INVESTIGATING THE INTERACTIVE USE OF COMPUTER SIMULATIONS AND VIDEOS IN TEACHING GRADE 10 MAGNETISM: A CASE STUDY OF FOUR HIGH SCHOOLS IN MPUMALANGA PROVINCE.

BY

LISTER MUNODAWAFA DZIKITI

Thesis submitted in fulfilment of the requirements for the degree

of

MASTER OF SCIENCE

(MATHEMATICS, SCIENCE AND TECHNOLOGY EDUCATION)

in the subject

PHYSICS EDUCATION

at the

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: PROF. J. KRIEK

January 2019

DECLARATION OF ORIGINALITY

I, LISTER MUNODAWAFA DZIKITI, declare that *Investigating the interactive use of computer simulations and videos in teaching Grade 10 magnetism: A case study of four high schools in Mpumalanga Province* is research work of my own originality and that any material from other sources, articles and texts that I have utilised or quoted have been acknowledged by means of complete references.

Signature ____________________________ Date ________________

ABSTRACT

This study investigated the interactive use of computer simulations (CS) and videos on magnetism in Grade 10 at four high schools in the Mpumalanga province. Magnetism is one of the sections of the Physical Sciences CAPS curriculum. Four MST high schools in the Badplaas/Mashishila circuits of the Gert Sibande district in Mpumalanga were used as a case study.

Three schools were used as experimental groups while the fourth school was used as control group. The first group was taught using computer simulations. The second group was taught using videos. The third group was taught using both computer simulations and videos, and the fourth group was taught using normal traditional methods. Using the pre-post test non-equivalent control group design, it was found that learners in all the experimental groups, who were taught using either computer simulations or videos or both, achieved significantly higher scores after being subjected to the post-test than learners in the control group, who were taught only by the normal traditional method. Furthermore, learners who were taught using a combination of CS and videos achieved significantly higher scores than learners who were exposed to only CS or only videos. Class observations conducted during the study reported that the use of information communication technology (ICT) tools with learners in the experimental groups proved to be informative, motivational and inspirational. This was evidenced by active learner participation, the learners being able to make predictions after observations and provide scientific explanations of concepts through discussions. The use of ICT tools in the form of CS and videos proved to be an effective instrument which can enhance learning.

KEYWORDS

Information communication technology; computer simulations; pedagogy; videos; TPACK; Mathematics Science and Technology; magnetism; CAPS.

ACKNOWLEDGEMENTS

I acknowledge with heartfelt thanks my almighty God for healthy brains and the lifetime chance He granted me to present this thesis. I shall always praise Him forever.

I salute my family and friends for their support, spiritually and emotionally, which I greatly needed to do this work.

I would like to thank the support of my friend Leopold Shinya, a Mathematics lecturer at CUT, Welkom campus, for taking his time to go through my work. It was almost impossible to proceed with this work without his contribution.

A countless number of thanks go to Professor Jeanne Kriek for dedicating most of her time to encourage me. I earnestly thank you, Professor, for the thorough scrutiny of my work as well as paying full attention to every detail. You were my greatest source of inspiration and my eye opener as your full assistance enabled me to work independently. There was a time when I nearly gave up but you stood by my side. You were not only the best academic supervisor I have ever known but also my motivator. It did sometimes it become tough but you always made it a point that I should “have fun”. You are and will remain my pillar of strength.

I also wish to thank Professor Michael Piburn from the USA for allowing me to adopt his RTOP instrument during class observations.

I would also like to further extend my thanks to Jonas K. Kotoka for granting permission to use and modify the questionnaire which he used in his master’s thesis with UNISA.

Many thanks go to the head of the Mpumalanga Provincial Education Department and her team for permission to carry out my studies in their schools, as well as all the learners and teachers from the MST schools where the research took place, the principals of these schools and the circuit managers for giving me the go-ahead to execute my research.

DEDICATION

This study is dedicated to my late grandmother,

ELLEN NYENGEDZAI DZIKITI,

who inspired me to pursue knowledge for its own sake.

ACRONYMS

ANOVA	Analysis of Variance
CAPS	Curriculum Assessment Policy Statement
CK	Content Knowledge
CS	Computer Simulations
DEEP	Digital Education Enhancement Programme
DoE	Department of Education
EFA	Education For All
EJS	Easy Java Simulations
ELRC	Education Labour Relations Council
ICT	Information Communication Technology
ISE	Interactive Science Experiments
MFM	Magneto Force Microscopy
MOFE	Magneto Optical Faraday Effect
MOKE	Magneto Optical Kerr Effect
MOM	Magneto Optical Microscopy
MPU EDU	Mpumalanga Education
MST	Mathematics, Science and Technology
NEIMS	National Education Infrastructure Management System
NSC	National Senior Certificate
PCK	Pedagogical Content Knowledge
PhET	Physics Education Technology
PK	Pedagogical Knowledge
PS	Public Schools
RTOP	Reformed Teaching Observation Protocol
SA	South Africa
SBA	School-based Assessment
SGB	School Governing Body
SME	Subject Matter Expert
SPSS	Statistical Package for Social Sciences
SQUID	Superconducting Quantum Interference Device
SSA	Sub-Saharan Africa
TCK	Technological Content Knowledge
TPACK	Technological Pedagogical Content Knowledge
WEC	World Economic Forum

DEFINITION OF TERMS

Pedagogy	Teaching practice and its influence on students' learning
Teaching	Organizing and blending content knowledge and pedagogical tools to enhance comprehension of particular topics
Magnetism	The field of study which focuses mainly on ferromagnetic substances and metallic conductors
Interactive Screen Experiment (ISE)	Contains pre-recorded numerical and audiovisual data which is most suitable for teaching physics
The physics education technology project (PhET)	A software package associated with animated simulations most suitable for physics teaching and learning
Spiral curriculum	A curriculum which advocates for logical progression from simple to complicated ideas
Traditional approach to teaching	Approach in which the ICT resources are not easily utilised or accessed by learners during the learning process and there is thoughts transfer from teacher to learners with little or no room for student independent reasoning and questions
Technological pedagogical content knowledge (TPACK)	A collective term which refers to a combination of TCK and PCK and is a contemporary knowledge base for ICT integration in physics teaching
Simulation	An approximate imitation of the operation of a system or process in order to gain insight into their functioning.

TABLE OF CONTENTS

ACRONYMS .... **vii**
DEFINITION OF TERMS .... **viii**
LIST OF TABLES .... **xiv**
LIST OF FIGURES .... **xvi**
LIST OF APPENDICES .... **xx**

CHAPTER 1 BACKGROUND OF THE STUDY **1**

1.1 INTRODUCTION **1**
1.2 PROBLEM STATEMENT **2**
1.2.1 Learner performance 2
1.2.2 Teacher knowledge 3
1.2.3 Infrastructure 3
1.2.4 CURRICULUM AND ASSESSMENT POLICY STATEMENT (CAPS) 5
1.2.5 SUMMARY OF PROBLEM STATEMENT 5
1.3 CONTEXT OF THE STUDY **6**
1.4 RATIONALE OF THE STUDY **7**
1.5 THE AIM OF THE STUDY **8**
1.5.1 Research questions 8
1.5.2 Hypotheses 9
1.6 THE SIGNIFICANCE OF THE STUDY **10**
1.7 SUMMARY **11**

CHAPTER 2 LITERATURE SURVEY AND THEORETICAL FRAMEWORK **12**

2.1 INTRODUCTION **12**
2.2.1 THE TEACHING AND LEARNING PROCESS **12**
2.2.2 THE TRADITIONAL APPROACH TO TEACHING 13
2.2.3 THE CONSTRUCTIVIST APPROACH 14
2.2.4 THE SPIRAL CURRICULUM IN SOUTH AFRICA 16
2.2.5 THE ROLE OF EXPERIMENTS IN THE PHYSICS CLASSROOM 16
2.2.6 THE INTEGRATION OF ICT IN PHYSICS EDUCATION 18
2.2.7 MAGNETISM 19

2.3.1 USING TECHNOLOGY IN TEACHING MAGNETISM ... 20
2.3.2 ICT INTEGRATION IN SUB-SAHARAN AFRICA ... 21
2.4.1 COMPUTER SIMULATIONS ... 22
2.4.2 USE OF COMPUTER SIMULATIONS IN MAGNETISM ... 23
2.4.3 PHYSICS EDUCATION TECHNOLOGY PROJECT (PHET) ... 24
2.4.4 EASY JAVA SIMULATIONS ... 25
2.5.1 THE USE OF VIDEOS IN MAGNETISM ... 25
2.5.2 YOUTUBE IN THE CLASSROOM ... 26
2.5.3 THE USE OF COMPUTER SIMULATIONS AND VIDEOS IN THE SA CONTEXT ... 28
2.6 CONCLUDING REMARKS ON LITERATURE SURVEY ... 28
2.7 THEORETICAL FRAMEWORK ... 29
2.8 SUMMARY ... 31

CHAPTER 3 RESEARCH METHODOLOGY ... 32

3.1 INTRODUCTION ... 32
3.2 THE RESEARCH DESIGN ... 32
3.3 POPULATION ... 34
3.4 SAMPLING ... 34
3.5 INSTRUMENTATION ... 37
3.5.1 Pre-post-test ... 37
3.5.2 Reformed Teaching Observation Protocol (RTOP) ... 38
3.5.3 Questionnaire ... 38
3.6 VALIDITY AND RELIABILITY ... 39
3.6.1 The validity of pre-post-tests ... 39
3.6.2 The reliability of pre-post-tests ... 39
3.6.3 The validity and reliability of the classroom observation protocol (RTOP) ... 40
3.6.4 The validity of the classroom observation protocol (RTOP) ... 40
3.6.5 The reliability of the Reformed Teaching Observation Protocol (RTOP) ... 41
3.6.6 The validity of the questionnaire ... 41
3.6.7 The reliability of the questionnaire ... 41
3.7 INTEGRATION OF SIMULATIONS AND VIDEOS INTERACTIVELY WHEN TEACHING GRADE 10 MAGNETISM ... 42

3.8 DATA COLLECTION ... 42
3.9 LESSON PLANS ... 47
3.10 QUANTITATIVE DATA ANALYSIS ... 47
3.10.1 The t-test ... 47
3.10.2 The chi-square test ... 48
3.10.3 Hake's average normalised gain ... 49
3.11 QUALITATIVE DATA ANALYSIS ... 49
3.12 INTERVENTION ... 50
3.13 PILOT STUDY ... 51
3.14 ETHICAL CONSIDERATIONS ... 52
3.14.1 Official permission ... 52
3.14.2 School-based permission ... 52
3.15 SUMMARY ... 53

CHAPTER 4 QUALITATIVE ANALYSIS AND DISCUSSION ... 54

4.1 INTRODUCTION ... 54
4.2 SCHOOL D: USING COMPUTER SIMULATIONS INTERACTIVELY IN TEACHING AND LEARNING MAGNETISM ... 55
4.2.2 Mr W's interactive CS lessons with the experimental group ... 55
4.3 SCHOOL E: USING YOUTUBE VIDEOS INTERACTIVELY IN THE TEACHING AND LEARNING OF MAGNETISM ... 71
4.3.1 Context of School E ... 71
4.3.2 Mr. X's interactive video lessons with the experimental group ... 72
4.4 SCHOOL F: USING COMPUTER SIMULATIONS AND YOUTUBE VIDEOS INTERACTIVELY FOR THE TEACHING AND LEARNING OF MAGNETISM ... 89
4.4.1 Context of School F ... 89
4.4.2 Mr Y's interactive CS and video lessons to the experimental group ... 89
4.5 SCHOOL G: NON-INTERACTIVE APPROACH – TEACHING AND LEARNING MAGNETISM WITHOUT USING CS OR VIDEOS ... 108
4.5.1 Context of School G ... 108
4.5.2 Miss Z'S non-interactive lessons, control group (traditional method) ... 108
4.6 General overview of the RTOP lesson observations ... 119
4.7 QUALITATIVE PRESENTATIONS FROM QUESTIONNAIRE FINDINGS ... 123
4.7.1 Introduction ... 123

4.7.2 Section A: Background of sampled teachers 123
4.7.3 Section B: Computer knowledge and skills 125
4.7.4 Section C: Responses related to ICT integration in the teaching and learning of Physical Sciences 127
4.8 SUMMARY 129

CHAPTER 5 PRESENTATION OF QUANTITATIVE DATA ANALYSIS AND DISCUSSION 130

5.1 INTRODUCTION 130
5.2 EQUIVALENCE OF THE FOUR GROUPS 131
5.3 PRE-POST-TESTS COMPARISON BETWEEN GROUPS 134
5.4 THE USE OF THE INDEPENDENT T-TEST IN HYPOTHESIS TESTING 135
5.4.1 The independent t-test for School D using CS in the experimental group 136
5.4.2 Independent t-test for School E using videos in the experimental group 136
5.4.3 Independent t-test for School F using videos in the experimental group 137
5.5 COMPARISON OF POST-TEST SCORE OF EXPERIMENTAL GROUPS AT SCHOOLS AND THE CONTROL GROUP AT SCHOOL G 138
5.6 THE RELATIONSHIP BETWEEN POST-TEST ACHIEVEMENT LEVEL AND THE INTERVENTION APPROACH 139
5.7 CHI-SQUARE TEST FOR THE RELATIONSHIP BETWEEN THE POST-TEST ACHIEVEMENT LEVEL AND THE INTERVENTION APPROACH 140
5.8 THE EFFECT OF INTERVENTION APPROACHES ON POST-TEST SCORES.. 141
5.9 HAKE'S AVERAGE NORMALISED GAIN 143

5.10 FINDINGS OF STUDY SITUATED IN TPACK 144

5.11 PRESENTATION OF QUANTITATIVE DATA ANALYSIS, DISCUSSIONS AND CONCLUSIONSERROR! BOOKMARK NOT DEFINED.

5.11.2 FINDINGS OF STUDY BASED ON INTERACTIVE USE OF CS 146
5.11.3 FINDINGS OF STUDY BASED ON INTERACTIVE USE OF VIDEOS 147
5.11.4 FINDINGS OF STUDY BASED ON INTERACTIVE USE OF CS AND VIDEOS 149

5.12 IMPACT OF ICT ON TEACHING AND LEARNING…………… ... ……………152
5.12.1 FINDINGSOF STUDY BASED ON RTOP LESSON OBSERVATIONS 152
5.12.2 FINDINGS OF STUDY BASED ON QUESTIONNAIRES……….…... ………153.
5.13 LIMITATIONS OF THE STUDY 153
5.14 GENERAL RECOMMENDATIONS 156
5.15 RECOMMANDATIONS FOR FURTHER STUDIES 159
5.16 CONCLUSION 160
5.17 SUMMARY OF STUDY 161
LIST OF REFERENCES 162
APPENDICES 1800

LIST OF TABLES

Table 1.1 Physical Science results for Grade 12 in Mpumalanga Province 3
Table 1.2 Laboratory facilities in SA schools (Adapted from NEIMS, 2016:4) 4
Table 1.3 Summary of the available communication systems in South African schools 5
Table 2.4 Programme of Assessment for Grade 10 (extracted from CAPS document) 18
Table 3.1 A summary of the variables per school during intervention 35
Table 3.2 A summary of data collection through the administration of pre-post tests 43
Table 3.3 A summary of lesson observations timetable during intervention 44
Table 3.4 A summary of lesson observations conducted at four MST schools 46
Table 3.5 Rating codes and percentages for reporting in Grades R-12 48
Table 3.6 Converting rating codes to categorical variables 49
Table 4.1 Rating of Mr W's lesson 1 using the RTOP monitoring instrument 60
Table 4.2 Rating of Mr W's lesson 2 using the RTOP monitoring instrumen 63
Table 4.3 Rating of Mr W's lesson 3 using the RTOP monitoring instrument 66
Table 4.4 Rating of Mr W's lesson 4 using the RTOP monitoring instrument 69
Table 4.5 General comments on Mr W's lesson observations using RTOP..........69
Table 4.6 Rating of Mr X's lesson 1 using the RTOP monitoring instrument 74
Table 4.7 Rating of Mr X's lesson 2 using the RTOP monitoring instrument 78
Table 4.8 Rating of Mr X's lesson 3 using the RTOP monitoring instrument 83
Table 4.9 Rating of Mr X's lesson 4 using the RTOP monitoring instrument 86
Table 4.10 General comments on Mr X's lesson observations using RTOP...........87
Table 4.11 Rating of Mr Y's lesson 1 using the RTOP monitoring instrument 92
Table 4.12 Rating of Mr Y's lesson 2 using the RTOP monitoring instrument 98
Table 4.13 Rating of Mr Y's lesson 3 using the RTOP monitoring instrument 102
Table 4.14 Rating of Mr Y's lesson 4 using the RTOP monitoring instrument 105
Table 4.15 General comments on Mr Y's lesson observations using RTOP.........106
Table 4.16 Rating of Miss Z's lesson 1 using the RTOP monitoring instrument ...110
Table 4.17 Rating of Miss Z's lesson 2 using the RTOP monitoring instrument ...112
Table 4.18 Rating of Miss Z's lesson 3 using the RTOP monitoring instrument ...114
Table 4.19 Rating of Miss Z's lesson 4 using the RTOP monitoring instrument ...117
Table 4.20 General comments on Miss Z's lesson observations using RTOP......117

Table 4.21 Summary of the analysis of the percentage rating RTOP lesson observations....120
Table 4.22 Summary of the demographics of the Grade 10 teachers from the sampled schools 124
Table 4.23 Summary of teachers' responses to section B of the questionnaire....125
Table 4.24 A summary of sampled teachers' responses to section C of the questionnaire 128

LIST OF FIGURES

Figure 1.1 Link between the first three research questions and the hypotheses 10
Figure 2.1 The technological pedagogical content knowledge (TPACK) conceptual framework....30
Figure 3.1 An overview of the research approach....36
Figure 4.1 Screenshot from PhET simulations with field meter showing magnetic field strength close to a magnet....58
Figure 4.2 Screenshot from PhET simulations with a field meter showing the strength of a magnetic field away from a magnet 58
Figure 4.3 Screenshot from PhET simulations showing the magnetic field around a magnet....59
Figure 4.4 Screenshot from PhET simulations showing magnetic field lines existing between unlike poles 61
Figure 4.5 Screenshot from PhET simulations showing magnetic field lines existing between like poles 61
Figure 4.6 Screenshot from PhET simulations showing a magnetic field strength at various points from a magnet....62
Figure 4.7 Screenshot from PhET simulations showing a magnetic field around a coil carrying current 63
Figure 4.8 Screenshot from PhET simulations showing randomly aligned domains....65
Figure 4.9 Screenshot from PhET simulations showing an external magnetic field being applied to a ferromagnetic material 65
Figure 4.10 Screenshot from PhET simulations showing a magnetised material with aligned domains 66
Figure 4.11 Screenshot from PhET simulations showing the earth’s magnetic field....67
Figure 4.12 Screenshot from PhET simulations showing how the solar wind is deflected by the earth’s magnetic field 68
Figure 4.13 Screenshot from YouTube video showing magnetic field view when iron filings are being attracted by a magnet....72
Figure 4.14 Screenshot from YouTube video showing a magnet attracting iron nails from a distance....73
Figure 4.15 Screenshot from YouTube video showing the magnetic field around a permanent magnet....73
Figure 4.16 Screenshot from YouTube video showing an electromagnet....74
Figure 4.17 Screenshot from YouTube video showing permanent bar magnets attracting each other 76

Figure 4.18 Screenshot from YouTube video showing two permanent bar magnets repelling each other 77
Figure 4.19 Screenshot from YouTube video showing repulsion 77
Figure 4.20 Screenshot from YouTube video showing paper clips being attracted by a current-carrying coil around an iron nail 78
Figure 4.21 Screenshot from YouTube video showing compasses representing randomly arranged domains in an unmagnetised material 79
Figure 4.22 Screenshot from YouTube video showing magnetic compasses representing aligned domains in a magnetised material 80
Figure 4.23 Screenshot from YouTube video showing randomly aligned needles representing magnetic domains in an unmagnetised material 80
Figure 4.24 Screenshot from YouTube video showing aligned needles to resemble magnetic domains in a magnetised material 81
Figure 4.25 Screenshot from YouTube video showing randomly aligned magnetic domains 81
Figure 4.26 Screenshot from YouTube video showing how a material becomes magnetised after applying a strong external magnetic field 82
Figure 4.27 Screenshot from YouTube video showing a permanent magnet being demagnetised by strong heating 82
Figure 4.28 Screenshot from YouTube video showing a permanent magnet being used to generate electricity 83
Figure 4.29 Screenshot from YouTube video showing the earth's core and magnetic field 84
Figure 4.30 Screenshot from YouTube video showing a gyromagnetic compass in the earth's magnetic field 85
Figure 4.31 Screenshot from YouTube video showing an aurora borealis 85
Figure 4.32 Screenshot from YouTube video showing the solar wind being deflected by the earth's magnetic field 86
Figure 4.33 Screenshot from PhET simulations showing the north pole of a magnetic compass being attracted to the south pole 90
Figure 4.34 Screenshot from YouTube video showing ferromagnetic and non-ferromagnetic materials 90
Figure 4.35 Screenshot from PhET simulations showing a gyromagnetic compass and magnetometer being used to determine the magnetic field strength at different positions around a bar magnet 91
Figure 4.36 Screenshot from YouTube video showing how attraction occurs when two unlike poles of a magnet are facing each other 93
Figure 4.37 Screenshot from PhET simulations showing magnetic field lines existing between unlike poles during attraction 93

Figure 4.38 Screenshot from YouTube videos showing how repulsion occurs when two like poles of a magnet are facing each other 94
Figure 4.39 Screenshot from PhET simulations showing magnetic field lines existing between like poles during repulsion......................................94
Figure 4.40 Screenshot from PhET simulations showing a bar magnet with its internal and external magnetic fields exposed 95
Figure 4.41 Screenshot from YouTube video showing the existence of a magnetic field and field lines around a current-carrying coil 95
Figure 4.42 Screenshot from PhET simulations showing the existence of a magnetic field around a coil carrying current 96
Figure 4.43 Screenshot from YouTube video showing how a simple electromagnet can be constructed..96
Figure 4.44 Screenshot from YouTube video showing paper clips being attracted by current-carrying coil around an iron nail 97
Figure 4.45 Screenshots from YouTube videos showing (a) randomised magnetic compasses representing unmagnetised material; (b) magnetic compasses representing aligned domains in a magnetised material.........99
Figure 4.46 Screenshots from PhET simulations showing (a) randomly aligned domains before magnetisation; (b) aligned domains after magnetisation by using an external magnetic field 99
Figure 4.47 Screenshot from PhET simulations showing how a magnet and its aligned domains would appear from the inside 100
Figure 4.48 Screenshots from YouTube videos showing (a) a permanent magnet attracted to the head of an iron nail being heated strongly; (b) the magnet loses its magnetic properties and falls off; (c) magnet can no longer attract ferromagnetic materials because it has lost its magnetic properties forever 100
Figure 4.49 Screenshot from YouTube video showing how a gyromagnetic compass is used on planet Earth for navigation 103
Figure 4.50 Screenshot from PhET simulations showing a magnet aligned with the earth’s magnetic field...103
Figure 4.51 Screenshot from YouTube video showing the aurora borealis..........104
Figure 4.52 Screenshot from PhET simulations showing how a magnetosphere defends the earth from solar winds..104
Figure 4.53 Screenshot from YouTube video showing the solar wind being deflected as it enters the earth’s magnetic field 105
Figure 4.54 Magnetic field lines around a bar magnet 110
Figure 4.55 Magnetic field lines between unlike poles during attraction when using (a) iron filings and (b) sketch diagrams 111
Figure 4.56 Magnetic field lines between like poles during repulsion when

using (a) iron filings and (b) sketch diagrams 112
Figure 4.57 Magnetic domains (a) randomly aligned in an unmagnetised material, and (b) aligned in a magnetised material after the application of a strong external magnetic field 113
Figure 4.58 How to use a magnet to predict the earth's magnetic north and south pole 115
Figure 4.59 Difference between the actual magnetic north and south pole and the geographic south and north pole 116
Figure 4.60 The earth's magnetosphere exhibiting the northern lights (aurora borealis) 116
Figure 4.61 The solar wind being deflected by the earth's magnetic field............117
Figure 5.1 Comparison of pre-post-test means between experimental and control groups 135
Figure 5.2 Comparison of average normalised gain between the four groups...143

LIST OF APPENDICES

APPENDIX A	Pre-post-test instrument
APPENDIX B	RTOP instrument
APPENDIX C	Questionnaire instrument
APPENDIX D	Request for permission from Mpumalanga Department of Education
APPENDIX E	Request for permission from circuit managers
APPENDIX F	Request for permission from school principals
APPENDIX G	Request for permission from educator participants
APPENDIX H	Request for permission from parents/guardians
APPENDIX I	Request for permission from learner participants
APPENDIX J	Letter of permission granted to adopt the RTOP instrument
APPENDIX K	Letter of permission granted to use/modify questionnaire instrument
APPENDIX L	Lesson plans used by educator participants during intervention
APPENDIX M	Permission letter from UNISA Ethics Review Committee
APPENDIX N	Permission letter from Mpumalanga Education Department
APPENDIX P	RTOP lesson observations during intervention
APPENDIX Q	Questionnaire responses from educator participants

CHAPTER 1
BACKGROUND OF THE STUDY

1.1 INTRODUCTION

The evolution of technology and new learning methods allows physical sciences teachers to adopt and assimilate rich and motivating learning environments in classroom practice (Barak, Nissim, & Ben-Zvi, 2011). Integrating information and communication technology (ICT) into teaching physical sciences as means of aiding existing pedagogical tools has risen on the South African agenda particularly with the advent of e-learning, as released in the 2003 white paper (Wilson-Strydom, Thomson & Hodginson-Williams, 2005).

