education (DoE). (2016). White paper on e-education: transforming learning and teaching through information and communication technologies (ICTs).
- Sweller, J. (1999). Instructional Design in Technical Areas. Australian Education Review, No. 43. PCS Data Processing. Inc. USA.
- Vanichvasin, P. (2013, November). Enhancing the quality of learning through the use of infographics as visual communication tool and learning tool. In *Proceedings ICQA 2013 international conference on QA culture: Cooperation or competition* (p. 135).
- Wallace, G. W. (2011). Why Is the Research on Learning Styles Still Being Dismissed by Some Learning Leaders and Practitioners?. *eLearn*, 2011(11).
- Wellington, J., & Wellington, C. B. (1962). What is a Question?. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, 36(8), 471-472.
- Williams, R. (2004). *The non-designer's design book*. Berkeley, CA: Peachpit Press.
- Yarbrough, J. R. (2019). Infographics: in support of online visual learning. *Academy of Educational Leadership Journal*, 23(2), 1-15.
- Zull, J. E. (2002). *The art of changing the brain*. Sterling, VA: Stylus

Questions to answer while observing the teacher delivering the lesson using multimedia

1. Does the teacher introduce his/her lesson with multimedia? If so, how? If not, does the lesson could have been introduced better with multimedia? ❖ Multimedia used capture learner's attention ❖ Multimedia used to highlight concepts to be learnt ❖ Multimedia used have variety accommodate variety of learning styles i.e., visual, verbal etc	
2. Does the teacher use multimedia to explain difficult concepts in the lesson? If so, how? ❖ Clear real-world connection ❖ Always refer to the multimedia used ❖ Multimedia helps the teacher to explain concepts	
3. Does the teacher effectively engage the learners with geography concepts through multimedia? If so, how? ❖ Learners ask questions by referring to multimedia ❖ Learners answer questions by referring to multimedia ❖ Real world examples are shown on the multimedia	

4. Does the learners show interests in the multimedia that are used in the lesson? Explain how? ❖ Learners are asking questions ❖ <u>Learners</u> expressions show that they are interested in the lesson ❖ Learners ask question relating to the multimedia used	
5. What are the strengths indicated by the teacher while teaching with multimedia <u>Strengths</u> ❖ Teacher refer to multimedia at all the times ❖ Concepts are shown well on the multimedia ❖ Teacher shows experience of using such multimedia and use it correctly and accordingly ❖ Multimedia used is of high quality ❖ Multimedia is not used in isolation and it is integrated with the concepts taught	
6. Generally, do you think the teacher used multimedia to teach geography concepts effectively? Explain ❖ Learners enjoyed the lesson ❖ Lesson was interactive between the teacher, learners and multimedia ❖ Learners did not show any confusion during the lesson	

APPENDIX B**Interview questions for the teachers**

1. Which multimodal do you use the most in your lesson? Why?	
2. How do you select multimedia to use for each lesson?	
3. How does the usage of multimedia help with pedagogy?	
4. How does the usage of multimedia help during instruction?	
5. How do you use multimedia creatively so that it does not teach on your behalf?	
6. How do you use multimedia to enhance the understanding of the concepts?	
7. What are the teaching strategies and techniques that help you to use multimedia effectively?	
8. How do you avoid overloading students cognitively?	
9. How does the usage of both pictures and words help in your teaching?	
10. Suggest any strategies that you use of multimedia in your teaching that you find useful.	
11. Any recommendations of how teachers could use multimedia in their teaching.	
12. Any comments about the usage of multimedia in your teaching.	

APPENDIX C: APPROVAL LETTER FROM THE GRADUATE STUDIES COMMITTEE OF THE WSoE



FACULTY OF HUMANITIES

01 April 2022

Person Number: 479389

Mokurubane Simon Sethole

By Email: 479389@students.wits.ac.za

Cc: Drs. Nokulunga Ndlovu & Khanyisile Mbatha

RESULTS FOR THE DEGREE OF MASTER OF EDUCATION PROPOSAL

I am writing to inform you that the Graduate Studies Committee of the Faculty of Humanities, acting on behalf of the Senate has considered your proposal entitled *"Enhancing the Teaching of Grade 12 Geography climatology concepts with multimedia: A case study of four of Johannesburg North schools in Gauteng Province"* and recommended the research proposal can pass.

Kindly liaise with your supervisors regarding the contents of the reader's report.

The reader's reports have been emailed to your supervisors.

I confirm that **Drs. Nokulunga Ndlovu & Khanyisile Mbatha** have been appointed as your supervisors.