Recently there has been an appeal for physical sciences teachers to stop using the traditional approach and switch to an inquiry-based and ICT-biased learner-centred approach in order to allow learners to be more responsible for their own learning (Muller, 2008). However, available research confirms that even though many teachers are aware of the educational potential of integrating ICT in teaching and learning, a siseable number of them still practise the traditional approach (Muller, Sharma, Lindstrøm, & Kuan, 2012). Wilson-Strydom et al., (2005) also point out that most of the schools that have enjoyed access to ICT facilities have placed the emphasis on learning about ICT rather than integrating it into teaching and learning. Therefore, this study focused on the integration of ICT in the teaching and learning of Grade 10 learners regarding magnetism.

Computer simulations and videos are regarded as ICT tools that have benefits for student learning, (Graziano, Foulger, Crawfor, & Slykuis, 2017). For example, when computer simulations were used in the teaching and learning of Grade 11 learners in certain Mpumalanga schools, it was found that learner performance increased compared to traditional teaching methods (Kotoka & Kriek, 2014). In another study using videos led to greater learner performance and motivation (Wilson, 2015). However, no study has used the combination of videos and simulations compared to videos alone, simulations alone and traditional teaching in the Mpumalanga Province in South Africa.

1.2 PROBLEM STATEMENT

1.2.1 Learner performance

This study was undertaken in certain schools in the Mpumalanga Province. According to the Mpumalanga 2016 provincial diagnostic report that there was a significant difference and decrease in performance of the MST schools compared to other ordinary public schools (PS) regardless of the availability of ICT facilities at MST schools (DoE, 2017). MST schools are mathematics, sciences and technology (MST) schools with the intention to increase the number of young people leaving school with at least a 50% pass in Mathematics and Physical Sciences so as to meet the demand of producing skilled people for economic growth (DoE, 2013). These schools were formally referred to as Dinaledi schools. However, there were some challenges associated with the successful implementation of the MST schools, most of which were the same as those experienced by non-MST public high schools.

Table 1.1 provides the Grade 12 Physical Sciences results from MST and all other PS in Mpumalanga over the past two years (adapted from MPU EDU, 2016).

Table 1.1 Physical Sciences results for Grade 12 in Mpumalanga Province

PHYSICAL SCIENCES PERFORMANCE				
	ALL SCHOOLS		MST SCHOOLS	
	2015	2016	2015	2016
Total no. of learners who wrote	17564	18929	5349	5955
Pass % at 30%	62.6%	63.6%	62.6%	58.9%
Pass % at 50%	23.1%	24%	23.4%	21.9%
Number of distinctions	455 (2.6%)	612 (3.2%)	142 (2.7%)	214 (3.6%)
No. of schools obtaining 100%	42 (7.9%)	42 (7.8%)	2 (2.1%)	0 (0%)
No. of Schools obtaining 70-99%	205 (38.6%)	212 (39.3%)	50 (51.5%)	40 (40%)
No. of schools obtaining 0-69%	282 (53.3%)	288 (53.3%)	45 (46.4%)	61 (61%)
No. of schools obtaining 0%	1	2	0	0
Total number of schools	529	540	97	100

The trends shown by the results provided in Table 1.1 call for serious interventions to help Mpumalanga MST schools to improve their performance in Physical Sciences.

1.2.2 Teacher knowledge

An assessment report by Education For All (EFA) 2000 (2005) also indicated that, in spite of approximately 84% of science teachers being professionally qualified, only 42% are qualified in science. Another remarkable observation (DoE, 2001a) is that only a handful of mathematics and science graduates opted for the teaching profession. Some researchers in physical sciences education also observed that neither government officials nor the community at large are aware of the importance of physical sciences to society (Rashid & Khalid, 2005).

1.2.3 Infrastructure

Lack of laboratories

The mid-term report issued by NEIMS South Africa in 2016 demonstrated that most schools in nearly all provinces have major challenges of accessing laboratory facilities (see Table 1.2).

Table 1.2 Laboratory facilities in SA schools (Adapted from NEIMS, 2016, p4)

PROVINCE	Number of sites	With laboratory	% with laboratory	Without laboratory	% without laboratory
Western Cape	1440	479	33.26	961	66.74
Eastern Cape	5641	310	5.68	5151	98.32
Northern Cape	537	91	16.95	446	83.05
Free State	1227	327	26.65	900	73.35
KwaZulu-Natal	5861	667	11.38	5194	88.62
North-West	1440	272	18.89	1168	81.11
Gauteng	2071	689	33.27	1382	66.73
Mpumalanga	1721	214	12.43	1507	87.57
Limpopo	3831	228	5.95	3603	94.05
Total	23589	3277	18.27	20312	81.73

Under these circumstances of inadequate access to laboratory resources, the development of an ICT culture in MST schools can fill the shortages (Madlela, 2015). That is why the Department of Education embarked on a mission to equip especially all rural MST schools with an ICT infrastructure and internet connectivity to overcome the challenges associated with a lack of laboratory access (Madlela, 2015).

Lack of internet connection

The NEIMS 2016 report also showed that Mpumalanga had the lowest internet source facilities, with only 71 out of 1 721 public schools having internet connectivity and a WIFI network specifically used for teaching and learning, as shown in Table 1.3. In full support of MST schools, the Mpumalanga provincial department of education's mandate was to ensure that resources for e-learning broadcasting in 100 MST schools be provided before the end of 2013 (DoE, 2012).

Table 1.3 Summary of the available communication systems in South African schools (Adapted from NEIMS, 2016, p4)

Available Communication Systems						
Province	**Number of sites**	**Cell network**	**Computer centre**	**Teaching & learning internet connectivity**	**Administrative internet connectivity**	**2-way radio**
Eastern Cape	5433	5286	**588**	**550**	798	35
Western Cape	1441	1038	**854**	**1252**	1258	89
Northern Cape	534	497	**293**	**194**	301	11
Free State	1227	1167	**435**	**304**	387	29
KwaZulu-Natal	5839	5642	**1942**	**535**	945	55
North-West	1485	1464	**641**	**270**	581	7
Gauteng	2069	1757	**1662**	**1331**	1436	131
Mpumalanga	1715	1642	**690**	**71**	101	3
Limpopo	3834	3785	**575**	**139**	234	5

From Table 1.3 it is clear that the Western Cape and Gauteng with many urban schools have the highest internet connectivity, which is used primarily for teaching and learning, while Mpumalanga, being mainly rural, has the lowest access to the internet. Accessibility to education associated with ICT-enhanced learning environments is currently limited to urban schools while the majority of rural schools do not have such a privilege. ICT-enhanced learning environments are assumed to raise the standards of education and life (Koranteng, 2012).

1.2.4 CURRICULUM AND ASSESSMENT POLICY STATEMENT (CAPS)

Another reason for the poor performance by Physical Sciences learners could be the Curriculum and Assessment Policy Statement (CAPS) as it is highly prescriptive and content-packed. The outcome is that physical sciences teachers especially engage in syllabus coverage rather than involving learners in engagement and discovery through the integration of ICT teaching (Du Plessis, 2014).

1.2.5 SUMMARY OF PROBLEM STATEMENT

Many South African rural schools do not have adequate access to ICT infrastructure and those that do mainly use them for the acquisition of basic ICT skills instead of integrating it as a pedagogical tool (Baydas, 2013). In line with this, the National Education Infrastructure Management System (NEIMS) standard report of June 2016 found that internet connectivity for teaching and learning (see Table 1.1) was limited to a few provinces (NEIMS, 2016).

Furthermore, even though many MST schools have so far been equipped with ICT e-learning resources, their performance in the Physical Sciences national examinations is still far below the expectations of the Department of Education (DoE, 2016). This means that the acquisition of ICT infrastructure by schools is of little value to knowledge economics if the learners are not going to benefit directly (Fu, 2013).

In addition, the pedagogical content knowledge offered to pre-service teachers by higher education institutions in South Africa is not ICT adequate and is not aligned with the requirements within the schools' subject specific CAPS curriculum (DoE, 2015). Moreover, one of the problems could also be that teachers in the rural areas of South Africa do not know how to use ICT in the classroom as this was not included in their initial training (Koranteng, 2012). For that reason, the focus of the study was to train teachers currently teaching in a rural area in South Africa to integrate ICT (videos and computer simulations) in their classroom in a creative and interactive way in order to enhance learning in their classes.

1.3 CONTEXT OF THE STUDY

South Africa is a multiracial coastal country which has a land size of approximately 1 219 090 square kilometres and borders with Namibia and Botswana to the west, Zimbabwe to the north, Mozambique and Swaziland to the east, while Lesotho is a country fully surrounded by it (Statistics SA, 2015). A report from the World Economic Forum (WEC) indicates that South Africa has a population of just above 55 million and a GDP of $313 billion (WEC, 2016). There are nine provinces and 11 official languages in South Africa. The national government is decentralised in its nine provinces. Mpumalanga Province, where the research study was conducted, is predominantly rural. Mpumalanga is divided into four districts, namely Bohlabela, Enhlanzeni, Gert Sibande and Nkangala.

The educational affairs of each district are decentralised to circuits. Besides being geographically adjacent to each other, Badplaas and Mashishila circuits fall under the Gert Sibande district. The administrative affairs of the two circuits are also all housed at Siphumelele teachers' centre near Elukwatini township along the R541 route. High schools from the two circuits cluster together for meetings and workshops. This study targeted four MST high schools in these two circuits, mainly because they are easily accessible to the researcher.

The learners enrolled in the four schools mainly speak siSwati as their home language and are mixed in terms of gender. English is the language of Physical sciences instruction at each of the four sampled schools. The sampled MST schools fall under the category of quintile one (no-fee) schools with school feeding programmes effectively running. The sampled MST schools are all located close to Elukwatini rural township in the Gert Sibande district and also enrol the highest number of Physical sciences learners in the area. The Physical Sciences curriculum used in the sampled schools is the same spiral CAPS curriculum that is used by nearly all public schools in South Africa.

1.4 RATIONALE OF THE STUDY

The 2015 Physical Sciences diagnostic report points out that one of the contributing factors to the poor performance in Physics paper is misconceptions in the field of electricity and magnetism (DoE, 2016). This was also pointed out by Hekkenberg (2012), when she indicated that limited research had been done on the misconceptions associated with the intimate relationship between electricity and magnetism. Electricity and magnetism demand a large number of experiments to assist learners to conceptualise it (Lofciu, Miron, Dafinei, Dafinei, & Antohe, 2012). However, very few schools in rural South Africa have direct access to laboratory accessories and other advanced laboratory equipment (NEIMS, 2016). Hence CS and videos could potentially be integrated to assist learners in visualising and concretising the abstract nature of magnetism. Both interactive CS and videos focus on the visualisation of concepts. This might enable learners to better comprehend the underlying physics principles and application of magnetism.

In order to assist Grade 10 learners to create cognitive links between the theory and reality of magnetism, teachers should incorporate interactive CS and videos in their pedagogy, especially when teaching abstract scientific concepts such as magnetism. Having been done at lower grades, magnetism is reintroduced in Grade 10 as a prerequisite to Grade 11 electromagnetism and Faraday's law. This is examined in the Grade 12 final examinations as electrodynamics.

One way to tell whether a learner has learnt and conceptualised physics appropriately is that the learner develops the skills to tackle unseen problems in society (Hussain, Azeen, & Shakoor, 2011). This means that all teacher education programmes ought to assume a leadership role in effectively using new pedagogical tools for learning to transform physical sciences education or be left behind in a world of rapid technological change (UNESCO, 2002, p3).

1.5 THE AIM OF THE STUDY

The aim of the study was to investigate the impact of the interactive use of CS and videos on Grade 10 learners' performance on the topic of magnetism.

1.5.1 Research questions

The main research question was as follows:

- To what extent does the interactive use of computer simulations and videos impact on the learning and teaching of magnetism in Grade 10?

In order to answer the main research question, the following sub-questions were formulated:

i) Does the interactive use of computer simulations have an impact on the Grade 10 learners' performance in magnetism?

ii) Does the interactive use of videos have an impact on the Grade 10 learners' performance in magnetism?

iii) Does the interactive use of the combination of computer simulations and videos have an impact on the performance of Grade 10 learners in magnetism?

iv) To what extent does the use of computer simulations and videos influence the teaching of magnetism in Grade 10?

1.5.2 Hypotheses

The following null hypotheses were tested for the first three research questions:

i) **H01**: There is no significant difference in the performance in magnetism for Grade 10 learners exposed to the interactive use of computer simulations compared to the traditional approach to teaching.

ii) **H02**: There is no significant difference in the performance in magnetism for Grade 10 learners exposed to the interactive use of videos compared to the traditional approach to teaching.

iii) **H03**: There is no significant difference in the performance in magnetism for Grade 10 learners exposed to the interactive use of a combination of computer simulations and videos compared to the traditional approach to teaching.

The link between the research hypotheses and the first three research questions is shown in the flow diagram in Figure 1.1.

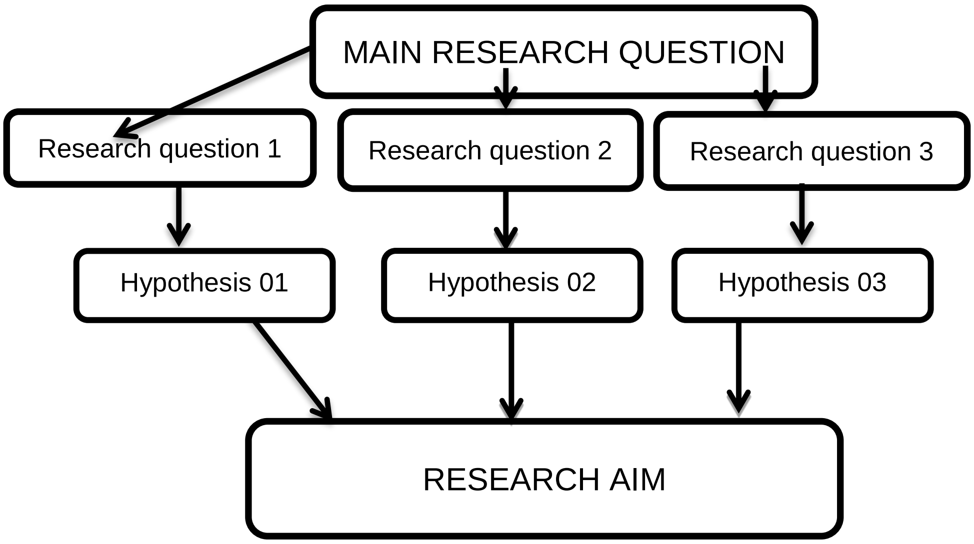


Figure 1.1 Link between the first three research questions and the hypotheses

1.6 THE SIGNIFICANCE OF THE STUDY

The study findings might help in revealing the pedagogical skills that are needed to enrich knowledge economics of 21st-century teaching and learning. The findings also provided the Department of Education with information regarding the advantages of using interactive CS and video learning and its effect on the performance of Grade 10 learners in magnetism.

This could possibly be extended to other topics in the Grade 10 Physical sciences curriculum. The results of the study were communicated to:

i) the Education Department, so as provide an insight into ways of adopting and implementing the integration of interactive CS and videos in physical sciences teaching and learning regarding magnetism since it has the potential to improve learner performance and achievement;

ii) high school learners, to enable them to be proficient in solving unforeseen problems associated with magnetism and possibly physical sciences in general;

iii) high school physical sciences teachers, to enable them to integrate ICT tools (e.g. CS and videos) in their lesson design and teaching methods in order to improve learners' conceptual understanding and performance in magnetism and possibly physics in general; and

iv) curriculum developers, science education specialists and Physical Sciences subject advisors, so that they are better able to assist novice, in-service and underqualified teachers when teaching magnetism as well as other sections of the Physical sciences curriculum.

1.7 SUMMARY

The chapter started with the background of the study. Then it provided an outline of the problem statement, the aim of the study, the research questions and associated null hypotheses. The context of the study, rationale of the study and significance of the study were also emphasised.

CHAPTER 2

LITERATURE SURVEY AND THEORETICAL FRAMEWORK

2.1 INTRODUCTION

This chapter provides an overview of the literature related to the study topic as well as the theoretical framework. This will assist in gaining insight into the circumstances under which CS and videos can be adopted for study purposes. The chapter proposes a theoretical framework which acts as a foundation to provide the rationale for the interactive use of CS and videos in teaching magnetism in Grade 10.

2.2.1 THE TEACHING AND LEARNING PROCESS

Teaching is an educational process which takes into cognisance a series of activities where students learn and acquire opportunities via specific pedagogical instructions (Draper, 2010). Teaching entails the application of pedagogical skills for a specific subject matter in a particular context (Reynolds, 1992). This involves organising and blending content knowledge and pedagogical tools to enhance comprehension of particular topic concepts such as magnetism in a manner which addresses learners' diverse interests and cognitive abilities (Resnick, 1987). Teaching also involves having the knowledge of cognitive roadmaps necessary to guide and gauge learners' progress (Bransford, Brown, & Cocking, 2000).

Learning on the other hand is the process of constructing knowledge from personal experience through interaction with the immediate surroundings (Niess, Lee, & Kajder, (2007). A learner is said to have acquired knowledge if there is an observable permanent change in behaviour and capabilities if exposed to situations which demand solving unforeseen problems (Sharma, 2008). The learning process remains entirely the responsibility of the learner in a conducive learning environment (Kaheru, 2014). The most important responsibility of a teacher therefore is to guide the social process of learning through inspiring, motivating and providing challenges and suitable learning platforms for learners (Muller, 2008). Learning itself is an active process in which students are active sense makers involved in actual thinking and not just doing (Adams, 2010).

There is a need to provide different teaching approaches as Learners tend to get into class while exhibiting different abilities, different styles of learning, and various personalities. Teachers have the mandate to ensure that all learners produce the best out of themselves (Adams, Reid, Lemaster, Mckagan, Perkins, & Dubson, 2008a). Teachers can possibly meet the needs of many learners by using differentiated teaching approaches in order to assist them surpass established national expectations. (Madlela, 2015) advocates for a problem solving theory and practice arguing that it is quite eminent to think while solving problems. Hence Lofciu et al., (2012) suggests that it is practically possible to execute teaching of thinking skills under circumstances where little or insignificant amount of knowledge of a scientific problem is required. Hence there are decisions involved concerning the what, how where and when to teach a specific learning technique in order to enhance learners to unleash their thinking potential (Alev, 2003). Such techniques depend on the view of a teacher about learners as sense makers, response strengtheners as well as information processors (Aina, 2013). The selection, organization and integration of information to be presented to learners with their existing knowledge forms a cognitive process much needed for fruitful learning (Bada, 2015). Hence a highly effective teaching method can be considered as one which drives learners to deduce sense from expository texts within the contextual realm of academic authenticity (Muller, Sharma, & Reimann, 2008). This implies that teachers should advocate the use of variable teaching styles and strategies to expose learners to both familiar and non-familiar learning methods which gives them the ultimate provision of multiple excelling ways (Egunsola, 2014).

2.2.2 THE TRADITIONAL APPROACH TO TEACHING

According to Lee & Tsai (2011), the traditional approach to teaching is one which is teacher-centred. The teaching and learning resources if available are usually used by teacher for demonstration purposes (Stofflet, 1998). Any available resources are not utilised or easily accessed by learners during the learning process (Balasubramanian, Manchanda, Skomski, Mukherjee, Valloppilly, Das, Hadjipanays, & Sellmyer, 2016). In a traditional classroom, learners are inactive recipients of knowledge while the teacher is at the centre-stage, providing direct and unilateral instructions (Kaheru, 2014). Adherents of this approach assume that learners come to acquire knowledge from a fixed source (Khalid & Azeem, 2012). The traditional approach does not allow for learners' thinking processes and potential to be maximised (Stofflet, 1998). However, it should be appreciated that the foundation and origin of teaching is all but a child-brain of the teacher-centered approach (Muller et al., 2008). This means that the extension and modifications of the so-called common sense is solely under the jurisdiction of the teacher, who happens to be the presiding officer in the classroom more than 80% of the time (Halloun & Hestenes, 1985). Needless to say that modern methods of teaching are founded on the traditional approach. That is why most of the followers of the traditional approach in rural high schools in South Africa are still chalk-and-talk classroom practitioners (Muller, 2008). In the traditional approach a thought transfer from teacher to learners occurs with little or no room for learner independent reasoning, questions and interactive learning (Binkley, Erstad, Herman, Raizen, Ripley, & Miller, 2012). Teachers often feel that they are teaching when they provide subject-related notes without allowing learners to actively interact with each other on issues regarding the subject matter (Sprague & Dede, 1999).

This teacher-centred approach does not necessarily permit participants to exercise critical thinking and assumes the same academic background in the subject (Lord, 1999). Even though teachers do not see any wrong in the traditional pedagogy, however studies have confirmed that the teacher-centred approach is less productive in knowledge economics (Zoller, 2000). In the traditional teaching approach, it is difficult to resolve misconceptions, particularly in magnetism, which could be held by teachers themselves (Wenning, 2008). If teachers have misconceptions this could be transferred from teacher to learners.

While the traditional approach is still the method of choice amongst teachers, its effectiveness can be improved by blending it with other methods of teaching (Chigona, 2014). In the next subsection, the researcher tackles literature related to constructivist approach to teaching.

2.2.3 THE CONSTRUCTIVIST APPROACH

Constructivism is a teaching and learning approach belonging to the philosophical school of thought which maintains that cognitive development is a direct outcome of mental construction where learners learn by acquiring new information together with their prior knowledge (Honebein, 1996). A constructivist teacher holds the view that knowledge is not simply transmitted to learners without them actively constructing it in their own minds (Bada, 2015). A constructivist believes that learners are active agents and analysts during the knowledge acquisition process (Ashcraft, Treadwell, & Kumar, 2008). The constructivist school of thought also holds the view that learning mainly depends on contextual factors such as teaching methods and also learners' beliefs and general attitude (Har, 2013). Hence the constructivist strategy requires students to exercise discovery and information transformation, comparison of new against the old information, and revision and adjustment of rules if they cease to be applicable (Jonassen & Murphy, 1999). A constructivist learner takes ownership of the learning process as a personal investment and develops questioning skills which are applicable to their natural curiosity of the world (Bada, 2015).

The constructivist approach provides for higher order creative thinking and critical analysis skills among learners (Hussain, Azeem, & Shakoor, 2011). The constructivist strategy demands that the teacher's strategy be a facilitator in the construction of knowledge rather than spoon-feeding learners with knowledge (Balachandran, 2016). The constructivist teacher assists learners through higher order problem solving and inquiry-based cognitive activities in which learners consider several alternatives and provide genuine reasons to support their solutions (Barak et al., 2007). Learners develop investigative and hypothesising skills and are then able to draw conclusions and recommendations in line with their collaborative environment (Badri et al., 2016).

A constructivist strategy provides learners with opportunities of experiencing ways of scientific thinking and acquiring expert skills in scientific argumentation and reasoning in the course of knowledge construction (Barak, 2011). The task of teachers in a successful constructivist classroom is that of facilitating learning, support and translation of information into a format relevant to a specific learner's state of comprehension (Khalid & Azeem, 2012). The constructivist approach implies greater involvement of learners to enable them to acquire skills and attitudes that allow seeking for solutions to questions and issues as they construct new knowledge (Muller et al., 2012). Teachers only pave the way for learners to develop new knowledge insights and link them with prior knowledge (Hussain et al., 2011). The constructivist teacher poses questions to the class and learners then work collectively in small groups to discover the vital answers and later share their findings with the entire class (Martinez, 2013). However, one of the reasons why teachers disregard the constructivist approach is that it requires intensive lesson preparation compared to the traditional model (Scheurman, 1998).

2.2.4 THE SPIRAL CURRICULUM IN SOUTH AFRICA

The roots of the spiral curriculum lie in Jerome Bruner's theory of cognitive development, namely that even complex concepts, such as magnetism, can be comprehended by young students if properly structured (Johnston, 2012). This allows a logical progression from simplistic to complicated ideas.

The CAPS curriculum was developed using a spiral approach in which learners learn best by building on their current knowledge in order to promote higher order critical and creative scientific skills (DoE, 2011). Hence the concept of magnetism is broadened, reinforced and solidified each time the learner revisits it in the next grade. The challenges, such as how electricity is intimately related to magnetism and the physics of electromagnetism, become more evident when learners in Grade 11 have to be re-taught Grade 10 magnetism before being introduced to electromagnetism and Faraday's law. Learners learn best through repeated experience and increasing complexity of the same concept – magnetism – each time they revisit it in their school career as advocated by the spiral approach, therefore a strong and clear Grade 10 foundation is needed. The traditional pedagogical skills being employed to teach the concept of magnetism at Grade 10 level need a technological facelift in order to substantially impact on the learner performance (DoE, 2015).

2.2.5 THE ROLE OF EXPERIMENTS IN THE PHYSICS CLASSROOM

Laboratory experiments are essential in the study of physical sciences since the subject is by nature a hands-on thinking and inquiry-based discipline (Vilaythong, 2011). Physical sciences experiments enable learners to manipulate laboratory equipment, take measurements, observe and obtain data which should be consistent with the intended conclusion (Miller, 2004). Experiments can be classified into real (actual), interactive screen experiments (ISE), remote and simulation (Jeschke, Thomsen, Richter, & Scheel, 2007). Remote experiments are real experiments that are remotely operated with web technology to allow the learners to monitor an actual experiment from a different and distant location and collect data through computer screen display (Jodl, 2004). ISE contain pre-recorded numerical and audio-visual data which allows the learner to observe the outcome of an experiment depending on his activities with no noticeable delay (direct manipulation), thus allowing active participation and individual control of the experiment with immediate feedback (Kirstein & Nordmeier, 2007). ISE have limited manipulation possibilities which are dependent on the scope of the recorded experimental data (Priemer, 2010). The simulation experiment offers the learner a high degree of freedom with regard to the possible variations in the parameters (qualitatively and quantitatively) and modelling (Koopman, 2014).

According to the Physical Sciences CAPS document, experiments involve learners by observing and following a set of given instructions to obtain data needed to confirm or prove a theory or physical law, whereas practical activity involves demonstrations, experiments or projects learners do in order to improve their level of conceptual understanding of scientific ideas (DoE, 2011). Grade 10 learners are expected to cover at least seven formal and informal practical assessments. One of the informal practical assessment activities is based on magnetism and also involves problem-solving activities without calculations. In the context of South Africa Physical Sciences experiments form part of the school-based assessment (SBA) (DoE, 2011). The SBA tasks are a compulsory component of the final promotion mark for all candidates registered for the National Senior Certificate examination (DoE, 2014). Furthermore, experimental tasks are heavily weighted if compared to control tests. The table below, extracted from the CAPS document (DoE, 2011), provides the assessment plan and weighting of SBA tasks for Grade 10 learners.

Table 2.4 Programme of Assessment for Grade 10 (from CAPS document)

ASSESSMENT TASKS						
TERM 1		**TERM 2**		**TERM 3**		**SBA**
TYPE	%	TYPE	%	TYPE	%	
Experiment	20	Experiment	20	Project or Practical investigation	20	
Control Test	10	Mid-year Examination	20	Control Test	10	
Total	30		40		30	100

From Table 2.4 the weighting of experiments is at the same level as mid-year examinations.

2.2.6 THE INTEGRATION OF ICT IN PHYSICS EDUCATION

The innovations in information and communication technology (ICT) have improved efficiencies in 21st-century living (Koranteng, 2012). Muller et al (2012) observe that using technologically centred pedagogical methods like CS and videos are bound to revolutionise the entire system of education in the 21st century. Although the teaching fraternity acknowledges the great benefits associated with ICT integration in schools the technological pedagogical content knowledge as well as the beliefs of individual teachers play an active role in determining ICT usage (Sudipta, 2015). Teachers are aware of the educational potential of ICT integration into existing pedagogical structures, but the majority still trust the traditional approach (Barak et al., 2011). Research has also shown that teachers who adhere to the constructivist school of thought are persistent and consistent users of ICT (Tasir, Abour, Halim, & Harun, 2012), whereas those who believe in traditional pedagogical approaches adopt limited ICT usage. To adjust the learning and teaching to suit individual needs it is apparent that ICT should be adopted and integrated into existing pedagogical approaches and be made available for use in physics teaching and learning since it offers greater opportunities (Sudipta, 2015). The fast-changing technological pace in 21st-century teaching and learning has seen more emphasis being placed on what learners are learning than on what teachers are teaching (Tasir et al., 2012).

To meet the challenges in teaching and learning in the 21st century, teachers are under pressure to design lessons that will allow learners to be active participants while constructing knowledge and solving problems (Koh, Hwee, Chai, Benjamin, & Hong, 2015). Kotoka & Kriek (2014) emphasise that using technology as a pedagogical tool in science education can help a great deal in improving learners' performance and achievement. One of the world's greatest educational concerns is that of the deployment and integration of ICT in the form of instructional multimedia ICT as a pedagogical tool as well as in contemporary research activities due to its learner-centredness (Muller et al., 2008). Nguyen, Williams, & Nguyen (2012) also note that the continued use of multimedia ICT assets in teaching and learning saves time and ensures the development of interactivity, communication and collaboration as well as higher order cognitive skills. This also provides learners with the computer skills demanded by the market (Thomas, 2011). Besides improvements in the standards of teaching and learning in physical sciences at school level, ICT skills also help to prepare learners for the workplace, where ICT competency is now a requirement (Aina, 2013). Greater motivation and a higher level of knowledge acquisition have been reported in technology enriched classrooms as well as in technology enhanced learning environments (Nguyen et al., 2012). The following sub-section (2.2.7) provides brief literature of the physics of magnetism.

2.2.7 TEACHING MAGNETISM

Magnetism is a very difficult topic to study because it is multifaceted and all facets need to be considered simultaneously (Nousiainen & Koponen, 2017). The abstract nature of magnetism makes it hard for students to comprehend (Kotoka & Kriek, 2014). The research findings by Bramowicz, Kulesza, & Mrozek, (2014) reveal that limited research has been done so far in the physics of magnetism due to the lack of advanced laboratory equipment that can sensor magnetism, which poses greater conceptual challenges than electricity.

The modern technology of contactless sensing, data storage and energy conversion processes is dominated by the use of magnetic materials (Sanvito, Oses, Xue, Tiwari, Zic, Archer, Tozman, Venkatesan, Coey, & Curtarolo, 2017). However, the magnetisation process is among the most construed physics concepts (Leliaert, 2016).

Hence comprehending the intrinsic quantum mechanical properties of magnetic behaviour requires computational complexity (Magnus et al., 2016). That is why many learners find it difficult to visualise and bring into their imagination the concept of magnetism and what physically happens when a ferromagnetic material is being magnetised (Leliaert, 2016).

This study seeks to make use of ICT tools as a pedagogical alternative to the teaching of magnetism in grade 10. The next sub-section (2.3.1) provides the literature of the type of technology that has been used over the years to teach magnetism.

2.3.1 USING TECHNOLOGY IN TEACHING MAGNETISM

In a research article based on magnetism, the magneto-optical Kerr effect (MOKE) has also been suggested for use to simulate magnetic domains in a bid to investigate their potential applications in data storage and logic devices (Yoshimura, Kim, Taniguchi, Tono, Ueda, Hiramatsu, Takahiro, Keisuke, Yoshinobu, & Teruo, 2016). While investigating the attractiveness of magnetic materials for use in logic and memory circuits, CS combined with high resolution Kerr microscopy were used effectively to reveal domain formation (Magnus, Desmet, Gielen, & Rianne, 2016). Magnetic measurements in multiferroic magneto-electric materials in terms of magnetisation and hysteresis loop determination have been conducted via advanced experimental techniques which involve using a vibrating sample magnetometer and a hysteresis loop tester (Sanchez, Magana, Sederberg, Richards, Jones, & Tan, 2013). Advanced technologies such as magneto-optical microscopy (MOM), MOKE and the magneto-optical Faraday Effect (MOFE) have also been suggested for use by McCord (2015) in order to comprehend the behaviour of ferromagnetic materials through direct visualisation of their domain structure. Precise magnetic measurements of size, shape and the distribution of magnetic nanoparticles were performed by Balasubramanian et al., (2016) using a superconducting quantum interference device (SQUID). Even though Bramowicz et al (2014) propose that magnetic domain boundaries can easily be exposed practically with metallographic techniques as well as magnetic force microscopy (MFM), the majority of schools cannot afford such advanced equipment. Since MOKE, MOFE, SQUID and MOM are too expensive to use in South African schools, there is a need to seek and opt for cheaper ICT tools. This study shall also adopt and integrate ICT tools that are compatible with the CAPS Physical sciences syllabus without compromising standards. The next sub-section 2.3.2 provides literature of how the African continent particularly sub-saharan Africa, has embraced the use of ICT tools in the education system.

2.3.2 ICT INTEGRATION IN SUB-SAHARAN AFRICA

Countries in sub-Saharan Africa (SSA) place emphasis on the technological development of teachers as the key to implementing policy and curricula using ICT to improve teaching and learning and raise the standards of education (Utterberg, Lundin & Lindström, 2017). Accessibility to quality education associated with ICT enhanced learning environments is currently limited to urban schools, while the majority of rural schools in SSA do not have such a privilege to raise the standards of education and life (Koranteng, 2012). Many SSA rural schools do not have adequate access to ICT infrastructure (Mathevula & Uwizeyimana, 2014.) and those with access to ICT facilities mainly use them for the acquisition of basic ICT skills instead of integrating it as a pedagogical tool (Baydas, 2013). This is because ICT is a modern instructional approach in the teaching profession which enhances learners' comprehension and problem-solving skills in knowledge construction (Chigona, 2014). The implementation of ICT in science education remains highly limited despite teachers' acknowledgement its impact in teaching and learning, (Law & Chow, 2008a). The major obstacle to ICT classroom use faced by many SSA countries is the lack of computer hardware, software and reliable internet connections (Koopman, 2014). In addition, a lack of time in classes and in schedules planning as well as the unavailability of a national policy on the use of computers in SSA schools has been identified as a challenge (Tondeur, Krug, Bill, Smulders, & Zhu, 2015). While there has been emphasis on teaching basic ICT skills for software use and information gathering (Chikasha, Ntuli, Sundarjee, & Chikasha, 2014), research indicates that integrating ICT into teaching and learning is far more effective for learners (Hassler, Major, & Hennessy, 2016). Most teachers in the SSA perceive ICT to be useful since it makes teaching and learning easier (Mereku & Mereku, 2015).

2.3.3 DIGITAL EDUCATION ENHANCEMENT PROGRAMME IN SOUTH AFRICA

Research study initiatives focusing on the digital education enhancement programme (DEEP) carried out for rural disadvantaged schools in South Africa, reports that ICT use enhances teachers' professional knowledge and capabilities by extending subject knowledge (Dzansi & Amedzo, 2014) and also causes the preparation for teaching to be more efficient (Hennessy, Harrison, & Wamakote, 2010).

In South Africa the Department of Basic Education is working hand in hand with the Department of Information and Telecommunication to ensure that ICT infrastructure and connectivity is made available to all rural schools (Madlela, 2015). Exploring new technology in education has always been the desire of the South African government ever since the country attained its independence in 1994 (Draper, 2008). The 2004 white paper on e-education is the only policy document so far to show South Africa's strong commitment to the integration of ICT in the education system (DoE, 2004). Hence there is need to embark on a study to investigate the effectiveness of the interactive use of CS and videos in teaching of magnetism in grade 10. The following sections (2.4.1 to 2.5.3) provide the literature related to the ICT tools which formulated this study and, its potential use in interactively teaching grade 10 topic of magnetism.

2.4.1 COMPUTER SIMULATIONS

Computer simulation can be regarded as behaviour of reproducing a system so as to explore, estimate system performance and gain insights of a system (Alev, 2003). It is also regarded by Sentongo, Kyakulaga & Kibirige (2013) as the imitation of the real world operational processes.

The major role played by ICT as a pedagogical aid in the teaching and learning of physical sciences has been well documented (Beaufils, 2005). Computer modelling software, animation software, simulations software, virtual laboratory software, software for data capturing, processing and interpretation, information systems and computer projection technology are the main forms of ICT relevant in physics education (Osborne & Hennessy, (2003). It should be appreciated that no form of technology holds superiority over another (Muller, 2008). The use of ICT in the form of CSs, e-learning and interactive whiteboard, videos, sound, animations and diagrams enhances interaction among learners and makes learning more attractive (Dawson & Reid, 2006). Computer simulation experiments and data logging and processing software and probeware as well as CS can replace delicate and expensive laboratory equipment (Alev, 2003). The higher standards of practising natural sciences like physics involve using computers as a laboratory tool due the importance of measurements and data processing (Dawson, 2008).

A research study on the effect of CS experiments and a problem-solving approach on learner performance and learners' attitude towards science indicated a greater achievement in CS than in the traditional approach (Zacharia, 2003). It is therefore part of this study to adopt and assess the effectiveness of the interactive use of CS as a pedagogical tool in teaching grade 10 magnetism. The following sub-section provides the literature related to the potential use of CS interactively in teaching and learning of grade 10 magnetism.

2.4.2 USE OF COMPUTER SIMULATIONS IN MAGNETISM

Fu (2013) notes that limited studies have so far examined the barriers associated with the integration of ICT as a pedagogical tool in physics education. Hekkenberg (2012) detects the existence of alternative conceptions held by physics teachers about the behaviour of charged particles in electric and magnetic fields, the causes of magnetic polarity and how magnets are made, thus suggesting the need for different teaching methods to traditional ones. Kotoka (2012) further pointed out that the use of CS as a pedagogical alternative in electromagnetism aids schools with inadequate laboratory facilities and complement those with science labs in order to enhance learner performance in Grade 11 Physics. Dega, Kriek, & Mogese (2013) also suggest that CS can be used when giving instructions to abstract physics concepts like magnetism. According to Puente, Koning, & Mulders (2014), learning magnetism via CS occurs through accurate illustrations of highly visual and dynamic representations. The constructivist features of CS enable learners to create their own knowledge by learning from explorations of applying how magnetism principles operate when building virtual objects and getting dynamic feedback from that system (Du Plessis, 2014). Furthermore, Ramnarain & Moosaa (2017) revealed the potential of CS in confronting and uprooting possible misconceptions in electricity among the learners. Hence there is also need to investigate the potential of CS in confronting misconceptions in magnetism among grade 10 learners.

CS research critics have argued that simulations cannot reproduce experiments perfectly as they assume the absence of material defects especially in ferromagnetic materials, and hence the simulated magnetic domain pattern is not a true representative of reality (Eib, 2015). However, it was still decided to use CS in South African schools because the CS software is easy, motivational, informative, user friendly, freely available online and compatible with the CAPS curriculum (Kaheru, 2014). Therefore these researchers are suggesting that besides complementing laboratory experiments in schools with laboratory equipment or substituting experiments in schools which are without laboratory equipment, CS could also go a long way in eliminating misconceptions held by learners (Kotoka & Kriek, 2014).

The following sub-section provides the literature related to the potential use of PhET simulation software interactively in teaching and learning of grade 10 magnetism.

2.4.3 PHYSICS EDUCATION TECHNOLOGY PROJECT (PhET)

The physics education technology (PhET) simulations are animated, interactive and game-like environments which provide an extensive suite for the teaching and learning physics (Perkins, Adams, Dubson, Finkelstein, Reid, Wieman, & LeMaster, 2006). The PhET is a software package developed as a CS project by the University of Colorado at Boulder, USA, and was aimed at specifically substituting expensive or inaccessible laboratory equipment and enhancing the comprehension of abstract physics, chemistry and biology concepts which would otherwise be difficult or impossible for learners to imagine (Paul, Podolefsky, & Perkins, 2013). The PhET simulations were first developed for small groups in order to increase learners' level of engagement with simulation materials and participation (Adams et al., (2008a). When the problem-solving approach to teaching and learning is used in conjunction with PhET CSs there will be a remarkable improvement in terms of learner performance (Kaheru, 2014). The PhET simulations, which are freely accessible online by all science teachers and science learners, were developed from the results based on physics education research in order to improve the teaching and learning process under the auspices of technology

(Wieman, Perkins, & Adams, (2007). Interactivity in CS through the use of PhET simulation software has been proved by many physics education researchers to greatly improve the performance of learners (Adams, 2010). The PhET simulation software can therefore be integrated for interactive CS when teaching the topic of magnetism in Grade 10 since it is compatible with the CAPS syllabus.

The following sub-section provides the literature related to the potential use of easy java simulations in teaching and learning grade 10 magnetism.

2.4.4 EASY JAVA SIMULATIONS

Easy Java Simulations (EJS) is specifically designed to enhance interactive simulations using the Java computer programming language. It can easily be set up or run on any operating system which supports Java Virtual Machine, for example Microsoft's Windows operating system (Esquembre, 2005). The software required for the installation and running of EJS software is free online and can be downloaded from the Webserver of EJS (Martinez, 2013). Some of the advantages of using EJS include simulating real physical phenomena as models which can easily be shared, thus ensuring easy integration of ICT in teaching and research (Christian & Esquembre, 2007). The other advantage of EJS is that it can easily be modified to include new possibilities so as to adapt to one's preferences (Esquembre, 2005). The EJS simulation package can be used just like the PhET for interactive CS of magnetism in Grade 10 since it is compatible with the CAPS syllabus.

The following section provides the literature related to the potential use videos interactively in teaching and learning grade 10 magnetism.

2.5.1 THE USE OF VIDEOS IN MAGNETISM

Videos DVDs from DSTv learning channel, Youtube, e-learning and other academic platforms can be adopted and possibly be used as pedagogical tools during teaching in order to improve the performance of Grade 10 learners in magnetism.

Shabiralyani, Hasan, Hamad & Iqbal (2015) ascribe the impact that digital video devices have on interactive learning to their dynamic informative approach. Muller et al., (2012) propose the use of YouTube videos despite the lack of reliable supporting research, as audiovisual multimedia technologies have become so popular in 21st-century learning. The impact of videos is being appreciated in education as evidenced by learning video discs being distributed to schools by many government departments the world over (Koranteng, 2102). Even in South Africa the physics DVDs from learning channels have been on distribution especially to most rural schools (DoE, 2015). Research has also demonstrated that technological advances like video projector and network resources have brought notable improvements in physics teaching of electromagnetism as well as making a positive impact on active learning and undergraduate learner performance Del Campo, Amante, & Martínez, 2012). Willmot, Bramhall, & Radley (2012) also reported that digital video learning has the potential to inspire and engage K-12 learners through increased motivation and performance in magnetism if adopted for a transformative learner-centred approach. Digital video technology is also one of the ways of enhancing learning for learners at risk as well as for hard to reach learners (McLinden & McCall, 2016). In yet another recent investigation, Shaikh, Magana, Neri, Castillejos, Noguez, & Benes (2017) recommend the use of videos in the form of visuo-haptic simulations in order to ease conceptual understanding and improve performance of learners in magnetism. Buskulic & Maurin (2014) advocates using videos in examination preparations and discovery learning in electricity and magnetism, while Stickel (2014) also suggests using videos before introducing abstract concepts like magnetism as students have the chance to pause and rewind videos to understand the underlying concepts. In a separate but related study, Wilson (2015) recommends the use of YouTube in physics, citing as its main advantage easy accessibility by nearly all learners through use of their own mobile devices such as smartphones and tablets. Magana, Sanchez, Shaikh, Jones, Tan, & Guayaquil (2017) also recommend that different forms of ICT multimedia tools be adopted in combinations to demonstrate how the magnetisation process occurs in ferromagnetic materials. The next sub-section provides the literature based on the integration of YouTube videos in the classroom.