The research report is normally submitted to the Faculty Office by 15 February, if you have started the beginning of the year, and for mid-year the deadline is 31 July. All students are required to RE-REGISTER at the beginning of each year

Please note that should you miss the deadline of 15 February or 31 July you will be required to submit an application for extension of time and register for the research report extension. Any candidate who misses the deadline of 15 February will be charged fees for the research report.

Kindly keep us informed of any changes of address during the year.

Regards,

Faith Herbert

Faith Herbert
Senior Faculty Officer
Faculty of Humanities
Education Campus
Tell: 011 717 3018

Private Bag 3, WITS 2050, South Africa | T +27 11 717 4007 | E help.humanities@wits.ac.za | www.wits.ac.za/humanities

[YUN|VES|TH] YASEW|TWATERSRAND | YUN|VES|TH] YA W|TWATERSRAND

APPENDIX D: APPROVAL LETTER RE: REQUEST TO CONDUCT RESEARCH IN GAUTENG SCHOOLS



GAUTENG PROVINCE

Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	13 June 2022
Validity of Research Approval:	08 February 2022– 30 September 2022 2022/232
Name of Researcher:	Sethole M.S
Address of Researcher:	1406 Lara's Place 187 Lilian Ngoyi Street Johannesburg
Telephone Number:	0846981292
Email address:	479389@students.wits.ac.za
Research Topic:	Teaching of climatology concepts in Grade 12 through multimedia: Cases of four schools in Johannesburg North.
Type of qualification	Master of Education
Number and type of schools:	4 Secondary Schools
District/s/HO	Johannesburg North

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below are met. Approval may be withdrawn should any of the conditions listed below be flouted:

Making education a societal priority

Office of the Director: Education Research and Knowledge Management

7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

APPENDIX E: A LETTER ADDRESSED TO HEADS OF SCHOOLS

REQUEST TO CONDUCT RESEARCH AT THEIR INSTITUTIONS

May-August 2022

Dear Principal

My name is Sethole Mokurubane Simon. I am a B Ed (Bachelor of Education) Masters student in the School of Education at the University of the Witwatersrand.

My research study is titled **“Teaching of climatology concepts in Grade 12 through multimedia: Cases of four schools in Johannesburg North”**.

My research involves coming to your school to observe and audio record one of your Grade12 Geography teachers delivering a climatology lesson. Subsequently, I will interview the teacher concerning the pedagogy; instruction and the planning that s/he went through in preparation and delivery of the lesson. These will be done in order to understand the techniques and strategies that your Geography teacher uses in order to obtain outstanding results every single year. The teacher will be interviewed during his/her free periods or preferably after school so that I do not deprive him/her the right to teach during school hours.

The reasons why I have chosen your school is firstly, Geography classrooms have technological resources that allow the usage of multimedia in teaching and learning. Secondly, your school has been performing very well in Geography amongst schools in Gauteng and across the country as well as achieving above average for the district and the province.

I am inviting your school to participate in this research because the findings of the research project might not only benefit Geography grade12 teachers in the Gauteng province but also the whole of South Africa especially in schools where multimedia is used and results are not yet seen.

The research participants will not be advantaged or disadvantaged in any way. They will be reassured that they can withdraw their permission at any time during this project without any penalty. There are no foreseeable risks in participating in this study. The names of the research participants and identity of the school will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project. The participants will not be paid for this study.

Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Yours sincerely

APPENDIX: F
A LETTER ADDRESSED TO GRADE 12 GEOGRAPHY EDUCATORS

May-August 2022

Dear Teacher

My name is Sethole Mokurubane and I am a B Ed (Bachelor of Education) Masters student in the School of Education at the University of the Witwatersrand.

My research study is titled **“Teaching of climatology concepts in Grade 12 through multimedia: Cases of four schools in Johannesburg North”**.

My research involves observing and audio recording you while you teach Grade 12 climatology concepts or any topic that I will please ask to discuss with you. At the end of the lesson, I will also need to interview you and audio record your responses in order to understand the pedagogy; instruction and the planning that you went through in preparation and during the delivery of the lesson.

The reason why I have chosen your school is that it is located in the North of Johannesburg, which is where most schools have technological resources to allow usage of multimedia in teaching and learning. Furthermore, your school has been performing very well in Geography in Gauteng and across the country achieving above average for the district and the province.

I therefore ask for your permission to come and observe you while you teach a Geography Grade12 class using multimedia and consequently interview you at the end of the lesson.

Your name and identity will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

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

Please let me know if you require any further information.
Thank you very much for your help in advance.