2.5.2 YOUTUBE IN THE CLASSROOM

According to Thelwall (2012) no research has been done on the overall impact of YouTube videos on learner performance in magnetism. Despite the lack of reliable supporting research, audio-visual multimedia technologies have become very popular in 21st-century learning as evidenced by teaching and learning video discs being distributed to schools by many government departments the world over (Muller et al., 2012). This provides a multimedia platform for teachers as well to integrate YouTube technology into their already existing pedagogical practices to adjust and adapt to the ever-changing world of technological knowledge, thus ensuring that their innovative services will be of relevance in the 21st-century community's classrooms (Wilson, 2015). The navigation of YouTube as an effective educational tool in classrooms can be associated with little or no sophistications through the educator's proper application of the framework (June, Yaacob, & Kheng, 2014). (The TPACK framework is discussed in section 2.7). Any approach to lesson execution can be reformulated using the video approach to enable learners to understand physical concepts (Muller et al., 2012).

The major advantage of YouTube is that mobile learning (m-Learning) can easily be accessible by nearly all learners through use of their own mobile devices like smartphones and tablets (Wilson, 2015). This is highly possible since internet connectivity for all YouTube compatible devices can easily be accessed in schools with a WIFI network while YouTube videos can easily be shared among learners via the share function (June et al., 2014). Schools can monitor and customise the proper use of YouTube for learning purposes by allowing students to sign in to YouTube through a gmail-enabled school account (Wilson, 2015). According to Muller et al., (2012), using mobile devices in the 21st century is increasingly becoming inevitable. Most of South African schools with a WIFI network should consider it as a privilege and make effective use of it in order to improve learners' performance and realise the learning outcome goals. A survey carried out in Germany revealed that only 9% of academics use YouTube in teaching abstract concepts like magnetism in physics (Thelwall, 2012). June et al., (2015) also suggested that videos are more convenient for presenting experimental details to learners without adequate access to laboratory resources.

MST schools with basic ICT infrastructure and internet connectivity can potentially make use of YouTube videos interactively when teaching the topic of magnetism to grade 10 learners. The next sub-section provides more literature related to the use of other videos types as pedagogical tools.

2.5.3 THE USE OF COMPUTER SIMULATIONS AND VIDEOS IN THE SA CONTEXT

The Physical Sciences CAPS curriculum stipulates that all science learners (DoE, 2011, p9-14) should exhibit specific competences such as experimental investigations inside the laboratory as well as the handling and manipulation of laboratory apparatus. However, the lack of access to adequate laboratory equipment and advanced experiments especially in rural areas remains a challenge (NEIMS, 2016). Besides that, Leliaert (2016) reported that in real experiments it is impossible to visualise magnetic domains and their behaviour. Hence a combination of CS and videos could be analogous to real laboratory experiments in MST rural high schools. Studies performed in other countries suggested that CS and videos were reliable ICT pedagogical tools in enhancing learners` performance as well as eradicate misconceptions (Songer, 2007). For this reason, Nancheva (2017) observe that even though the simulation of laboratory exercises allows investigating the magnetisation of different ferromagnetic materials at different temperatures and external magnetic field intensities, the reality is more complex than the virtual one. It is imperative for South Africa as an emerging economy to exploit and integrate ICT usage in physical sciences education to advance acquisition of scientific knowledge (Ramnarain & Moosaa, 2017). For such a reason, the SA DoE has embraced the use of ICT in teaching and learning process (DoE CAPS document, 2012). Even the monitoring instrument used by the DoE officials when visiting schools has a provision of assessing ICT usage during teaching and learning. Hence it has become mandatory for all SA physical sciences teachers to employ ICT tools like CS and videos in their lesson planning, preparation and presentation.

2.6 CONCLUDING REMARKS ON LITERATURE SURVEY

A great deal of research work so far has dealt with teachers’ and learners’ acknowledgement of ICT as a pedagogical tool (Chigona, 2014). The benefits of co-opting for an ICT pathway to redress historical imbalances have also been studied (Koranteng, 2012). South Africa’s position insofar as the implementation of ICT policies in its schools and the associated benefits thereof have also received extensive research with some of the researchers dwelling more in Grade 11 physical sciences education (Madlela, 2015). However, researchers have so far remained silent about the use of CS and videos in teaching the Grade 10 physics of magnetism in schools. This might be due to the fact that more attention is being paid to the performance of Grade 12 learners. Furthermore, a comparison of the traditional approach with the interactive use of CS and videos when teaching the concept of magnetism to Grade 10 learners in Mpumalanga schools has so far been a research gap.

The next section provides the theoretical framework that underpins this study.

2.7 THEORETICAL FRAMEWORK

TPACK is one of the teaching models based in constructivism that can be effectively used in physical sciences education (Graziano et al., 2017) The constructivist learning theory is of the view that students must be confronted with a discrepant event that conflicts with their preconceptions (Bada, 2015). Furthermore, constructivists advocate that learning happens when learners participate in active involvement in the process of knowledge construction (Mirana, 2016). Hence a constructivist teacher can utilise ICT by making learners to actively engage in technological devices while focusing on physical sciences. This may also involve the development of attitudes and values of learners in a constructivist learning environment (Goosen & Van der Merwe, 2015). Therefore a successful constructivist teacher should be aware of how to teach from a knowledge base (Draper, 2010). Shulman (1987) refers to such a knowledge base as pedagogical content knowledge (PCK), a combination of content knowledge (CK) and pedagogical knowledge (PK), while Mishra & Koehler (2009) advise teachers to give higher priority to PCK as it ensures professional understanding and effective learning processes. The recent advances and proliferation of technology have emerged as another field of knowledge base whose skills ought to be taught (Draper, 2010). This will then imply that an effective constructivist teacher's knowledge base should be a combination of content, pedagogy and technology (Mishra & Koehler, 2006). A teacher equipped with technological content knowledge (TCK) as well as PCK will then be capable of effectively designing ICT integrated lessons for 21st-century learning (Koh et al., 2015). Therefore, TPACK is a collective term used by researchers and teachers to refer to a combination of TCK and PCK (Draper, 2010), and is a contemporary knowledge base for ICT integration in teaching and learning (Mishra & Koehler, 2006).

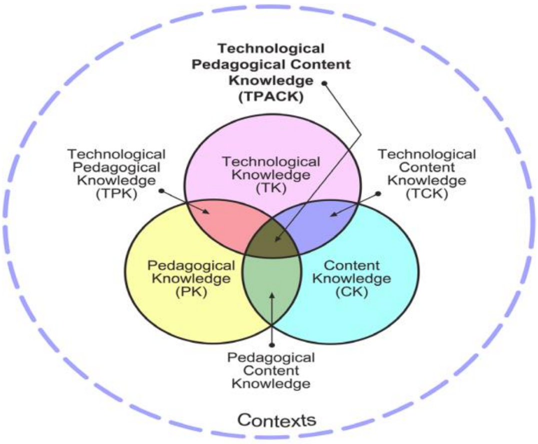


Figure 2.1 The technological pedagogical content knowledge (TPACK) conceptual framework (Adapted from Koehler, 2012).

The central part of Figure 2.1 is the intersection between CK, PK and TK, collectively known as TPACK (Leendertz et al., 2013). Constructivist physics teachers with TPACK select a specific teaching strategy, together with appropriate ICT tools, to teach curriculum content to learners (Draper, 2010). TPACK requires physics teachers to possess an idea of representing physics concepts with technology and the knowledge of how technologies can be of assistance to learners when dealing with alternative conceptions in physics (Mirana, 2016). This model advocates that pedagogies should be integrated with content and technology (Mishra & Koehler, 2006) and therefore could transform physics teaching and learning efficiently and valuably (Maor, 2016). Furthermore, TPACK requires constructivist teachers to know how to make use of technology in constructing new knowledge while making use of learners' pre-existing knowledge (Koehler & Mishra, 2009). However, the main reason why a vast number of educators do not prefer using or integrating TPACK into their traditional pedagogical skills is their mediocre technological content knowledge and inadequate experience and confidence in it (Henschel et al., 2009). Graziano et al., (2017) indicate that it is high time for the global education system to adopt the TPACK model. Hence, higher priority is now being directed towards TPACK skills in order to increase the levels of motivation and performance and also to enhance the impact of integrating ICT in teaching and learning (Leendertz et al., 2013). Mishra and Koehler (2006) state that for successful integration of ICT as a pedagogical enterprise teachers ought to demonstrate competency with TPACK skills.

Teachers are expected to excel beyond traditional ways teaching and develop new innovations needed in knowledge construction of learners (Koh et al., 2015). Furthermore, teachers with suitable TPACK skills can utilise various pedagogical approaches in their teaching practices (Mirana, 2016). The process of educational modernisation demands that physical sciences teachers employ TPACK in their pedagogy in order to improve performance as well as eliminate misconceptions. Hence physical sciences teachers ought to support TPACK-based initiatives in order to ensure digital pedagogical integration in their physical sciences classes (Graziano et al., 2017).

2.8 SUMMARY OF CHAPTER TWO

This chapter outlined the literature associated with the teaching and learning processes, the traditional and constructivist teaching approaches, the spiral curriculum in the South African context, ICT and its integration in teaching and learning physics, magnetism and the use of ICT tools in teaching magnetism, CS and videos. The last section of the chapter focused on the theoretical framework.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 INTRODUCTION

In order to answer the main research question, namely to what extent does the interactive use of CS and videos impact on the teaching and learning of magnetism in Grade 10, four sub-questions were stated:

i) Does the interactive use of CS have an impact on Grade 10 learners' performance in magnetism?

ii) Does the interactive use of videos have an impact on the Grade 10 learners' performance in magnetism?

iii) Does the interactive use of the combination of CS and videos have an impact on the performance of Grade 10 learners in magnetism?

iv) To what extent does the use of CS and videos influence the teaching of magnetism in Grade 10?

Quantitative and qualitative data was captured. The first three sub-questions were analysed quantitatively and the last one qualitatively. This section presents the research design (section 3.2), the population and sampling of research participants (section 3.3 and 3.4), the research instruments (section 3.5), data collection (section 3.8) and analysis methods (section 3.10). Ethical considerations were also considered (section 3.12)

3.2 THE RESEARCH DESIGN

Research design refers to a systematic plan which is used to study a problem of scientific origin (Cohen, Manion, & Morrison, 2011). It is a standardised framework that is structured to provide answers to specific scientific questions (Harding, 2013). The design of a scientific study can assume descriptive, correlational, quasi-experimental, experimental, qualitative, meta-analytic approach (Creswell, 2003). The case study research design used in this study followed the mixed method approach.

3.2.1 QUANTITATIVE APPROACH

For the quantitative approach a non-random, quasi-experimental pre-post-test control group design was used to avoid disruption of the normal teaching-learning programmes at the selected schools. The quasi experimental approach used a pre-test/post-test design which involved studying the same participants before and after the experimental manipulation or intervention (Richardson, 2012). For study purposes, learners remained in their normal classes into which they were randomly assigned at the beginning of the academic year and with the same educator in each of the schools. No alterations and deviations were instituted to each school's teaching timetable, pacesetters, annual teaching plans and number of learners in each class. The only exception was the integration of the interactive use of computer simulations and videos when teaching magnetism to the Grade 10 learners in the different schools.

3.2.2 QUALITATIVE APPROACH

For the qualitative approach an exploratory case study research design was followed. A case study was done because the schools were all part of one region and the Grade 10 learners were the focus. An exploratory research design provides qualitative information needed to identify the main research issues that should be addressed in order to reduce the level of bias in a study (Maxwell, 2012). The research design also involved the qualitative exploratory approach where questionnaires and RTOP observation tools were administered to the teacher participants of sampled schools.

3.2.3 PARADIGMS

Quantitative quasi experimental approach based on the positivist paradigm of measuring variables was used in this study. Positivism is a nomothetic research in which reproducible objective reality of knowledge is obtained statistically from empirical testing (Richardson, 2012). This approach assisted in providing responses to the research sub-questions (i), (ii) and (iii) (see section 1.5.1):

The qualitative exploratory research approach based on the interpretivist paradigm was also used in this study in order to assist in providing responses to research sub-question (iv) (see section 1.5.1). According to Richardson (2012), Interpretivism research approach is an ideographic method which seeks to holistically discover the participants` experience and in which the research has direct interaction with participants during the study (Bryman, 2012) indicated that interpretivism thrives to comprehend the viewpoints of different participants as evidenced by its subjective and detailed data collection methods.

3.3 POPULATION

Welman (2005) defines “population” as a group of people from where research participants are sampled. The target population of this study was approximately 1 500 Grade 10 Physical Sciences learners and about 25 teachers from the 18 different public high schools in the Badplaas/Mashishila Circuits of Mpumalanga Province in South Africa.

All Physical Sciences teachers currently teaching Grade 10 were B.Ed. degree holders and formed part of the target population regardless of their qualifications, age, race, physical disability, gender, permanent or temporary, local or foreign.

3.4 SAMPLING

According to Rodgers (2008) sampling is a statistical method of selecting participants for a research study. Convenience and accessibility have to be taken into consideration when selecting a sample (McMillan & Schumacher, 2010).

The schools were selected because they were easily accessible to the researcher. All learners in the existing Grade 10 Physical sciences classes of the selected schools were participants (Trochim, 2006). Those who participated in the study from each of the sampled schools were the two Physical Sciences classes together with their usual subject teacher in the Badplaas/Mashishila Circuits of Mpumalanga. In the four MST schools the learner participants’ ages ranged from 15 to 18 years while the teachers’ ages ranged from 24 to 59. The total sample size for the research study was approximately 388 Grade 10 Physical Sciences learners and four teachers.

The impact of interactive CS and video learning was investigated using the sampled four MST schools. At each of the sampled schools there was a control group which received no ICT intervention. After the intervention all the Grade 10 learners were exposed to the interactive use of CS and videos to ensure that all learners would benefit. All the Grade 10 learners from sampled schools sat for the pre-post-tests.

The schools were only identified as D, E, F and G. Throughout this research and for purposes of consistency class B at each school was considered the control group while class A was used as the experimental group. The Grade 10 Physical Science teachers at schools D, E, F and G were only identified as W, X, Y and Z. Two classes (experimental and control) in each of the three schools were considered and the fourth school served as the final control. The schools code-named D, E and F played the role of experimental groups. At School D the learners were exposed to computer simulations. The learners at School E were taught using videos. The learners at F were subjected to both CS and videos. School G was subjected only to the usual traditional teaching and demonstrations method. The pre-post-test results from School D, E and F were used to respond to research questions i), ii) and iii). In order to respond to the research questions (i–iii) the variables in Table 3.1 were considered.

Table 3.1 A summary of the variables per school during intervention

SCHOOL	CLASS	CATEGORY	TEACHING ACTIVITIES
D	A	EXPERIMENTAL	Normal teaching + **Computer Simulations** & Demonstrations
	B	CONTROL	Normal Teaching + Demonstrations
E	A	EXPERIMENTAL	Normal teaching + **Videos** and Demonstrations.
	B	CONTROL	Normal Teaching + Demonstrations
F	A	EXPERIMENTAL	Normal Teaching + **Computer Simulations, Videos** & Demonstrations
	B	CONTROL	Normal Teaching + Demonstrations
G	A & B	CONTROL	**Normal Teaching + Demonstrations**

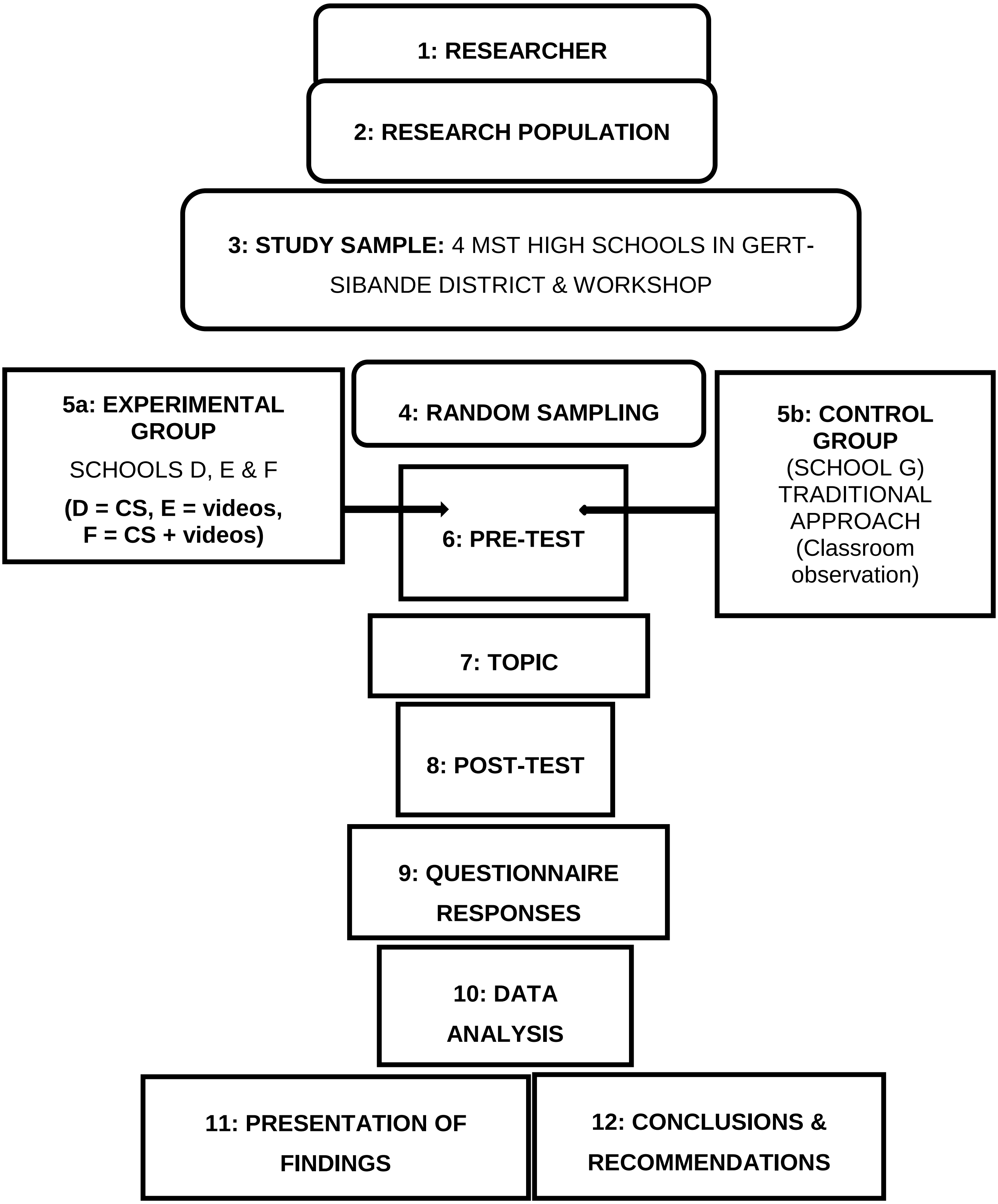


Figure 3.1 An overview of the research approach

3.5 INSTRUMENTATION

Data was gathered by using a combination of data gathering instruments, namely the achievement tests (pre-post-test) for learners (Appendix A), the reformed teaching observation protocol (RTOP) classroom observation schedule (Appendix B) and the structured questionnaire (Appendix C).

3.5.1 Pre-post-test

An effective style of designing pre-post-test questions is one which involves lower order and higher order cognitive levels (Swart, 2010).

The researcher constructed the pre-post-test with the aid of the Grade 10 examination guidelines (DBE Grade 10 examination guidelines, 2015, p12-13), CAPS documents (DoE, 2011, p86) and textbook sources (Kelder, 2014, p123) based on magnetism in line with the South African Grade 10 syllabus (see appendix A). The same pre-test was also used as post-test and was developed for probing the conceptual understanding of magnetism and magnetic domains among learner participants. The pre-post-test questions were constructed in order to ensure learners' mastery of basic cognitive skills and the achievement of learning outcomes (Lister & Leaney, 2003). The test involved all learning outcomes in line with the grade 10 examination guidelines and CAPS document. The aim of giving all the Grade 10 learners in selected schools a pre-test was to ensure that before intervention there would be no statistical differences between the seven classes (two at each of the three experimental schools and one at the control school).

The pre-post-test instrument (Appendix A) consisted of three parts. The first part consisted of 10 multiple-choice questions (MCQ). These were based on knowledge and the comprehension of magnetism. The second section also consisted of 10 multiple-choice questions different from those in first section, but learners were expected to provide reason(s) for their choices. These questions were based on comprehension and the application of magnetism. The third section consisted of open-ended questions where learners were expected to predict, analyse and solve problems based on magnetism. Learners were expected to respond to all questions in all sections within the specified time-frame. All tests were administered at the same time at all the schools.

3.5.2 Reformed Teaching Observation Protocol (RTOP)

During classroom observations the researcher used the reformed teaching observation protocol (RTOP). RTOP consists of quantitative assessment criteria based on constructivism theory, which allows for specific instructional segments and provides teachers with greater strength in planning and instructional growth (Piburn, 2000). The 25-question observation schedule has been developed more specifically for high school and tertiary mathematics and science classes (Sawada, Piburn, Judson, Turley, Falconer, Benford, & Bloom, 2002).

RTOP (Appendix B) was made available to the Grade 10 teachers of selected schools prior to the commencement of the lessons (see section 3.4) so as to assist in making adequate preparation of science lessons in terms of class culture; lesson design and implementation; prior knowledge; and pre-conceptional, propositional and procedural knowledge. It was also emphasised to the teachers involved that the RTOP observation tool was specifically meant to obtain data for research purposes (see Appendix B for RTOP).

3.5.3 Questionnaire

A questionnaire is a predetermined set of questions used to collect data (Pintrich, Smith, Garcia, & McKeachie, 1993). A structured questionnaire was developed to gather qualitative data related to the effectiveness of using CS and videos interactively in teaching and learning magnetism. The questionnaire items consisted of guided-ended and open-ended questions. Guided ended questions are structured questions with guideline principles of responding to questions, (Denzin & Lincoln, 2011). On the other hand an open ended question is one which cannot take a “Yes” or a “No” as answer especially when comparative responses are needed, (Richardson, 2012). An open ended question demands a full answer from the respondents while using his/her own knowledge or feelings, (Gelman, Carlin, Stern, Dunson, Vehtari, & Rubin, 2014).

Prior to the study, the researcher requested and was granted permission via email (Appendix K) to adopt parts of the questionnaire from Kotoka (2012) which he used while pursuing his master’s studies at UNISA.

The questionnaire instrument (Appendix C) was structured into three sections, namely A, B and C. Section A sought details for the personal profile of the teacher participants. Section B consisted of guided questions. Section B questions assumed a 6-point Likert scale (from 0 = Not sure up to 5 = Strongly agree). Spaces were also provided for comments. Section C comprised open-ended questions in which teacher participants would be reflecting on their experiences after the interactive use of CS and videos on magnetism (see Appendix C). The questionnaire as instrument served to provide additional qualitative data to that obtained through the use of the RTOP.

3.6 VALIDITY AND RELIABILITY

Reliability focuses on the consistency of test instruments, while validity deals with how appropriate the test instruments are for the study (Gay, 2003). Validity is the extent to which a test achieves the outcome which it is intended to measure (Christine, 2013).

3.6.1 The validity of pre-post-tests

To achieve validity on the test items, four subject matter experts in physics and education were consulted to verify the validity of the achievement test instruments. They were asked whether the questions would be suitable for the grade as well as their consistence with the examination guidelines and compliance with the CAPS syllabus. This was meant for face and content validity. One expert was a post-doctorate research fellow at the University of Forte Hare's Department of Physics. Expert two was a PhD Physics Education research student at the University of Johannesburg and the principal of a high school in the Mashishila circuit. He has at least 10 years of Physical Sciences teaching experience. Expert three was a PhD student and lecturer in Mathematics and Physics Education at CUT Welkom campus. Expert four was a Physical Sciences teacher and a principal who is currently doing a PhD in Physics Education at UNISA.

3.6.2 The reliability of pre-post-tests

Reliability informs the users of test instruments about the numerical level of consistency in measurements over a time period (Christine, 2013). If results can be consistent after repeated trials a test is deemed reliable.

The Cronbach reliability index is used to describe the reliability associated with the variation in actual scores of the underlying constructs (Santo, 1999). Cronbach's alpha coefficient or reliability index numerically ranges from 0.0 *the minimum possible* to 1.0, which is *the maximum possible*. A score greater than or equal to 0.7 is accepted as reliable. For this study the reliability of the test instruments was statistically executed through the use of Cronbach's reliability index. According to Kothari (2004), any reliability index greater than or equal to 0.7 implies that the test instruments are highly reliable. To judge the reliability of the pre-post-test instrument which was used in this study, the tests were administered to a pilot study group. The marks obtained were then used to calculate Cronbach's alpha coefficient to establish the reliability level.

3.6.3 The validity and reliability of the classroom observation protocol (RTOP)

The validity and reliability of the classroom observation protocol (RTOP) has been established since it was developed over a period of at least two years. RTOP was selected for use to ascertain whether reform has occurred in class during and after intervention (Sawada et al., 2002). However, it needs to be established in the South African context.

3.6.4 The validity of the classroom observation protocol (RTOP)

The researcher requested permission to use the RTOP instrument and permission was granted (Appendix J). RTOP instruments were distributed to experienced and senior educators especially those in managerial positions. All the Natural Sciences departmental heads from the participating schools were involved in assessing the validity of the RTOP in the South African context. The Physical Sciences education advisors as well as the four experts indicated previously (see section 3.6.1) were also consulted in validating the RTOP. The circuit managers of both Badplaas and Mashishila, who themselves are former Physics teachers, were consulted for the evaluation of the validity of the RTOP instrument. All comments and constructive criticisms were noted and RTOP was adopted.

3.6.5 The reliability of the Reformed Teaching Observation Protocol (RTOP)

Previous researchers have reported that the RTOP reliability estimate based on 32 independent observations in physics obtained from best-fit linear regressions to be around 0.954 (Piburn, 2000). In order to check the reliability of the RTOP class observation schedule, the researcher made an arrangement with a North-West University (NWU) research colleague to undertake the RTOP practice observation sessions at the school which was used for the pilot study. During such practice sessions, field notes were taken and compared for consistency and agreement in RTOP observation. The RTOP data collected from practice sessions at the school for pilot studies was analysed quantitatively and best-fit linear regressions were drawn to check reliability.

3.6.6 The validity of the questionnaire

The validity of the questionnaire in this study was done through the face and content validity. Content validity refers to estimating and reviewing logical connections between the test items through gathering a group of subject matter experts (SMEs) together to scrutinise the test items (McDowell et al., 1987). Face validity means the questionnaire instrument appears to be suitable for measuring what it is intended to measure (Pinar, 2004).

The validity of the questionnaire was done through consultation with the same four SMEs as for the pre-post-test. The questionnaire was sent to these research experts in the field for thorough scrutiny and credibility. The researcher also made some necessary adjustments to the questionnaire as recommended.

3.6.7 The reliability of the questionnaire

The reliability of the questionnaire for educator participants was estimated using the internal consistency reliability method. Ten Physical Sciences teachers were selected from high schools in the Badplaas and Mashishila circuits, but the teachers from the four MST schools sampled for the study were not part of this. The selected teachers were requested to complete the questionnaire in order to collect data needed for calculating the internal consistency reliability index. This index of reliability is estimated using the split half method after only one test administration of the questionnaire to the participants was used. This method involves determining the extent to which the statements in the questionnaire instrument measure the same aspect. The split-half method involves dividing up the item responses into two parts, thus the first half of the items (0, 1, 2) and the second half of the items (3, 4, 5) after administering the items to the participants. Coefficient alpha (which represents the average of all split half estimates) was then calculated for each half. The difference between the two was then used to estimate the reliability, in which case the value of ≥ 0.70 rendered the questionnaire reliable.

3.7 INTEGRATION OF SIMULATIONS AND VIDEOS INTERACTIVELY WHEN TEACHING GRADE 10 MAGNETISM

Before the commencement of the study, there was an arrangement between the researcher and teacher participants to meet for a mini workshop. The workshop was for formal introductions and familiarisation. During the workshop the researcher explained the main aim and all the associated procedures of the study. The researcher also ensured that all teacher participants were well familiar with the ICT interventions software and equipment to be used in the study and how they were to be used during the lesson execution on magnetism. The RTOP tool was also discussed and made available to the Grade 10 teachers of the sampled schools during the workshop. This was done prior to the commencement of the lessons. This familiarised the teachers with the RTOP and also assisted them in making adequate preparation of science lessons in terms of class culture, lesson design and implementation, prior knowledge and pre-conceptional, propositional and procedural knowledge.

3.8 DATA COLLECTION

Before commencement of the teaching intervention, a pre-test was administered under strict examination conditions on the same day and at the same time to the four sampled schools. The Grade 10 Physical sciences teachers from the sampled schools assisted in the invigilation and collection of answer scripts from the learners. This was to ensure the validity, fairness and credibility of results. The pre-test scores were quantitatively analysed and compared to determine whether the Grade 10 learners in the different participating schools were at the same level prior to intervention.

A post-test was administered to all the groups at each of the four sampled schools after the teaching intervention using CS and videos. The post-test, just like the pre-test, was administered under strict examination conditions on the same day. This was done immediately after the intervention and, at the same time to the four sampled schools to ensure validity, fairness and credibility of results. The Grade 10 Physical sciences teachers from the sampled schools assisted in the invigilation and collection of answer scripts from the learners. The post-test was used to assess the impact of the interactive use of CS and videos on the performance in magnetism of the experimental groups if compared to the control groups in each of the schools. It was also be used to compare the performance of experimental schools against the control school.

The responses on the pre-test and post-test instruments were all marked by the researcher. The achievement of participants in the post test were quantitatively analysed and compared as outlined in section 3.6. The analysed scores are the ultimate marks of the four groups' performance in the pre-post tests. The researcher made use of Statistical Package for the Social Sciences (SPSS) 24.0 software to quantitatively analyse the data. This assisted determining whether there was any significant difference in the level of performance between the experimental and control groups. The researcher also used the average scores of the pre-post tests from each group to make a comparison of the learners' performance from pre-test to the post-test using Hake's average normalised gain (see section 3.10.3, equation 1).

Table 3.2 A summary of data collection through the administration of pre-post tests

SCHOOL	Intervention	EXPERIMENTAL		CONTROL		INTERPRETATION
		Pre-test	Post-test	Pre-test	Post-test	
D	CS	Compare pre- & post-test		Compare pre- & post-test		
		Determine gain/no gain		Determine gain/no gain		
E	VIDEOS	Compare pre- & post-test		Compare pre- & post-test		
		Determine gain/no gain		Determine gain/no gain		
F	CS plus	Compare pre- & post-test		Compare pre- & post-test		

	VIDEOS	Determine gain/no gain	Determine gain/no gain	
G	Traditional	Compare pre- & post-test	Compare pre- & post-test	
		Determine gain/no gain	Determine gain/no gain	

The post-test scores were also compared between experimental groups and control groups per school. The post-test scores of experimental groups from the three experimental schools were also compared against the control school to quantify if there is a significant difference in the level of performance after different teaching intervention strategies had been used.

Data collection was also done through the structured questionnaire survey and RTOP instruments. The questionnaire instruments were administered to the teacher participants of each sampled school.

The classroom observation schedule RTOP tool was also discussed and made available to the Grade 10 teachers of sampled schools during the workshop before commencing the lessons. The researcher also distributed the program of intervention as well as the observation timetable to the Grade 10 teachers during the workshop. (See table 3.3).

Table 3.3 A summary of lesson observations timetable during intervention

PRE-TEST TO ALL SCHOOLS BEFORE INTERVENTION							
LESSON OBSERVATIONS TIMETABLE DURING INTERVENTION							
DAY	PERIOD						
	1	2	3	LUNCH	4	5	6
	07:30-08:30	08:30-09:30	09:30-10:30	10:30-11:30	11:30-12:30	12:30-13:30	13:30-14:30
1	D_{CONTRL}		F_{CONTRL}	L	E_{CONTRL}	$G\mathbf{A}_{CONTRL}$	$G\mathbf{B}_{CONTRL}$
2		$G\mathbf{A}_{CONTRL}$	$G\mathbf{B}_{CONTRL}$	U	D_{EXPTAL}	E_{CONTRL}	E_{EXPTAL}
3	$G\mathbf{B}_{CONTRL}$	E_{CONTRL}	E_{EXPTAL}	N	D_{CONTRL}	$G\mathbf{A}_{CONTRL}$	F_{EXPTAL}
4	$G\mathbf{A}_{CONTRL}$	F_{CONTRL}	F_{EXPTAL}	C	D_{EXPTAL}		E_{EXPTAL}
5		D_{CONTRL}	D_{EXPTAL}	H	$G\mathbf{B}_{CONTRL}$	F_{CONTRL}	F_{EXPTAL}
6	E_{CONTRL}	E_{EXPTAL}	F_{CONTRL}		F_{EXPTAL}	D_{CONTRL}	D_{EXPTAL}
POST TEST TO ALL SCHOOLS AFTER INTERVENTION							

There were six periods per day per school. Three of the periods were taught before lunch and the other three after lunch. All lessons started at 07:30 and ended at 14:30. There is a full hour of lunch from 10:30 to 11:30.

There were two science classes at each of the sampled schools anonymously identified as D, E, F, and G. One class per school was chosen as the control group (e.g $D_{control}$) while the other class became the experimental (e.g D_{exptal}). The fourth school anonymously identified as G had two classes A & B, which were all used as control groups G**A**$_{control}$ and G**B**$_{control}$ respectively.

The Grade 10 Physical Science classes from the four sampled MST schools had their Physical Sciences lessons at different times of the day. So, it turned out to be highly convenient for the researcher to carry out lesson observations, one after the other as shown in Table 3.3. RTOP lesson observations were conducted by the researcher at all the four MST schools which participated in the study. Although eight observations per school were conducted during the study but only 4 per school are presented in this report. Four separate lesson observations per school based on three experimental groups and School G control group. This means that there were separate lesson observations done for each of the 4 sampled schools. It took about 60 minutes to observe each lesson.

During the teaching interventions when CS and videos were being used interactively, the RTOP classroom observation tool was used to collect data. The researcher was present during intervention lessons but did his best not to interfere with the class activities. The observations were meant to determine the impact of the interactive use of CS and videos during lesson presentations in the selected schools.

They were four Physical Sciences lessons observed per each of the four sampled teachers. This means that there were 4 chances for each of the 25 RTOP statements to be chosen in the 4 lessons. A total of 16 observations were done by the researcher. This means each of the 25 RTOP statements had 16 chances of being chosen for rating during observations. The total number of ratings of each statement out 16 expected chances was then expressed as a percentage (see table 4.3). This gave an overall impression and extend to which the interactive use of CS and videos had had on teaching of Grade 10 magnetism.

The researcher rated all teachers from sampled schools using RTOP observation instrument with 5 point Likert scale. Any rating score of either 0 or 1 implied negative and there did not support teaching and learning. Any rating of 2 fell under neutral and therefore neither favoured nor didn't favour proper teaching and learning. A rating of 3 or 4 was regarded as positive and therefore went a long way into demonstrating better teaching and learning practices. This also gives an overall impression as to whether or not normal teaching/learning did take place during the period of intervention. Furthermore, it also provides an impression as to whether the intervention was worth it or not.

Table 3.4 A summary of lesson observations conducted at four MST schools

SCHOOL	CLASS	CATEGORY	TEACHING ACTIVITIES	Lesson observation
D	A	EXPERIMENTAL	Normal teaching + **computer simulations** & demonstrations	4 x 60 minutes class observation
	B	CONTROL	Normal teaching + demonstrations	4 x 60 minutes class observation
E	A	EXPERIMENTAL	Normal teaching + **videos** and demonstrations	4 x 60 minutes class observation
	B	CONTROL	Normal teaching + demonstrations	4 x 60 minutes class observation
F	A	EXPERIMENTAL	Normal teaching + **computer simulations, videos** & demonstrations	4 x 60 minutes class observation
	B	CONTROL	Normal teaching + demonstrations	4 x 60 minutes class observation
G	A	CONTROL	**Normal teaching + demonstrations**	4 x 60 minutes class observation

The researcher also travelled to all four MST schools to meet with and formally introduce himself to learners prior to the intervention. The researcher met with learners separately in their schools in the presence of their usual teacher to try and emphasise on the importance of the study. The researcher also indicated that all the learners will be exposed to both CS and videos by the end of the study. The learners from both control and experimental classes expressed their excitement and pleasure to be part of the study. Their teachers also requested them to be well behaved and organised during the intervention lessons regardless of whether they were in the control or experimental group.

3.9 LESSON PLANS

A good lesson is characterised by realistic and achievable objectives which promote interaction and active involvement of learners (Anbalagan, 2017).

Before commencing with the study, the RTOP observation schedule was made available to all the teachers of the sampled schools in order to enable them to plan for their lessons in advance. The teachers were then able to design their lesson plans in line with RTOP observation schedule. During the period of intervention the teachers also managed to allow the researcher to have access to their lesson plans (see appendix L). The lesson plans were also part of the data collection process (see section 4.2 to 4.5)

3.10 QUANTITATIVE DATA ANALYSIS

This refers to the computation, management, transformation, and cleaning of the collected statistical data through a full description of the statistical tests used to examine each of the research questions in order to make it more replicable by other researchers (Gelman et al., 2014).

The statistical tools that were used to analyse data from this study included comparing the means and standard deviations, Hake’s equation, t-tests and Chi square tests.

3.10.1 The t-test

A t-test statistical significance shows whether or not there is a most likely real difference between two groups sampled from the same population (Hinkle, Wiersma, & Jurs, 2003). In this study a t-test was also used to test the null hypothesis $\mathbf{H_o1}$, $\mathbf{H_o2}$, and $\mathbf{H_o3}$ so as to evaluate whether there was a real difference in performance between the experimental group and control group per school, as well as between experimental schools and control school. The scores of the pre and post-tests were analysed quantitatively using the independent t-test to determine equivalence of the four groups and to determine whether the performance of the groups were statistically significantly different.

3.10.2 The chi-square test

The chi-square test is useful in research for testing the association between categorised variables with its null hypothesis predicting the non-existence of a relationship between independent population variables (Asparouhov & Muthén, 2006).

The chi-square (χ^2) test was administered to check the similarity in performance of learners exposed to computer assisted pedagogy and those exposed to traditional instructional methods. The following process was done in order to perform the chi-square test:

Determining the achievement levels

The variable achievement level in the post-test was generated as follows:

- Post-test scores were converted to rating codes as outlined in the CAPS document for Physical Sciences (page 155) using the following codes and percentages.

Table 3.5 Rating codes and percentages for reporting in Grades R-12 (adapted from DoE CAPS document, p. 155)

Percentage	Rating codes
80-100	7
70-79	6
60-69	5
50-59	4
40-49	3
30-39	2
0-29	1

- The rating codes were then further converted to the categorical variable achievement level according to the classification in the table below.

Table 3.6 Converting rating codes to categorical variables

Rating code	Achievement level
1-3	Below average
4	Average
5-7	Above average

A cross-tabulation analysis of achievement level versus intervention approach was conducted. Additionally a chi-squared analysis was carried out to assess the relationship between achievement level and intervention approach.

3.10.3 Hake's average normalised gain

Hake's normalised gain is a rough measure of the effectiveness of an interactive teaching method in enhancing conceptual understanding (McKagan et al., 2017). It is mathematically defined as

$$\langle g \rangle = \frac{\langle post \rangle - \langle pre \rangle}{100 - \langle pre \rangle} \quad (1)$$

where $\langle pre \rangle$ = average of pre-test scores

$\langle post \rangle$ = average of post test scores

$\langle g \rangle$ = average normalised gain.

In order to predict how much learners had gained if compared to what they were expected to gain the researcher made use of equation (1). This method of the average normalised gain was used to measure the effectiveness of interactive CS, videos and a combination of the interactive use of CS and videos since it strongly differentiated between teaching methods and is therefore suitable for consistent analysis of learner performance.

3.11 QUALITATIVE DATA ANALYSIS

An exploratory approach is used to guide the entire research goals towards the intended direction through its provision of open-ended questions to sampled participants (Creswell & Clark, 2007). The RTOP and questionnaire instruments were used to extract qualitative data in order to achieve aim 1.5.2 (see section 1.5) as well as addressing research question iv (see section 1.5.1) of this study.

The RTOP was qualitatively analysed using data extracted from lesson plans and field notes taken during lesson presentation. The qualitative description of RTOP provided evidence of the impact of the intervention approach used during the period of study.

The questionnaire was analysed qualitatively, based on the responses obtained from the teachers who participated.

- Section A: The responses assisted in getting the information related to teacher profile. This information was vital as it assisted in checking whether the experimental groups and control group would receive nearly the same treatment during the period of intervention. The data from this section also assisted the researcher to check the level of teacher competence in teaching Grade 10 Physics.
- Section B: The responses from this section were analysed qualitatively to check how often teachers embraced and made use of ICT methods during the teaching and learning of physics in general.
- Section C: The answers of the teachers were categorised into three categories, namely positive, negative and neutral. This provided a clear picture and created an overall impression of whether or not teachers were in support of the usage of ICT in the classroom.

3.12 INTERVENTION

Time management and planning during the pre-selection of appropriate interactive simulations and videos are of paramount importance before integrating such ICT tools in the classroom (Kriek & Coetzee, 2016).

The ICT tools that were used during the intervention period, namely computer simulations and YouTube videos, were preselected by the researcher. The computer simulations of magnetism were all freely downloaded from PhET interactive simulations' website, www.PhET.colorado.edu. It took more than four hours to preselect and download simulations that were appropriate to Grade 10 learners.

The YouTube videos were preselected from various YouTube websites. There were many videos related to magnetism. The pre-selection process took close to six hours since it also involved checking the video relevance to the Grade 10 and the CAPS syllabus.

3.13 PILOT STUDY

The school selected for the pilot study is situated within the Badplaas circuit and had two Grade 10 classes. The school is located about 30 km away from Elukwatini rural township, where other schools earmarked for the actual study are located. At the pilot school, Class A was used as the control group while B class was the experimental group. A pretest was given to the two classes a week before the pilot study.

During the pilot study a mock pilot of how to interactively use CS software like PhET and EJS as well as YouTube and video learning in magnetism was demonstrated first to the current Grade 10 teacher, who has a B.Ed. plus four years of teaching experience. This was followed by classroom observations using the RTOP instrument, where the educator now had to teach magnetism to the experimental group using CS and videos interactively. Thereafter he taught the same topic to the control group using a non-ICT-aided approach. A post-test was then given to both classes, after which the researcher marked and analysed them and made the necessary adjustments to ensure reliability, fairness and the credibility of the instruments. Feedback from both the learners and the educator of the pilot school was considered. After the construction of the research instruments, their language appropriateness was tested using learners from the pilot study school and the following necessary adjustments were done:

- The original pre-post tests consisted of 20 multiple choice questions and 10 structured questions. This was adjusted such that from question 1.11 up to 1.20 learners were required to responses with a reason (see appendix A).
- Furthermore, 6 out of the 10 structured questions were deleted after having been noted to be part of the grade 11 CAPS syllabus and not grade 10 (see appendix A).

- The original questionnaire had 20 statements in section C. These were reduced to 14 in the final draft since the other 6 questions were viewed as mere repetition (see appendix C).

3.14 ETHICAL CONSIDERATIONS

According to David & Resnik (2015) ethical considerations refer to morals, norms and standards of conduct to be considered when deciding on how to act in analysing complex problems and issues. Such considerations help researchers to coordinate their actions and activities in a manner which ultimately establishes public trust, support, accountability, fairness and mutual respect (David et al., 2015). Ethical considerations also demanded that the researcher assured all the participants that their names as well as all the data obtained during and after the study would remain strictly confidential.

3.14.1 Official permission

In order to proceed with the proposed research, the researcher applied for ethical clearance from the Ethics Review Committee of the University of South Africa (UNISA) (see Appendix M). This step ensures that the research done by any UNISA student complies with the protection of subjects' rights as well as allowing due processes to be followed. The researcher also applied for official permission from the Mpumalanga Department of Education and Circuit managers of Badplaas and Mashishila (see Appendix D and E). The researcher received a letter of approval from the Mpumalanga Education Department (see Appendix N).

3.14.2 School-based permission

Before participants in the research gave their consent, the researcher met with them and clarified everything about what would be expected from them in the study. During the meeting, the researcher emphasised that participation in the study was voluntary and that the confidentiality of information during and after the research was guaranteed, as outlined in their ethics letters. The researcher then issued consent letters to the principals (see Appendix F), Physical Sciences teachers (see Appendix G), parents through their SGBs (see Appendix H) and learners via the LRC representatives of the schools that chosen to participate in the pilot and actual study (see Appendix I). The researcher was guided by the RSA Constitution (chapter 2 sub(32)(1)(b) and chapter 2 sub(16)(1)(b)(d)), which stipulates the rights of access to information and scientific research. The researcher complied with this and ensured that no violation of the Acts from the Education Labour Relations Council (ELRC) occurred throughout his study.

SUMMARY

This chapter focused on the research methodology, which involved population and sampling, research design, instrumentation, collection and analysis of data, ethical considerations, validity and reliability of research instruments. The conducting of the pilot study was also dealt with in this chapter.

CHAPTER 4
QUALITATIVE ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

Richardson (2012) pointed out that qualitative research refers to any type of research that generates findings which cannot be arrived at by statistical means. Then Denzin & Lincoln (2002) suggested qualitative research focuses on analysing subjective meaning of issues through collection of non-standardised data as well as image and texts analysis rather than numbers and statistics. Bryman (2012) proposed the multi-method nature of qualitative research since it involves an interpretive and naturalistic approach. In other words, qualitative research is associated with multiple aspects that consider a broader range of epistemological viewpoints as well as techniques of interpreting and understanding human experiences.

In order to answer the fourth sub-question, namely to what extent does the use of computer simulations and videos influence the teaching of magnetism in Grade 10, two instruments (RTOP and questionnaires) were analysed qualitatively using the exploratory approach (see section 3.11).

The study compared modern ICT teaching methods and the traditional method of teaching. The ICT methods were divided into three categories, namely the interactive use of CS, the interactive use of YouTube videos and the interactive use of a combination of CS and YouTube videos in the teaching and learning of magnetism in Grade 10. An exploratory case study research design was followed using four high schools in Mpumalanga (see section 3.11). The first experimental group was taught by using CS (referred to as School D,and taught by teacher W); the second experimental group was taught by using videos (referred to as School E, and taught by teacher X), and the third experimental group was taught by using a combination of CS and videos (referred to as School F, and taught by teacher Y). The fourth MST school was used as a control group using the traditional method (referred to as School G and taught by teacher Z). The assignment of groups into experimental and control was random.