Yours in education

APPENDIX: G

A LETTER ADDRESSED TO GRADE 12 GEOGRAPHY STUDENTS

May-August 2022

Dear Learner

My name is Sethole Mokurubane Simon and I am a B Ed (Bachelor of Education) Masters student in the School of Education at the University of the Witwatersrand.

My research study is titled **“Teaching of climatology concepts in Grade 12 through multimedia: Cases of four schools in Johannesburg North”**.

My investigation involves observing and audio recording your lesson while your teacher is teaching you climatology concepts in a Geography lesson. At the end of the lesson, I will interview your teacher concerning the pedagogy; instruction and the planning that s/he went through in preparation and delivery of the lesson. The above mentioned are done in order to understand the techniques and strategies that your Geography teacher uses in order to obtain outstanding results every year.

I hereby ask for your permission to observe your lesson while your teacher is teaching you. There will be no interaction between myself and any of the learners.

I will not be using your real name but if a need arises, I will make up a fictitious one so that no one can identify you. All information about you will be kept confidential in all my writing about the study. Also, all collected information will be stored safely and destroyed between 3-5 years after I have completed my project.

Your parents have also been given an information sheet and consent form, but at the end of the day it is your decision to join us in the study.

I look forward to working with you!

Please feel free to contact me if you have any questions.

Thank you

Sethole Mokurubane Simon
mokurubane.sethole@students.wits.ac.za
0846981292

APPENDIX: H

A LETTER ADDRESSED TO GRADE 12 GEOGRAPHY STUDENTS' PARENTS

May-August 2022

Dear Parent

My name is Sethole Mokurubane Simon and I am a B Ed (Bachelor of Education) Masters student in the School of Education at the University of the Witwatersrand.

My research study is titled **“Teaching of climatology concepts in Grade 12 through multimedia: Cases of four schools in Johannesburg North”**.

My research involves going to the school where your child is attending and observing him or her while the teacher is delivering a Geography lesson. The lesson will be audio recorded. I will interview the teacher and audio record some of his/her responses in order to understand the pedagogy; instruction and the planning that s/he went through in preparation and delivery of the lesson.

I have chosen your child's class because my research requires me to observe Grade12 climatology lesson in order to understand the techniques and strategies that the teacher is using to obtain outstanding results every year.

I hereby ask for your permission to observe a lesson that your child will happen to be part of. Your child will NOT be interviewed at the end of the lesson.

Your child will not be advantaged or disadvantaged in any way. S/he will be reassured that he or she can withdraw his/her permission at any time during this study without any penalty. There are no foreseeable risks in participating in the study.

Your child's name and identity will be kept confidential at all times and in all academic writing about the study. His/her individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project. Your child will not be paid for this study.

Please let me know if you require any further information.

Thank you in advance for your help.

APPENDIX I

Consent form for the heads of schools

Title of the project: Teaching of climatology concepts in Grade 12 through multimedia: Cases of four schools in Johannesburg North

Name of researcher: Sethole Mokurubane Simon

I, agree to participate in this research project.

I agree to the following:

(Please circle the relevant options below)

The research study was explained to me. I understand what this study is about.	YES	NO
--	-----	----

I understand that I can volunteer to take part in the study	YES	NO
---	-----	----

I agree that the interview may be audio recorded	YES	NO
--	-----	----

I agree that direct quotations from my interview may be used by the researcher in their research report	YES	NO
---	-----	----

I agree that my participation will remain anonymous (my name will not be used by the researcher in their research report)	YES	NO
---	-----	----

I agree that	YES	NO
--------------	-----	----

Signature.....

Name of the participant.....

Date.....

APPENDIX J

Consent form for the teachers

Title of the project: Teaching of climatology concepts in Grade 12 through multimedia: Cases of four schools in Johannesburg North

Name of researcher: Sethole Mokurubane Simon

I, agree to participate in this research project.

I agree to the following:

(Please circle the relevant options below)

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that I can be interviewed and interview may be audio recorded	YES	NO
I agree that my lesson may be observed & audio recorded	YES	NO
I agree that my participation will remain anonymous (my name will not be used by the researcher in their research report)	YES	NO
I agree that other researchers may use the information I provide in my interview (depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO

Signature.....

Name of the participant.....

Date.....

APPENDIX K

Consent form for the learners

Title of the project: Teaching of climatology concepts in Grade 12 through multimedia: Cases of four schools in Johannesburg North

Name of researcher: Sethole Mokurubane Simon

I, agree to participate in this research project.

I agree to the following:

(Please circle the relevant options below)

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the class observation may be audio recorded	YES	NO
I agree that direct quotations from class observations may be used by the researcher in their research report	YES	NO
I agree that my participation will remain anonymous (my name will not be used by the researcher in their research report)	YES	NO
I agree that other researchers may use the information taken from class observations (depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO

Signature.....