The classroom observation schedule RTOP tool was discussed and made available to the Grade 10 educators of sampled schools during the workshop held prior to the commencement of the lessons. Classroom observations were done through the use of RTOP as the monitoring instrument to ascertain whether the Grade 10 teachers from the selected schools were adhering to their annual teaching plan in line with the agreement between the four teachers and the researcher. The RTOP instrument also helped in the provision of the differences in intervention methods adopted by the four teachers during their lessons.

Preliminary presentation of lesson observations. A day before the research began, the four teacher participants were observed by the researcher while teaching. This was done to verify if all four teachers were following the common annual teaching plan (ATP) which was distributed to schools as a directive from the head office of the Mpumalanga Education Department at the beginning of the 2018 school year. They were all due to start teaching magnetism when the researcher carried out the preliminary lesson observations.

What follows here are classroom observation notes and associated lesson plans of teachers, and an analysis of the RTOPs.

4.2 SCHOOL D: USING COMPUTER SIMULATIONS INTERACTIVELY IN TEACHING AND LEARNING MAGNETISM

According to Pestanaa, Duarteb & Coutinho (2016) the context of any schooling environment has a major role to play when engaging learners during the learning process. This is supported by Anbalagan (2017), who suggests that teachers provide a healthy academic environment within the schooling system since learners spend the greater part of the day with them.

4.2.1 CONTEXT OF SCHOOL D

School D is a large MST school located in Nhlazatshe 4 near the Elukwatini rural township in Mpumalanga Province (see section 1.2.1 about MST schools). The school enrolled more than 1 100 learners from Grade 8 to 12 in 2018. There are two Grade 10 Physical Sciences classes: 55 learners in the A class and 50 in the B class. Both classes are taught by Mr W. School D is a no-fee-paying public school with an active learner feeding programme. Each learner has access to free textbooks and stationery provided by the state. All classrooms are electrified and there is enough furniture for each learner, which includes a single sitter desk and a chair. There is a culture of discipline in the school with learners paying full respect to their teachers. School D teachers have good ‘time on task’ and class management skills. Teachers mostly make use of the chalkboard during their lessons. The percentage pass rate of the school in 2017 was 70.05% with an average of 69% in Physical Sciences.

At School D, just like at the three other MST schools in the area, some of the computer laptops are being utilised in the administration offices while most of the old desktops are housed in the computer lab. The school does not have any ICT tools in its classrooms. However, for the purposes of this study all lessons presented at this school by Mr W were conducted in the computer laboratory. The HOD for natural sciences granted permission to make use of the data projector and screen in the computer laboratory during the Physics lesson presentations on magnetism. This was done because the science laboratory had inadequate ICT devices, a situation which was common in all the other classrooms in the school. Furthermore, using the computer laboratory for teaching and learning posed security threats and the risk of theft, hence the need for permission to be granted in advance.

In order to actually integrate computers in the Physical sciences lessons during this intervention period of lesson presentations and observations, the teacher’s laptop had been loaded with PhET and Easy Java Simulations (EJS) software. The desktops could not be used for CS lesson presentations as they were alleged to be infested with computer viruses. The educator therefore opted to use his personal laptop in conjunction with the data projector and white smart board to present the lessons in the computer laboratory. The loading and testing of PhET simulation software and EJS packages was done by the researcher with the assistance of Mr W prior to lesson presentations (see section 3.12). The PhET and EJS programs were meant for use during a presentation on the interactive use of CS in Grade 10 magnetism since they are compatible with the CAPS syllabus.

The following is a report of the four lessons Mr W taught on magnetism in Grade 10, using CS.

4.2.2 Mr W's interactive CS lessons with the experimental group

Mr W taught the topic in four lessons, each 60 minutes in length. There was a unanimous agreement between the teacher and his learners to extend the last lesson by about 10 minutes, since it coincided with the last period. This was to ensure full completion of the magnetism section. The decision did not cause any challenges as learners were willing to remain behind for 10 minutes after school. Outlined below are the details of lesson observations extracted from the researcher's field notes and Mr W's lesson plans.

4.2.2.1 Mr W's lesson 1

Mr W's lesson objectives were stated as follows (see Appendix L1a):

After the lesson, the learners will be able to:

- Provide iron (Fe); nickel (Ni) and cobalt (Co) as examples of ferromagnetic materials
- Classify materials as ferromagnetic and non-ferromagnetic
- Define and simulate magnetic fields
- Differentiate magnetic field from electric and gravitational fields
- Simulate the magnetic behaviour of ferromagnetic materials

Mr W began his lesson with a quick review of magnetism as taught in Grade 9. He began by asking guiding questions such as: "Have you ever seen a magnet before? Explain how a magnet operates. Where do we usually encounter magnets?" The learners were then allocated randomly to small groups. Each group was given materials such as nails, money clips, aluminium foil, silver coins and a permanent bar magnet. Each group had to classify the materials according to whether they are attracted or not attracted by a magnet (see Appendix L1a). Learners were able to do that.

The teacher then explained to the learners that ferromagnetic materials are those that can be attracted to a bar magnet. Those that cannot be attracted to a bar magnet are called non-ferromagnetic. The teacher then presented a sequence of CS to enable learners to realise that the magnetic field strength deteriorates inversely with distance.

Figure 4.1 Screenshot from PhET simulations with field meter showing magnetic field strength close to a magnet

The learners observed that when a field meter is dragged closer to the magnet the magnetic field strength increased. The simulation was repeated at various distances between the field meter and the magnet, after which the teacher asked the learners to draw their own conclusion.

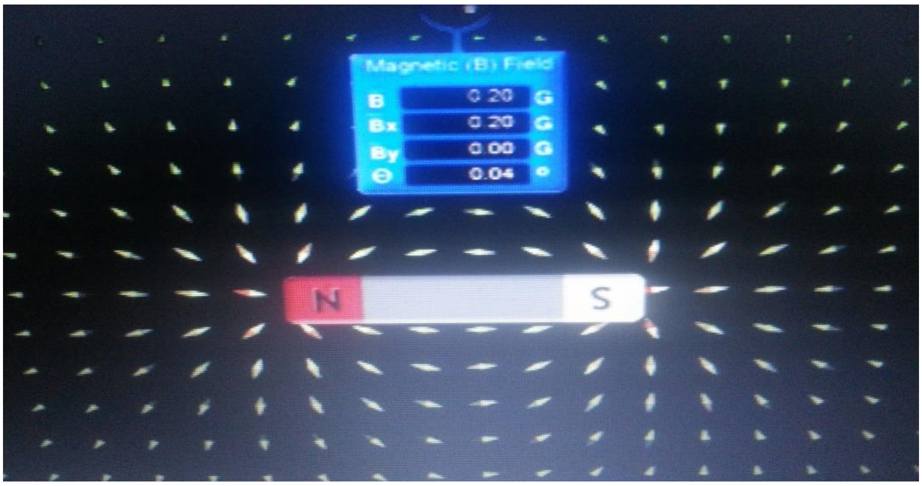


Figure 4.2 Screenshot from PhET simulations with a field meter showing the strength of the magnetic field away from a magnet

Many learners concluded that when the space separating the field meter and the bar magnet was very small the force and field strength would be very high. Others said that the greater the space separating the field meter and the magnet, the weaker the magnetic strength. After presenting the CS the teacher asked the learners to suggest a suitable definition of “magnetic field”. Learners were given a brief moment to discuss in pairs. This was followed by a class discussion based on what the learners thought was the most probable definition of magnetic field. Their answers were quite interesting. Some learners said, “It’s the point when the ferromagnetic field starts to experience the presence of a bar magnet.” Others said, “It’s the zone around a magnet where a magnetic force is felt.” Some also suggested, “It’s a region around a magnet whereby ferromagnetic substances can feel the attraction from the magnet.” The teacher and his learners later on defined magnetic field as a “zone around a bar magnet where a ferromagnetic material experiences a push/pull force”. The teacher consolidated the explanations about the definition of a magnetic field while using another simulation presentation.

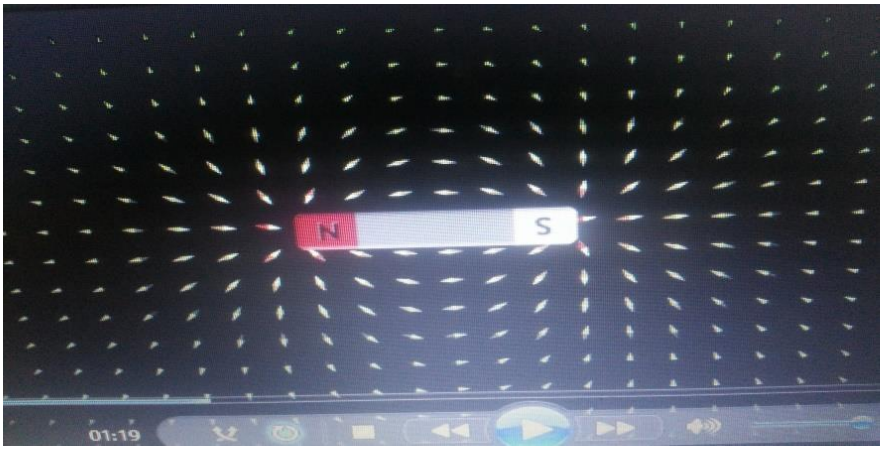


Figure 4.3 Screenshot from PhET simulations showing the magnetic field around a magnet

The teacher summed up the lesson by asking recall questions about all activities of the lesson. He also guided learners into realising that electrostatic and gravitational fields could also be compared with a magnetic field. Homework based on the comparison of a magnetic field with an electrostatic and gravitational field was given at the end.

Table 4.1 Rating of Mr W's lesson 1 using the RTOP monitoring instrument (see Appendix B for RTOP)

Statement	RTOP SECTION CATEGORY																								
	C					D					E					F					G				
	Rating					Rating					Rating					Rating					Rating				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1					✓					✓					✓				✓						✓
2				✓						✓				✓						✓				✓	
3				✓						✓				✓					✓					✓	
4					✓				✓					✓					✓					✓	
5					✓				✓					✓						✓				✓	

Comment: The role of a teacher during the lesson is to promote a better learning environment (Anbalagan, 2017). The teacher was active in ensuring that all the learners understood the concept of a magnetic field through paraphrasing some of their statements. There were high levels of learner involvement and active participation during the lesson. Learners were quite active during the lesson, and observed, discussed, predicted and explained the scientific concepts of a magnetic field through the guidance of the teacher and the CS.

4.2.2.2 Mr W's lesson 2

Mr W's lesson objectives were stated as follows (see Appendix L1b).

After the lesson the learners will be able to:

- State the laws of magnetism
- Identify the poles of a magnet and those of a gyromagnetic compass
- Outline the properties of magnetic field lines
- Draw magnetic field lines around a permanent bar magnet
- Demonstrate the repulsion and attraction between poles
- Demonstrate the existence of a magnetic field around a coil carrying current
- Identify an electromagnet as a temporary magnet

During the second lesson, Mr W started by reviewing his previous lesson on magnets through a question-and-answer approach. He also asked questions related to their findings from the homework on electrostatic and gravitational fields when compared to a magnetic field. The responses were overwhelming. Some learners said that in a gravitational field there was only attraction, but in a magnetic field there was either attraction or repulsion. Other learners said that a magnetic field involved only the attraction and repulsion of ferromagnetic materials whereas electrostatics involved attraction and repulsion of stationary charged bodies.

The teacher then provided each group with a pair of magnets so that they could interact with them and experience attraction and repulsion. He then simulated how magnets attract each other. During the simulation one end of a magnet was brought closer to the end of another magnet. The learners were to observe and record their observations.

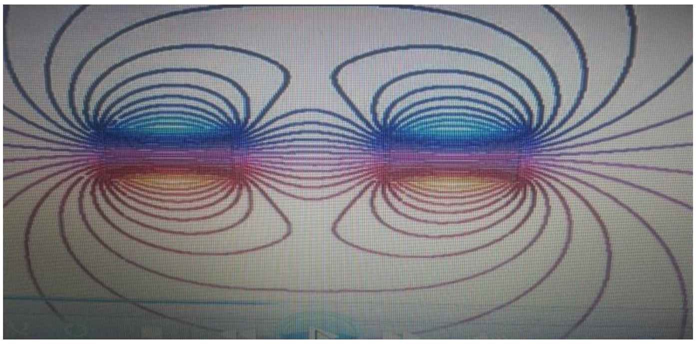


Figure 4.4 Screenshot from PhET simulations showing magnetic field lines existing between unlike poles

The simulations were then repeated while switching the polarity of one magnet and bringing its end closer to the end of the other magnet. The learners also recorded their observations. This simulation activity was meant to guide learners into concluding that like poles repel and unlike poles attract.

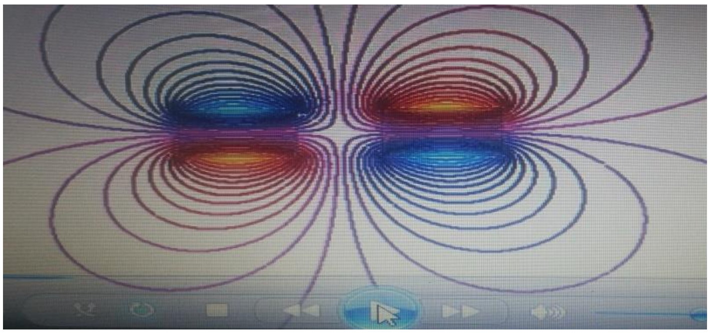


Figure 4.5 Screenshot from PhET simulations showing magnetic field lines existing between like poles

There was a general class discussion regarding the properties of field lines as observed from the simulations. Learners were then tasked to draw magnetic field lines depicting attraction and repulsion. There was also a heated argument about the origin of the magnetic field lines. Some learners suggested that the field lines were originating from the North Pole advancing towards the South Pole. Others said that the field lines were originating from the South Pole and terminating at the North Pole. Other learners ended up trying their luck by asking for the researcher’s opinion, but the only response they got was a smile. This prompted the teacher to provide another simulation in order to provide a probable answer. The simulation demonstrated what the field lines appear like from within the magnet.

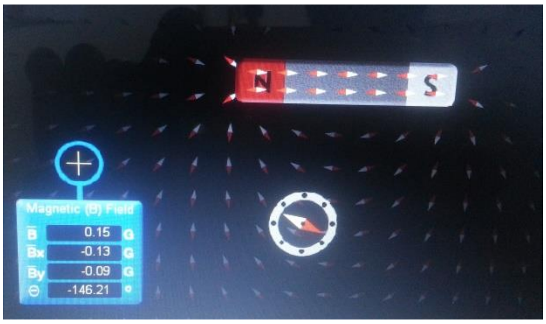


Figure 4.6 Screenshot from PhET simulations showing a magnetic field strength at various points from a magnet

The teacher also assured the learners who were still not convinced to wait till the end of the next lesson. The teacher introduced the concept of electromagnets. He explained to learners that a coil of wire can become magnetised if current is allowed to flow through it. The next simulation involved demonstrating a coil carrying current and the existence of a magnetic field around it. This simulation made it easier for the teacher to clarify the concept of electromagnets to the learners.

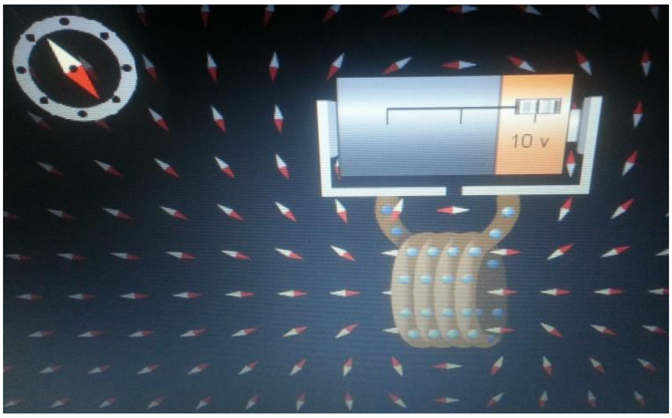


Figure 4.7 Screenshot from PhET simulations showing a magnetic field around a coil carrying current

The lesson was concluded with a general class discussion in which the teacher asked questions in order to check what learners had learned. Homework was then given in which learners had to find out more about electromagnets and their applications in everyday life.

Table 4.2 Rating of Mr W's lesson 2 using the RTOP monitoring instrument (see also Appendix B for RTOP)

Statement	RTOP SECTION CATEGORY																								
	C					D					E					F					G				
	Rating					Rating					Rating					Rating					Rating				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1					✓					✓					✓					✓					✓
2				✓						✓				✓						✓				✓	
3				✓						✓					✓					✓					✓
4				✓						✓				✓					✓					✓	
5					✓				✓					✓						✓			✓		

Comment: Learners were very excited throughout the lesson as was evidenced by their level of active involvement and participation in their groups and class discussions while reviewing what they had observed.

4.2.2.3 Mr W’s lesson 3

Mr W’s lesson objectives were stated as follows (see Appendix L1c).

After the lesson the learners will be able to:

- Define a magnetic domain
- Explain the domain theory as it pertains to the origin of magnets
- Demonstrate how a ferromagnetic material is magnetised through the application of the domain theory
- Use the domain theory to explain why some materials are attracted to a magnet while others are not
- Explain using the domain theory why magnetic monopoles cannot exist
- Use the domain theory to explain why thermal agitation and hammering/dropping a permanent magnet can cause it to lose its magnetic properties
- Use the domain theory to explain the existence of an intimate relationship between electricity and magnetism
- Identify everyday applications and uses of magnets

Mr W started by reviewing the previous lesson on magnetic field lines and examples of electromagnets through a question-and-answer approach. The learners participated by responding to the questions. He then began to ask probing questions about the origin of magnets and magnetism. Very interesting answers were suggested by the learners. Some suggested that there was “an inside force” that caused the “existence of a magnet” while others considered it as “pure magic”. The teacher asked questions like: “What makes up elements? What makes up atoms? Why then is it that some elements make up magnets while others do not?” Interesting answers were provided. Some learners said that “whether an element becomes a magnet or not has to do with the number of protons and electrons”. Others suggested that it had to do with “only electrons”. Others said it had to do with how electrons are arranged in the valence shell. Others thought of it as the arrangement and electron movement in ferromagnetic metals.

This gave the teacher the opportunity to introduce and explain the domain theory. The teacher explained that atoms of ferromagnetic materials can be regarded as very tiny magnets, each with its own North Pole and South Pole. He explained that the tiny atomic magnets are also called dipoles. He told the learners that dipoles are capable of interacting with their neighbouring dipoles. He said that the interaction may result in a group of them lining up with their magnetic poles in the same direction, forming a magnetic domain. The teacher then provided learners with a CS to enable them to understand better.

Learners were presented with a PhET simulation that would most probably resemble domains that are randomly aligned.

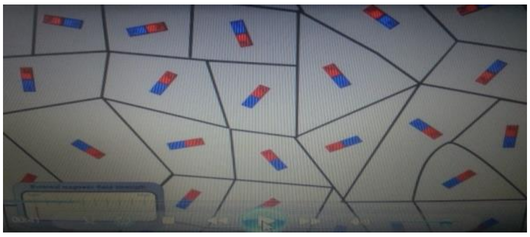


Figure 4.8 Screenshot from PhET simulations showing randomly aligned domains

Learners were then tasked in their groups to use the domain theory to explain on a piece of paper: How ferromagnetic materials are magnetised by applying an external magnetic field. This was followed by another PhET simulation which was assistive in providing a scientific explanation of what happens when a material is being magnetised.

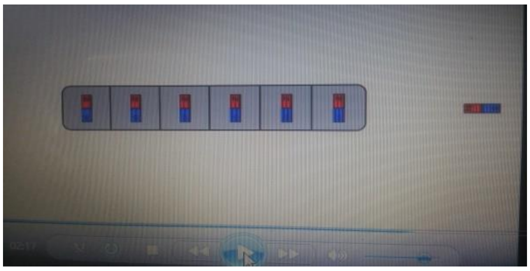


Figure 4.9 Screenshot from PhET simulations showing an external magnetic field being applied to a ferromagnetic material

When a strong magnetic field is applied to a magnetic material, the magnetic domains will align themselves resulting in a strong magnet. Under such circumstances the material is considered a magnet.

Figure 4.10 Screenshot from PhET simulations showing a magnetised material with aligned domains

The teacher then initiated a class discussion in which learners were to suggest why a permanent magnet can lose its magnetic properties after being dropped or hammered several times or heated strongly. The learner responses were quite interesting and thought provoking. During the discussion one learner asked whether it was possible to completely separate the North Pole from the South Pole. The teacher threw back the question to the entire class. Heated arguments ensued, but learners ended up realising that magnetic monopoles cannot exist after applying the domain theory.

The teacher concluded the lesson by directing learners to realise that magnetism, just like electricity, is directly associated with charge movements. The learners were then given homework based on magnetic saturation and also the everyday uses and applications of magnets.

Table 4.3 Rating of Mr W's lesson 3 using the RTOP monitoring instrument (see also Appendix B for RTOP)

Statement	**RTOP SECTION CATEGORY**																								
	C					D					E					F					G				
	Rating					Rating					Rating					Rating					Rating				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1					✓					✓				✓					✓						✓
2					✓					✓					✓					✓				✓	
3				✓						✓					✓					✓					✓

4				✓					✓						✓				✓					✓	
5					✓			✓						✓						✓				✓	

Comment: Learners were quite actively involved and participated in their groups as they discussed the physics of magnetic domains and their application while being guided by the PhET CS observations.

4.2.2.4 Mr W's Lesson 4

Mr W's lesson objectives were stated as follows (see Appendix L1d).

After the lesson the learners will be able to:

- Demonstrate how a compass indicates the direction of a magnetic field
- Use CS methods to demonstrate how a magnet is employed in navigation
- Give examples of phenomena that are affected by the earth's magnetic field, e.g. aurora borealis (northern lights), magnetic storms
- Discuss qualitatively through CS presentations how the earth's magnetic field provides protection from solar winds

In his fourth lesson Mr W started by asking questions based on the homework on magnetic saturation and the application of magnetism in our daily lives. There was a high level of responses while learners gave their findings based on the homework. The teacher then explained to learners the fact that our planet Earth is potentially a very large natural magnet. He also indicated through CS that iron is one of the most abundant metals in the earth's crust. During his CS presentation he also highlighted the importance of directions in navigation and how magnets are used in sensing directions. The CS presentation also assisted learners to see how magnets can be used in predicting the earth's North Pole.

Figure 4.11 Screenshot from PhET simulations showing the earth's magnetic field

The teacher also clarified the fact that the earth's geographical North pole does not coincide 100% with a permanent magnet's North Pole. They differ by a very small angle of around 24 degrees. This phenomenon is called magnetic declination.

The teacher then led a general class discussion on how magnets including gyromagnetic compasses are used in navigation systems. He also indicated that there are some natural phenomena like aurora borealis, magnetic storms and solar winds that are greatly affected by the earth's magnetic field.

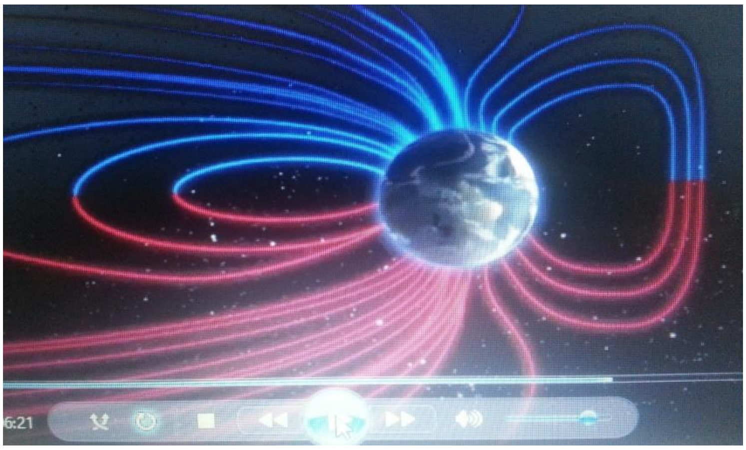


Figure 4.12 Screenshot from PhET simulations showing how the solar wind is deflected by the earth's magnetic field

The screenshot in Figure 4.12 was used to allow learners to observe the active and defensive role played by the earth's magnetic field against the solar wind. The teacher concluded the lesson by giving learners homework based on the earth's magnetic reversal and how it will affect the future of the planet.

Table 4.4 Rating of Mr W's lesson 4 using the RTOP monitoring instrument (see also Appendix B for RTOP)

Statement	RTOP SECTION CATEGORY																								
	C					D					E					F					G				
	Rating					Rating					Rating					Rating					Rating				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1					✓					✓					✓				✓					✓	
2				✓					✓					✓						✓				✓	
3				✓						✓				✓					✓						✓
4				✓					✓						✓				✓					✓	
5				✓					✓					✓					✓				✓		

Comment: There were high levels of learner-centred activities dominated by observations, discussions and predictions. The teacher used CS to guide the learners and they were able to explain concepts such as solar winds, aurora borealis, magnetic declination and navigation.

4.2.2.5 A summary of Mr W's lessons

Table 4.5 General comments on Mr W's lesson observations using RTOP

RTOP Section	LESSON			
	1	2	3	4
C	Lesson design and presentation were tailored to engage learners as members of the community.	Lesson preparation and design were meant to actively engage all learners.	Lesson preparation catered for learners and enabled them to observe, predict and apply the scientific concept of magnetic domain.	Lesson preparation catered for learners of various abilities. The questions asked by the learners during teacher-guided class discussions determined the direction of the lesson.
D	The lesson involved the fundamental concepts of the subject. Some elements of abstraction (i.e., symbolic representations of	The lesson involved the fundamental concepts of the field lines and the magnetic effect of coil-carrying current.	The lesson promoted strong coherent conceptual understanding and had connections with electricity.	The teacher had a sound content knowledge of the subject. Connections with other content disciplines like electricity were explored and valued.

	magnetic field) were encouraged where it was important to do so.			
E	Learners were quite active and reflective of their learning as they observed, predicted and hypothesised.	learners were actively engaged in a thought-provoking activity that often involved the critical assessment of procedures as they observed and made predictions.	Learners were also quite active and alert throughout as their attention was captured by the CS presentation.	Learners were active during the lesson. Intellectual rigour, constructive criticism and the challenging of ideas were valued.
F	Most of the communication occurred between learners as they discussed ideas associated with their CS observations. Most of the questions came from and were answered by learners.	Learners were involved in the communication of their scientific ideas with others. The level of excitement was very high as observed from the high levels of participation.	Learners were predominantly active in this lesson as they made predictions, estimations and/or hypotheses and devised means for testing them.	This was a learner-dominated lesson as they observed predicted and asked clarity-seeking questions. There was more of learner-to learner interaction. Teacher only acted as a facilitator.
G	Teacher's CS presentation influenced learners to actively participate in the lesson. Teacher acted mainly as a facilitator and initiated class discussions. This was a learner-centred lesson.	The teacher used CS and encouraged learners to observe and generate conjectures, alternative solution strategies and ways of interpreting evidence. Lesson was learner-centred.	Active participation of learners was encouraged and valued. The teacher used CS to encourage learners to observe and generate conjectures, alternative solution strategies and ways of interpreting evidence. This was a learner-centred lesson.	The teacher acted as a facilitator, working to support and enhance learners' investigations. Even though the teacher provided most of the explanations the learners were attentive and inquisitive during the lesson. Learners influenced the pace and direction of the lesson.

According to Kaheru (2014), a good CS lesson should aim at motivating learners and enable them to be eager to learn new ideas. Kotoka (2012) stresses that teachers should ensure that learners are concentrating on that which should be learned. Even though the teacher had problems with his laptop associated with acclimatising with PhET software in the first lesson, the interactive use of CS was successful in the end.

Mr W's CS lessons on magnetism grabbed the learners' attention. The levels of participation were very high throughout the period of intervention. Learners showed that that they really appreciated the teacher's approach of using simulation technology in order to enable them to learn. There were no signs of divided attention since all learners fully concentrated on what the teacher gave them during the lessons. The interactive use of CS in teaching magnetism was quite effective since the teacher can pause or even replay the simulation in order to enhance conceptualisation (Du Plessis, 2014). In the CS lessons handled by Mr W during the intervention learners were able to exhibit signs of appreciation as was evidenced by their level of participation and questions related to the topic of magnetism and the domain theory. The simulation strategy boosted the learners' motivation level as evidenced by high levels of excitement during all the magnetism lessons. Furthermore, most of the class discussions were initiated by the learners themselves.

4.3 SCHOOL E: USING YOUTUBE VIDEOS INTERACTIVELY IN THE TEACHING AND LEARNING OF MAGNETISM

4.3.1 Context of School E

The context of School E is almost the same as that of School D (see section 4.2.1). However, School E is located near the Sphumelele Teachers' Development Centre in Elukwatini rural township of Mpumalanga Province. The school enrolled close to 1 000 learners from Grade 8 to 12 in 2018. There are two Grade 10 Physical Sciences classes, 46 learners in the A class and 38 in the B class. Both classes are taught by Mr X. The percentage pass rate of the school for 2017 was 82% and 85% in Physical Sciences.

School E does not have ICT equipment in its classes. However, during the period of intervention for all observations at this school, Mr X made use of the computer laboratory fitted with 15 desktop computers, a ceiling mounted data projector and a white screen.

In order to integrate computers in the physical sciences lessons during this period of intervention and lesson presentations and observations, the teacher's laptop had been loaded with YouTube programs and videos related to Grade 10 magnetism. The loading and testing of YouTube and the sound system was done by the researcher with the assistance of Mr X prior to the lesson presentations. The YouTube and audio-visual simulation software packages were meant for use during presentations on the interactive use of videos in Grade 10 magnetism since they are compatible with the CAPS syllabus (see section 3.12).

4.3.2 Mr. X's interactive video lessons with the experimental group

The following is a report of the four lessons which Mr X presented on the interactive use of videos in Grade 10 magnetism as observed by the researcher.

4.3.2.1 Mr X's lesson 1

Mr X's lesson objectives for this lesson were exactly the same as those of Mr W (see section 4.2.2.1). The only difference was that Mr X used interactive videos as the intervention method.

Mr X began his first lesson with a quick review of magnetism as taught in Grade 9. He began by asking learners guiding questions which would enable them to explain what a magnet is in their own words. He asked questions such as: Who has seen a magnet before? How did you know that it was a magnet? Does a magnet attract every metal? The learners were then shown a video of a permanent magnet as well as iron filings being attracted to the magnet (www.youtube.com/watch?v=V-Gus-qIT74). This video triggered a lot of excitement as the learners could see the how iron filings interacted with a permanent magnet. The teacher then paused the video in order to guide learners into identifying iron as a ferromagnetic material since it can be attracted to a magnet.

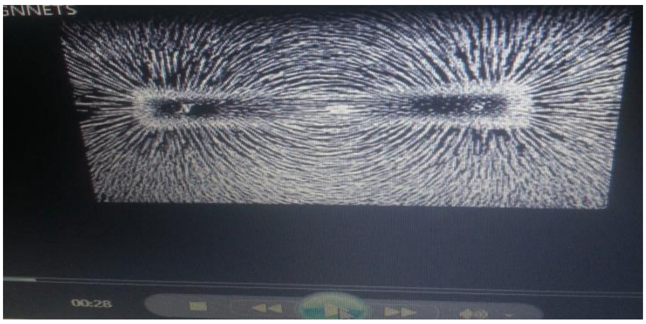


Figure 4.13 Screenshot from YouTube video showing magnetic field view when iron filings are being attracted by a magnet

The materials that cannot be attracted to a bar magnet are called non-ferromagnetic. Learners were then shown another video where they could observe nails being slightly pushed towards a magnet (www.youtube.com/watch?v=1KqFuSqKcek).

Figure 4.14 Screenshot from YouTube video showing a magnet attracting iron nails from a distance

They observed that the nails have to reach a particular point or distance from the magnet where it will experience a magnetic force. The teacher paused the video to ask questions related to magnetic fields, like: “How far from the magnet should the nails be before they get attracted? What can you observe regarding the speed of attraction as nail-to-magnet distance becomes smaller?” Many learners were quick to correctly say that when the distance from the nail to the magnet is very small the magnetic force experienced by the nail will be very high. The teacher then used another video to guide the learners into defining a magnetic field as a region of space around a magnet where a ferromagnetic material experiences a magnetic force. (www.youtube.com/watch?v=Vdkac3wJ9Aw).

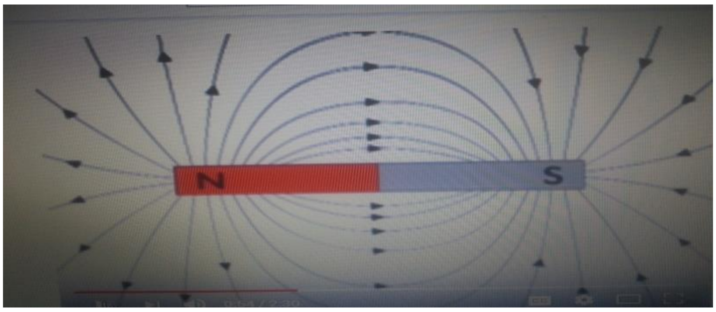


Figure 4.15 Screenshot from YouTube video showing the magnetic field around a permanent magnet

In the next video the learners were able to observe temporary magnets and how they are made (www.youtube.com/watch?v=ITKSfAkWWNO). When asked by the teacher some learners pointed out that temporary magnets are stronger than ordinary permanent magnets.

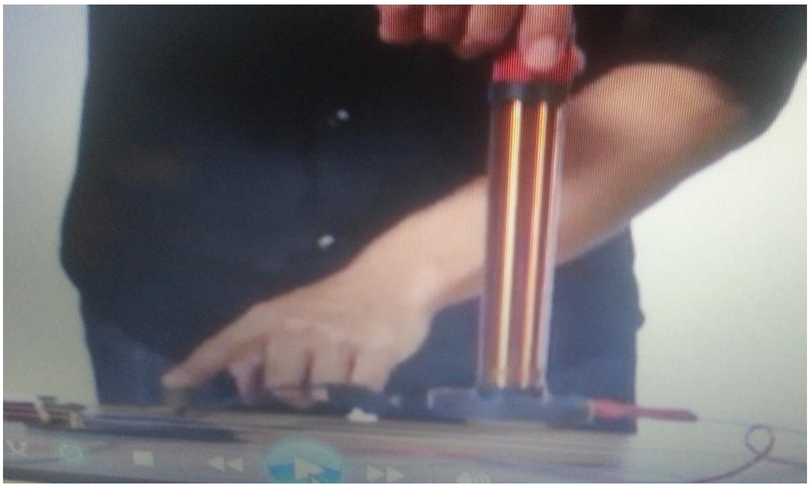


Figure 4.16 Screenshot from YouTube video showing an electromagnet

The teacher then concluded the lesson by asking recall questions about all the activities and observations of the lesson. He also indicated that electrostatic and gravitational fields were some of the fundamental fields of nature. A homework task based on the comparison of a magnetic field with a electrostatic and a gravitational field was given at the end.

Table 4.6 Rating of Mr X's lesson 1 using the RTOP monitoring instrument (see also Appendix B for RTOP)

Statement	RTOP SECTION CATEGORY																								
	C					D					E					F					G				
	Rating					Rating					Rating					Rating					Rating				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1					✓					✓				✓						✓					✓
2					✓					✓					✓				✓						✓
3				✓						✓					✓					✓					✓
4				✓						✓				✓					✓					✓	
5				✓				✓						✓						✓			✓		

Comment: During this lesson the teacher used YouTube videos interactively to teach learners magnetic force, magnetic field and give an introduction to magnetism. The learners were very excited as they could visualise the concepts from the videos and were actively involved at group and class level.

4.3.2.2 Mr X's Lesson 2

Mr. X's lesson objectives for the second lesson were exactly the same as those of Mr W (see section 4.2.2.2). The only difference was that Mr X used interactive videos as the intervention method.

Mr X started by reviewing his previous lesson on magnets through a question-and-answer approach. He asked questions such as: "What term is given to those materials that can be attracted to a magnet? How do we define a magnetic field? From the homework I gave you, what are the similarities between an electric field and a magnetic field? What are the similarities and differences between electric force, gravitational force and magnetic force?" Many hands were raised, a sign that the learners had done the homework. One learner said, "The similarity is that they are all non-contact vectors." Another learner said, "The difference between an electric and a magnetic force is that both are attractive and repulsive while gravitational force is only attractive." The discussions based on the comparison of fields were characterised by high levels of learner participation.

The teacher then presented a video in which the learners were able to see what happens when two permanent magnets are brought closer together (www.youtube.com/watch?v=MpOBu75MSj8). The teacher requested learners to record their observations in each case. The video activities were meant to guide learners into concluding that same poles push each other and unlike poles pull each other. The same video activity involved showing the learners a pair of permanent magnets interacting with powdered iron filings. The first part of the video was one where unlike poles are facing each other and iron filings were sprinkled between them.

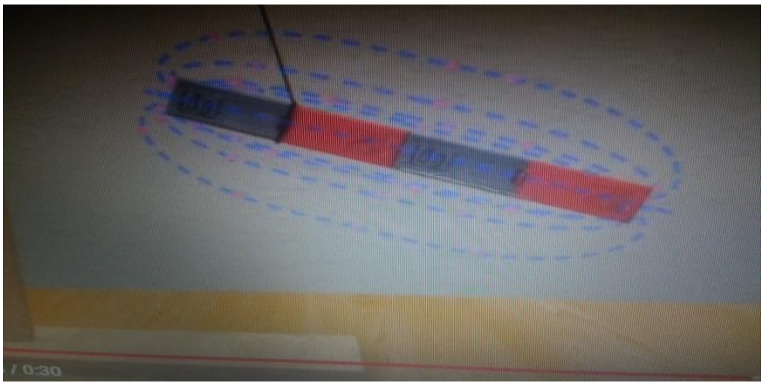


Figure 4.17 Screenshot from YouTube video showing permanent bar magnets attracting each other

The video was also shown with the same poles of a magnet facing each other.

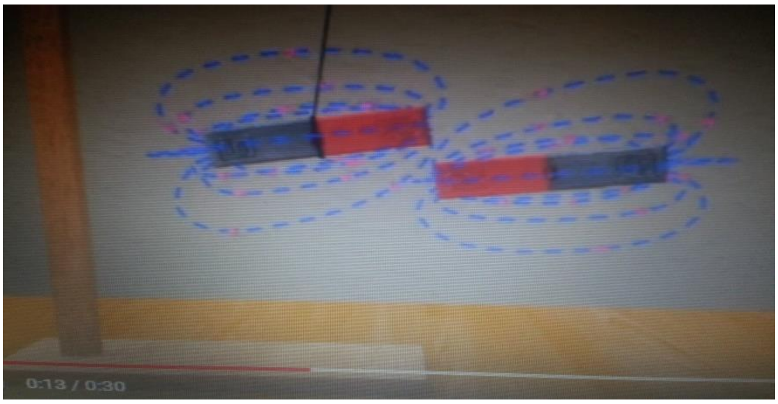


Figure 4.18 Screenshot from YouTube video showing two permanent bar magnets repelling each other

The learners were then requested to draw in their notebooks the magnetic field lines formed by the iron filings. The next video was one showing magnetic levitation to demonstrate repulsion (www.youtube.com/watch?v=hu1jEWLZVug). This video caused great excitement among learners as they observed repulsion in action.

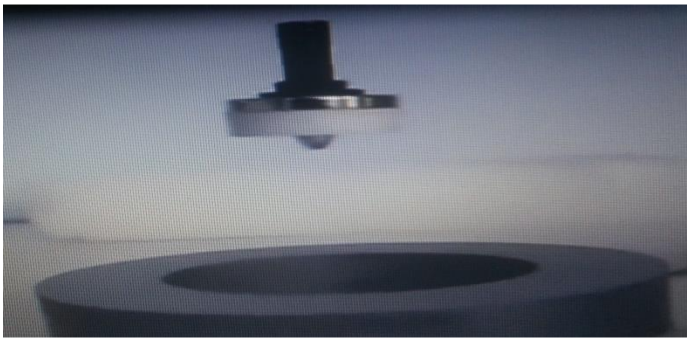


Figure 4.19 Screenshot from YouTube video showing repulsion

The teacher explained to the learners how electricity is related to magnetism. He explained that there exists a magnetic field around every coil that is carrying a current. In the next video the learners were able to observe the existence of a magnetic field around a coil carrying an electric current (www.youtube.com/watch?v=68It2haT2YI). The video was meant to direct learners into realising that there is an intimate relationship between electricity and magnetism.

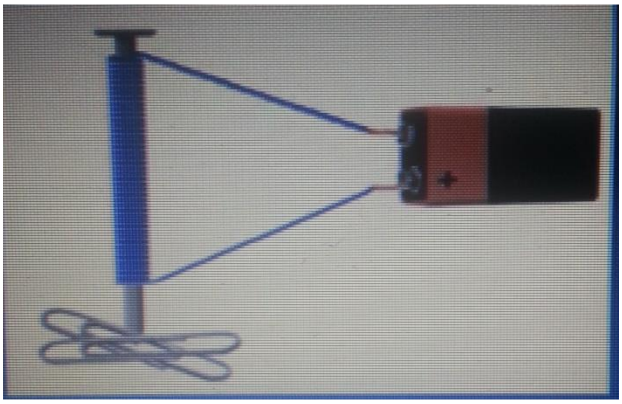


Figure 4.20 Screenshot from YouTube video showing paper clips being attracted by a current-carrying coil around an iron nail

This video created a lot of excitement among learners as they had never thought that a current-carrying coil wound around a nail can be magnetic. This video also led Mr X to provide a brief introduction to electromagnets.

Mr X then concluded the lesson by first recapping the main ideas of the lesson like attraction and repulsion. He then gave the learners homework based on the applications of electromagnets in our daily lives.

Table 4.7 Rating of Mr X's lesson 2 using the RTOP monitoring instrument (see also Appendix B for RTOP)

Statement	**RTOP SECTION CATEGORY**																								
	C					D					E					F					G				
	Rating					Rating					Rating					Rating					Rating				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1					✓					✓					✓					✓					✓
2				✓						✓					✓				✓					✓	
3				✓						✓					✓					✓				✓	
4				✓					✓					✓					✓					✓	
5					✓				✓					✓						✓				✓	

Comment: During this lesson the teacher used YouTube videos interactively to teach magnetism concepts such as attraction, repulsion and electromagnets. This was quite a lively lesson as the teacher allowed learners to actively interact with each other.

4.3.2.3 Mr X's lesson 3

Mr. X's lesson objectives for lesson 3 were exactly the same as those of Mr W (see section 4.2.2.3). The only difference was that Mr X used interactive videos as the intervention method.

Mr X started by reviewing his previous lesson on the laws of magnetism and magnetic field lines through a question-and-answer approach. His students participated by responding to the questions. He also asked a few questions based on electromagnets to check whether the learners had done the homework. He then asked probing questions about the origin of magnets and magnetism to guide learners towards the domain theory. He asked questions such as: Why does a magnetic material behave differently from other materials? How are the particles inside a magnetic material arranged? The video also helped to explain the domain theory (www.youtube.com/watch?v=85dlRpKMlwM).

Figure 4.21 Screenshot from YouTube video showing compasses representing randomly arranged domains in an unmagnetised material

The next part of the same video clip shows how the compasses would align themselves into domains afterwards. Such alignment as shown in Figure 4.22 created much excitement and enjoyment among the learners.

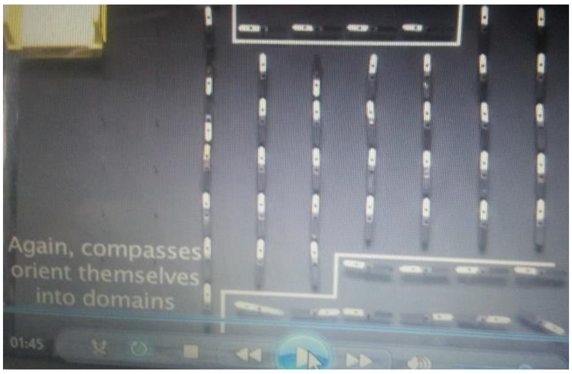


Figure 4.22 Screenshot from YouTube video showing magnetic compasses representing aligned domains in a magnetised material

In another video the teacher showed learners that even iron needles can be used to demonstrate the domain theory (www.youtube.com/watch?v=Bb2EZezvYMs). The video showed a lot of needles randomly distributed on top of a table as shown in Figure 4.23.

Figure 4.23 Screenshot from YouTube video showing randomly aligned needles representing magnetic domains in an unmagnetised material

The arrangement of needles after a magnetic field is applied from below the table would appear as shown in the video screenshot in Figure 4.24.

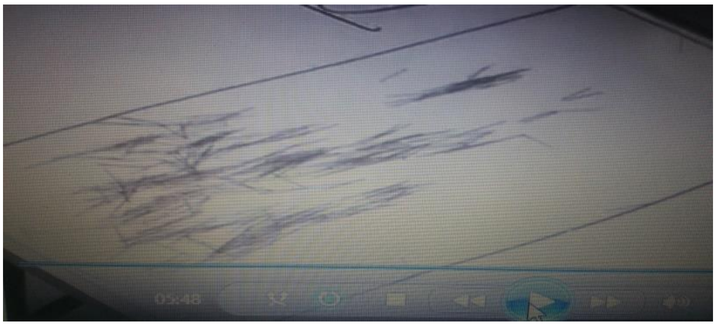


Figure 4.24 Screenshot from YouTube video showing aligned needles to resemble magnetic domains in a magnetised material

This video demonstrating domain theory using needles sparked a lot of interest among the learners, with some of them requesting a replay of the video.

The following question was then presented to learners by Mr X on PowerPoint:

“Why should the domains in some elements line up in the same direction after the application of a strong external magnetic field while the majority of elements do not?”

Interesting answers were provided during the class discussion. Some learners said saying that whether an element becomes magnetic or not “has to do with how electrons are arranged”. Others suggested that “electrons themselves are magnetic”. Some said it “has to do with how electrons are arranged in the valence shell”. A few thought of it as “the arrangement and electron movement in the ferromagnetic metals”.

Learners were then tasked to use the domain theory to explain how ferromagnetic materials are magnetised by applying an external magnetic field. Mr X asked the learners to try to find the answer to the question as they watched the next video (www.youtube.com/watch?v=hK_Yi5nxuKQ).