Name of the participant.....

Date.....

APPENDIX L

Consent form for the parents

Title of the project: Teaching of climatology concepts in Grade 12 through multimedia: Cases of four schools in Johannesburg North

Name of researcher: Sethole Mokurubane Simon

I, agree that my child (NAME & SURNAME)
..... participate in this research project.

I agree to the following:

(Please circle the relevant options below)

The research study was explained to me. I understand what this study is about.	YES	NO
--	-----	----

I understand that my child can volunteer to take part in the study	YES	NO
--	-----	----

I agree that my child's class can be observed and the lesson be audio recorded	YES	NO
--	-----	----

I agree that direct quotations from child's class observations may be used by the researcher in their research report	YES	NO
---	-----	----

I agree that my child's participation will remain anonymous (his/her name will not be used by the researcher in their research report)	YES	NO
--	-----	----

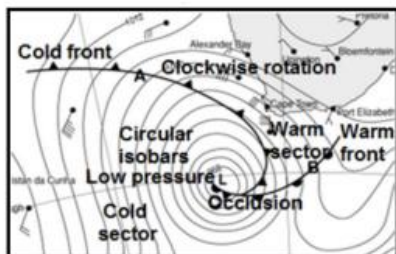
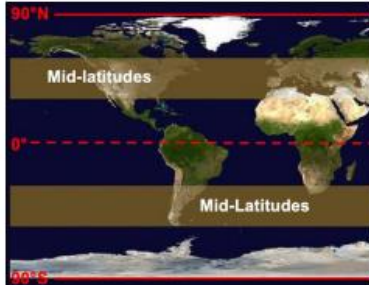
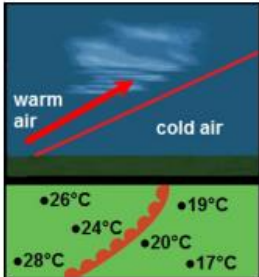
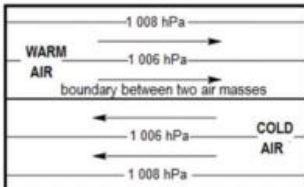
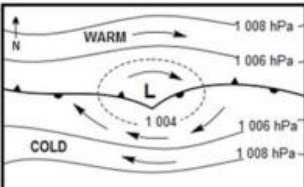
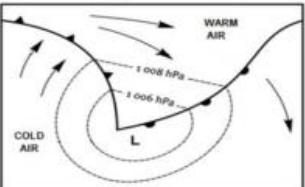
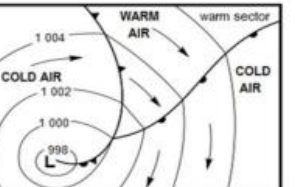
I agree that other researchers may use the information taken from my child's class observations (depending on their own ethics clearance being obtained) but his/her name and any personal information will not be used or passed on	YES	NO
--	-----	----

Signature.....

Name of the participant.....

Date.....

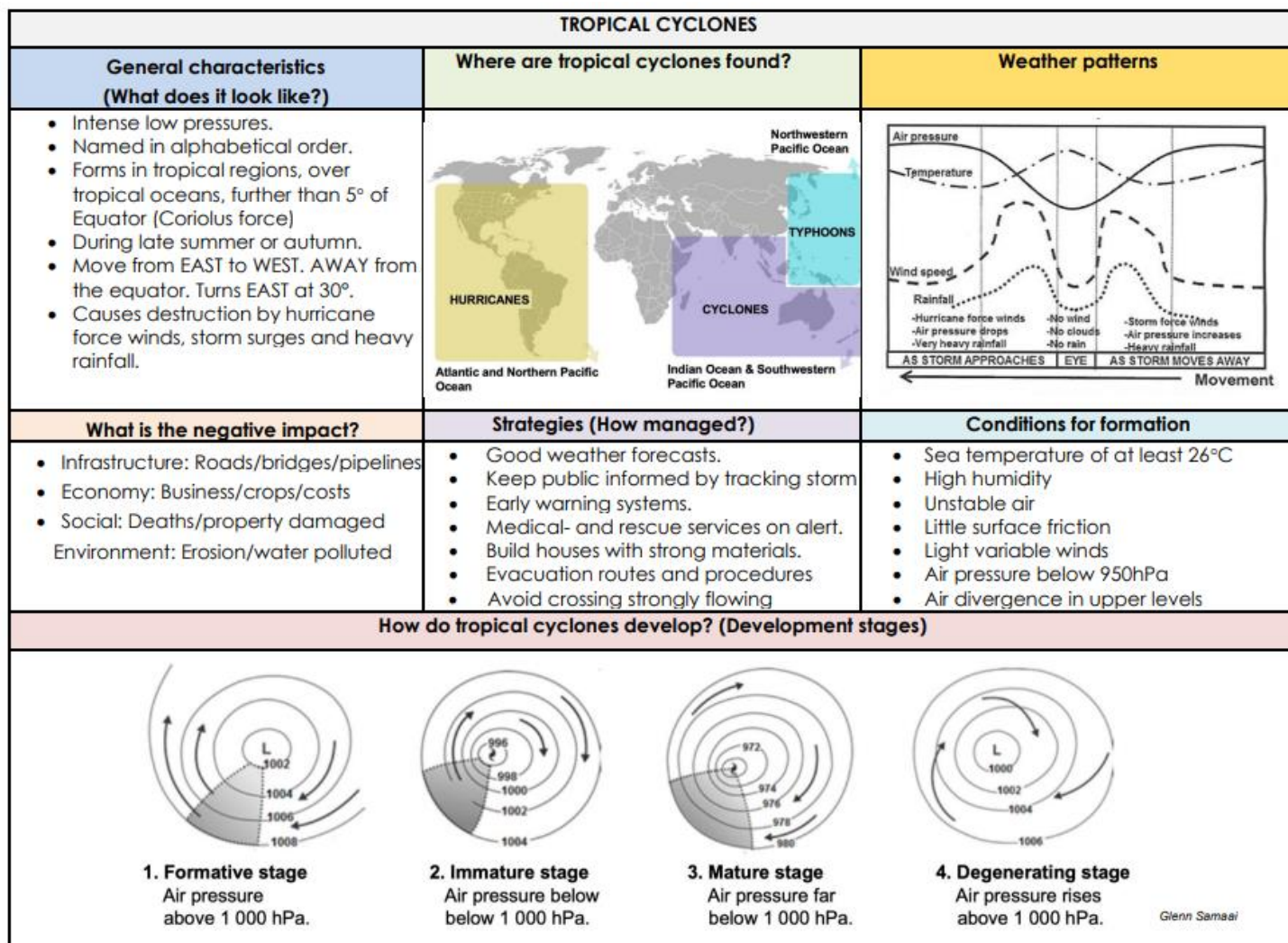
APPENDIX M (Infographics summarizing Mid-latitude cyclones)

MID-LATITUDE CYCLONES			
What does it look like?	Where are mid-latitude cyclones found?	What are cold and warm fronts?	
 Moves from west to east		WARM FRONT Air behind front warm. Warm air moves over the cooler air. 	
What weather changes occur when a cold front moves over an area?	What are the impacts?		
• Drop in Temperature • Wind changes from NW to SW • Increase in air pressure • Increase in cloud cover • Rainfall occurs <i>Must also know reasons for weather changes</i>	Positive	Negative	
	• Brings rain fills dams • Increases yield • Water table rises • Snow tourist attraction • Sustains natural vegetation and animals	• Snow damages crops • Flooding • Stock losses • Costly repairs • Erosion • Cold conditions - vegetation	
How does a mid-latitude cyclone develop? (Development stages)			
 1. Initial stage Cold and warm air meet at the polar front.	 2. Development stage Wave develops along the polar front.	 3. Mature stage Clear low pressure with distinct cold and warm fronts.	 4. Occluded stage Cold front catches up with warm front.

2

Adapted from Western Cape Department of Education

APPENDIX N (Infographics summarizing tropical cyclones)



Adapted from Western Cape Department of Education

APPENDIX O



WSoE
Wits School of Education

SCHOOL OF EDUCATION ETHICS COMMITTEE

CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE

PROTOCOL NUMBER: 2022ECE036M

PROJECT TITLE

Teaching of climatology concepts in Grade 12 through multimedia: Cases of four schools in Johannesburg North.

INVESTIGATOR

Sethole Mokurubane Simon

SCHOOL/DEPARTMENT OF INVESTIGATOR

WSoE

DATE CONSIDERED

22 July 2022

DECISION OF THE COMMITTEE

Approved unconditionally

RISK LEVEL

No Risk

EXPIRY DATE

Date of submission of the Research Report

ISSUE DATE OF CERTIFICATE

CHAIRPERSON

A handwritten signature in black ink, appearing to read "Mbokane", written over a horizontal line.

Dr. Batseba Mofolo-Mbokane

cc: Dr. Nokulunga Ndlovu