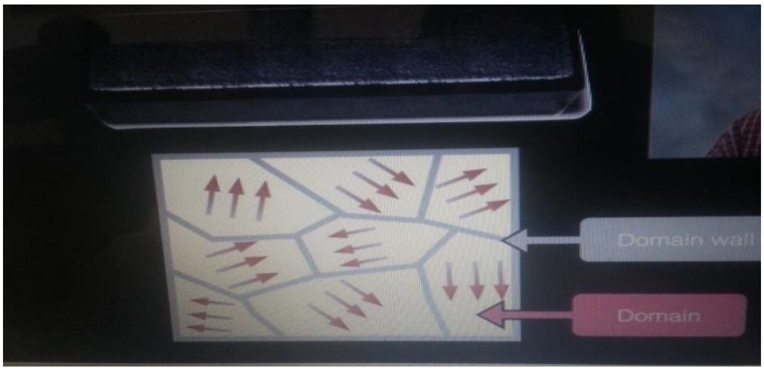


Figure 4.25 Screenshot from YouTube video showing randomly aligned magnetic domains

In the video learners were able to observe that as the external magnetic field is applied, the domains, appearing as small vertical magnets (Figure 4.25), will align themselves in the same direction as the external magnetic force field. The following is a screenshot from the YouTube interactive physics videos showing how the material would appear after being magnetised by the application of an external magnetic field.

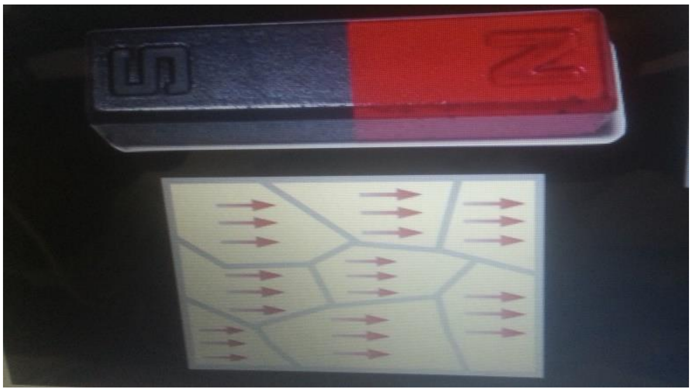


Figure 4.26 Screenshot from YouTube video showing how a material becomes magnetised after the application of a strong external magnetic field

Learners were quick to realise that the direction in which the external magnetic field is applied will eventually be the direction in which the domains will align themselves.

The teacher asked learners to provide a scientific explanation as to why a permanent magnet can lose its magnetic properties after being dropped or hammered several times or heated strongly. Mr X asked the learners to try to find the answers to the questions as they watched the next video (www.youtube.com/watch?v=1kqFuSqkcek).

Figure 4.27 Screenshot from YouTube video showing a permanent magnet being demagnetised by strong heating

As the learners keenly watched the video they were amazed when the magnet eventually fell down losing its magnetic properties for ever. The magnet could no longer attract the nail. After watching the video many learners explained, using the domain theory, that the arrangement of electrons and domain alignment are randomised by thermal agitation.

The teacher concluded the lesson with a discussion with the learners using another video to enable them to realise that magnetism is directly associated with charge movements (www.youtube.com/watch?v=E4CQTgDfDmo). This was also one of the videos which triggered a lot of excitement among learners.

Figure 4.28 Screenshot from YouTube video showing a permanent magnet being used to generate electricity

The video also made learners realise that electricity and magnetism were associated with each other. The learners were then given homework based on magnetic saturation and the everyday uses and applications of magnets.

Table 4.8 Rating of Mr X's lesson 3 using the RTOP monitoring instrument (see also Appendix B for RTOP)

Statement	RTOP SECTION CATEGORY																								
	C					D					E					F					G				
	Rating					Rating					Rating					Rating					Rating				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1					✓					✓					✓				✓					✓	

2					✓					✓				✓					✓					✓	
3				✓						✓					✓					✓				✓	
4				✓					✓					✓						✓				✓	
5				✓					✓					✓						✓			✓		

Comment: The teacher used YouTube videos interactively to teach the domain theory and enable learners to apply it to other physical phenomena. This was a learner-centred lesson. Learners were actively involved during class discussions and in their groups as they discussed what they had observed in the video presentation. This lesson was associated with a great deal of learner-to-learner interaction as they exchanged their scientific ideas on domain theory.

4.3.2.4 Mr X's lesson 4

Mr X's lesson objectives for this lesson were exactly the same as those of Mr W (see section 4.2.4). The only difference was that Mr X used interactive videos as the intervention method.

In his fourth lesson Mr X started by asking questions based on magnetic saturation and the application of magnetism in order to check whether the learners had done their homework. The learners' responses were overwhelming, indicating that they had done the homework. The teacher explained to the learners the fact that our planet earth is potentially a very large natural magnet. He also showed a video to convince learners that iron is one of the most abundant metals in the earth's crust (www.youtube.com/watch?v=5wZSt_LNq3U). He also highlighted the importance of directions in navigation and how magnets are used in sensing directions.

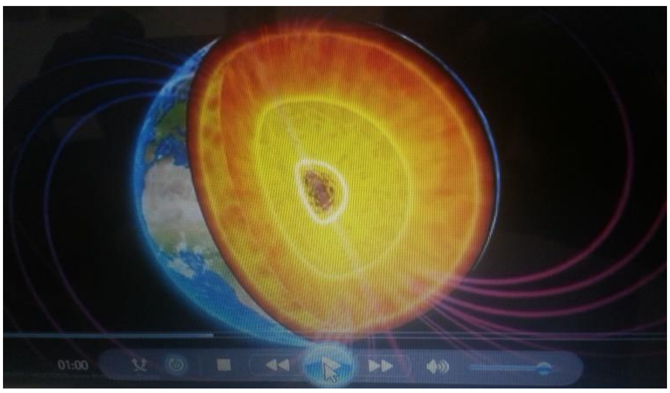


Figure 4.29 Screenshot from YouTube video showing the earth's core and magnetic field

The teacher then showed a video, which he also used to lead a class discussion on how magnets including gyromagnetic compasses are preferred in navigation systems and in predicting the earth's north pole (www.youtube.com/watch?v=kTZM9Se3EPo).

Figure 4.30 Screenshot from YouTube video showing a gyromagnetic compass in the earth's magnetic field

He also indicated that there are some natural phenomena like aurora borealis and magnetic storms. He also presented a video in which learners were able to view the spectacular aurora borealis, often called the northern lights, a natural phenomenon which occurs in the magnetosphere (www.youtube.com/watch?v=DGzL3wJ9Aw).

Figure 4.31 Screenshot from YouTube video showing an aurora borealis

The video of solar winds was the next to be presented by Mr X to the class (www.youtube.com/watch?v=XXFVpwecixY). Mr X used the video (Figure 4.32) to explain that the earth's magnetic field plays a major defensive role against strong radiation associated with solar winds.

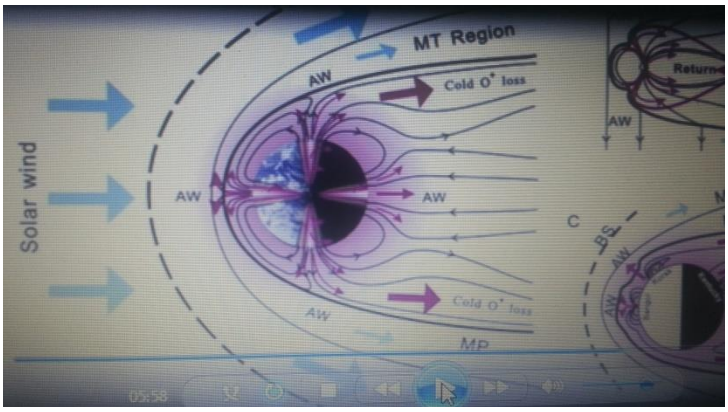


Figure 4.32 Screenshot from YouTube video showing the solar wind being deflected by the earth's magnetic field

The teacher concluded the lesson by a brief discussion based on the earth's magnetic reversal. He then gave learners homework in which they were to write in exercise books. The homework was based on the earth's magnetic reversal and how it will affect the future of the planet.

Table 4.9 Rating of Mr X's lesson 4 using the RTOP monitoring instrument (see also Appendix B for RTOP)

Statement	RTOP SECTION CATEGORY																								
	C					D					E					F					G				
	Rating					Rating					Rating					Rating					Rating				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1					✓					✓				✓					✓					✓	
2					✓				✓					✓						✓				✓	
3				✓						✓				✓					✓					✓	
4				✓					✓					✓					✓					✓	
5					✓				✓					✓					✓					✓	

Comment: The teacher used videos interactively to teach learners about the earth's magnetosphere and its influence on animals. Learners were actively involved during class discussions as they keenly observed and asked clarity-seeking questions. The level of excitement associated with video presentations was very high and the questions asked by the learners during and after the lesson were predictive of what was to be done next.

Table 4.10 General comments on Mr X's lesson observations using RTOP

RTOP Section	LESSON			
	1	2	3	4
C	Lesson design and presentation were tailored to engage learners.	Teacher acted mainly as a resource person. Lesson preparation and design were meant to actively engage all learners.	Lesson preparation catered for learners and enabled them to observe, predict and apply the scientific concept of magnetic domain.	Lesson preparation catered for learners of various abilities. The questions asked by learners during the teacher-led class discussion determined the direction of the lesson.
D	The lesson involved the fundamental concepts of the subject. Some elements of abstraction (i.e., symbolic representations of magnetic field) were encouraged where it was important to do so.	The lesson involved the fundamental concepts of the field lines and magnetic effect of a current-carrying coil.	The lesson involved elements of abstraction and the fundamental concepts of domain theory. The lesson also strongly promoted coherent conceptual understanding.	The teacher had a solid grasp of the subject matter content inherent in the lesson. Connections with other content disciplines and real world phenomena were explored and valued.
E	Learners were reflective of their learning as they observed, predicted and hypothesised.	Learners were actively engaged in thought-provoking activity that often involved the critical assessment of procedures as they observed and made predictions.	Learners were also quite active and alert throughout as their attention was captured by the video presentation. The lesson was learner-centred.	Learners were active during this lesson. Intellectual rigour, constructive criticism and the challenging of ideas were valued.
F	Most of the communication occurred between learners as they discussed ideas associated with their	Learners were involved in the communication of their scientific ideas with others.	Learners were predominantly active in this lesson as they made predictions, estimations and/or hypotheses and	This was a learner-dominated lesson as they observed, predicted and asked clarity-seeking questions.

	video observations.		devised means for testing them.	
G	Teacher’s video presentation influenced learners to actively participate in the lesson.	The teacher’s video presentation encouraged learners to observe and generate conjectures, alternative solution strategies and ways of interpreting evidence.	Active participation of learners was encouraged and valued. The teacher’s video presentation encouraged learners to observe and generate conjectures, alternative solution strategies and ways of interpreting evidence. This was a learner-centred lesson.	The teacher acted as a resource person, working to support and enhance learners’ investigations. Even though the teacher provided most of the explanations learners were quite attentive and inquisitive during the lesson.

The literature suggests that good teaching involves the use of strategies that provoke the active involvement of learners during the learning process (Anbalgan, 2017). This approach is also advocated by Usaini & Bakar (2015), who emphasise that modern teaching should involve a variety of ICT resources in order to ensure the easy and logical flow of lessons. The interactive use of ICT tools in the form of YouTube videos in Mr X’s lessons led to the easy illustration of magnetism concepts and processes from concrete to abstract.

This teacher was effectively able to implement the use of YouTube videos in teaching magnetism for the benefit of the learners as is recommended by Wilson (2015). The lessons were all associated with high levels of excitement and motivation as the learners acquired new knowledge related to magnetism. Table 4.9 also shows that learners had a positive attitude in all their lessons. Even though learners did not have direct access to laboratory bar magnets, they were able to understand the concept of magnetism through visualisation. This concurs with McLinden & McCall (2016). The use of YouTube videos in magnetism proved quite effective as the teacher was able to pause or rewind the videos during the presentations, in line with Stickel’s (2014) suggestions. The use of digital video learning acted as an inspirational source and increased learners’ level of motivation (Willmot et al., 2012).

4.4 SCHOOL F: USING COMPUTER SIMULATIONS AND YOUTUBE VIDEOS INTERACTIVELY FOR THE TEACHING AND LEARNING OF MAGNETISM

4.4.1 Context of School F

The context of School F was almost the same as that of School D and E. However, School F is located near Elukwatini rural township along the R541 and to the west of the Embuleni district hospital. The school enrolled more than 900 learners from Grade 8 to Grade 12 in 2018. There are two Grade 10 Physical Sciences classes: 56 learners in the A class and 60 in the B class. Both classes are taught by Mr Y. The percentage pass rate of the school for 2017 was 65% and 59% in Physical Sciences.

School F does not have ICT tools in its classes. However, during the period of intervention and observation at this school, Mr Y made use of the computer laboratory fitted with 12 desktop computers, a ceiling-mounted data projector and a white screen.

In order to integrate computers in the physics lessons during this intervention period of lesson presentations and observations, the teacher's personal laptop had been loaded with software with media-enabled programs with audio-visual capabilities. The loading and testing of YouTube and interactive PhET physics simulation software packages was done by the researcher in the presence Mr Y prior to lesson presentations. The YouTube videos and interactive PhET physics simulation software packages were meant for use during presentation with the interactive use of CS and videos in Grade 10 magnetism since they are compatible with the CAPS syllabus (see section 3.12). The following is a report of the four lessons which Mr Y presented on Grade 10 magnetism incorporating the interactive use of CS and videos.

4.4.2 Mr Y's interactive CS and video lessons to the experimental group

Mr Y taught the topic in four lessons, each 60 minutes in length. There was an agreement between the teacher and his learners to extend the last lesson by about 20 minutes, since it coincided with the last period of the day. Such a suggestion actually emanated from the learners themselves. This was to ensure completion of the magnetism section. The decision did not cause any challenges as learners were willing to remain behind for 20 minutes after school. Outlined below are the details of lesson observations extracted from the researcher’s field notes and Mr Y’s lesson plans.

4.4.2.1 Mr Y’s lesson 1

Mr. Y’s lesson 1 objectives were almost the same as those of Mr W (see section 4.2.2.1). The only difference was that Mr Y used both interactive CS and videos as the intervention method.

In his first lesson, Mr Y began by asking review questions related to magnetism taught in Grade 9. His guiding questions were to enable learners to explain the behaviour of a magnet in their own words. Mr Y then presented a CS lesson of a permanent bar magnet in which a magnetic compass North pole is being attracted to the South Pole.

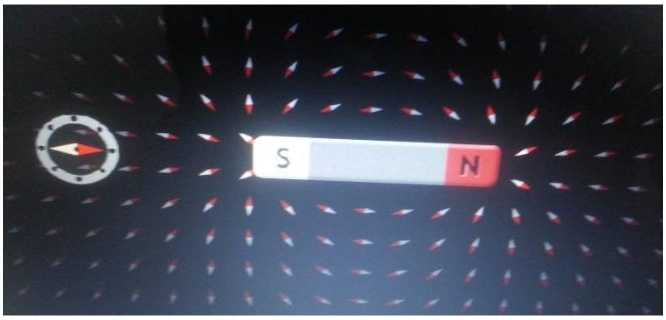


Figure 4.33 Screenshot from PhET simulations showing the north pole of a magnetic compass being attracted to the south pole

This was followed by a video presentation in which the learners were able to observe different classified materials according to whether they can be attracted or not attracted by a magnet (www.youtube.com/watch?v=1kFuSqkcek).

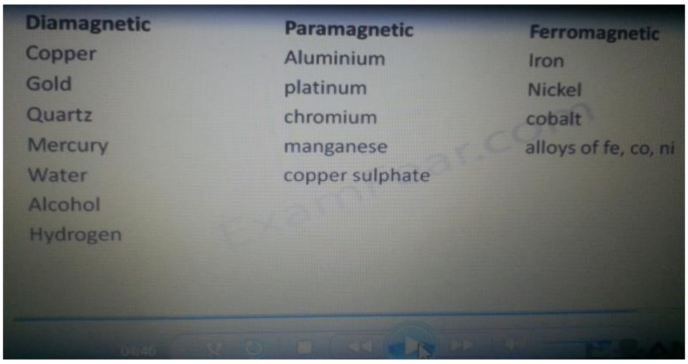


Figure 4.34 Screenshot from YouTube video showing ferromagnetic and non-ferromagnetic materials

The video in Figure 4.34 assisted learners in identifying magnetic materials as those that can be attracted to a bar magnet. Those that cannot be attracted to a bar magnet are called non-ferromagnetic.

The learners were then shown CS to enable them to recognise the magnetic field strength existing around a magnet. There was a magnetic compass in the CS which could be dragged to different positions around the magnet. In the CS learners were able to observe that when a magnetic compass was dragged to a particular position or distance from the magnet it will experience a magnetic force. The learners were also able to grasp through observations that the value of the magnetic force and the magnetic field strength varied inversely with the distance from the magnet.

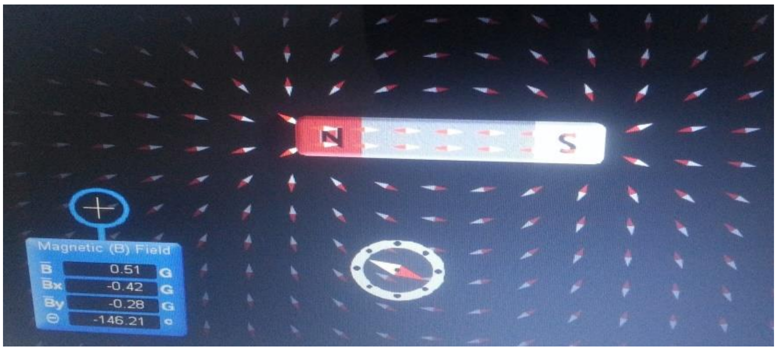


Figure 4.35 Screenshot from PhET simulations showing a gyromagnetic compass and magnetometer being used to determine the magnetic field strength at different positions around a bar magnet

The CS prompted the teacher to guide learners into defining “magnetic field” as a region of space around a magnet where a ferromagnetic material experiences a magnetic force.

The teacher concluded the lesson by summing up the main ideas in a general class discussion. Learners participated by responding to questions as well as asking clarity-seeking questions. A homework task based on the comparison of a magnetic field with an electrostatic and gravitational field was given at the end.

Table 4.11 Rating of Mr Y's lesson 1 using the RTOP monitoring instrument

Statement	RTOP SECTION CATEGORY																								
	C					D					E					F					G				
	Rating					Rating					Rating					Rating					Rating				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1					✓					✓				✓						✓					✓
2					✓					✓				✓						✓				✓	
3				✓						✓				✓						✓				✓	
4				✓					✓					✓					✓					✓	
5					✓				✓					✓						✓					✓

Comment: Learners were actively involved in class discussions as well as in their groups while discussing what they had observed in the CS and video presentations.

4.4.2.2 Mr Y's Lesson 2

Mr. Y's lesson 2 objectives were almost the same as those of Mr W (see section 4.2.2.2). The only difference was that Mr Y used both interactive CS and videos as the intervention method.

Mr Y began the second lesson by reviewing the previous lesson on magnets through a question-and-answer approach. He asked questions such as: Provide examples of ferromagnetic materials. What is the relationship between the magnetic force experienced by the ferromagnetic material and the distance from the magnet? How can a magnetic field be defined? He also asked questions related to the homework to check whether the learners had done it.

He then presented a video meant to enable learners to realise that like poles repel and unlike poles attract. Learners keenly watched the video and were emotionally excited. The first video clip was shown to learners to observe attraction when the unlike poles of a magnet were facing each other (www.youtube.com/watch?v=V-Gus-qIT74).

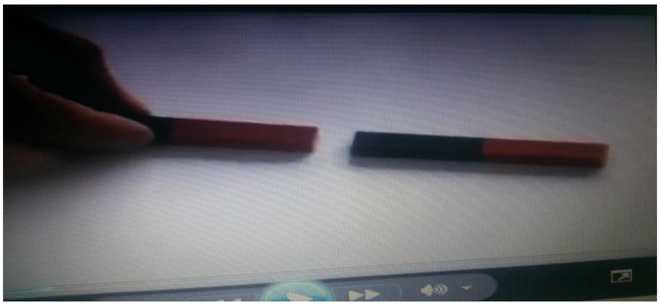


Figure 4.36 Screenshot from YouTube video showing how attraction occurs when two unlike poles of a magnet are facing each other

Learners were able to observe how fast the magnets advanced towards each other during attraction. The teacher also guided learners into realising that a magnetic force is a non-contact force. The video clip was followed by a CS presentation showing learners the presence of field lines during attraction.

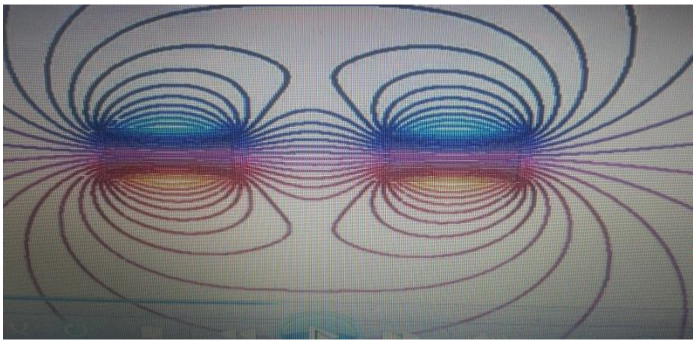


Figure 4.37 Screenshot from PhET simulations showing magnetic field lines existing between unlike poles during attraction

The CS presentation was paused to allow learners to view and respond to questions. The learners were then requested to draw the magnetic field lines observed from the CS presentation in their notebooks.

The next video clip showed what would happen when the same poles of a magnet were facing each other (www.youtube.com/watch?v=V-Gus-qIT74).

Figure 4.38 Screenshot from YouTube video showing how repulsion occurs when two like poles of a magnet are facing each other

The learners could observe one magnet moving away from the other when the same pole of another magnet was drawn closer to it. This video was meant to allow learners to observe that like poles repel each other. The video clip was followed by CS presentation showing learners the presence of field lines during repulsion.

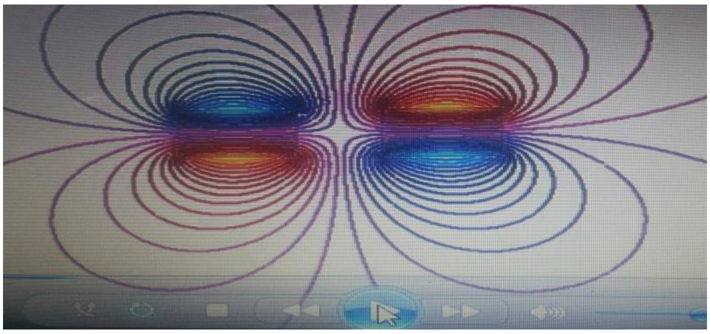


Figure 4.39 Screenshot from PhET simulations showing magnetic field lines existing between like poles during repulsion

Learners were again requested to draw the magnetic field lines observed from the CS presentation in their notebooks.

This was followed by a class discussion about the properties of magnetic field lines. One learner asked about the origin of the magnetic field lines. One learner suggested that the field lines were coming from the North Pole going to the South Pole. Another said that the field lines were originating from the South Pole and terminating at the North Pole. This prompted the teacher to present the CS with a screenshot shown below.

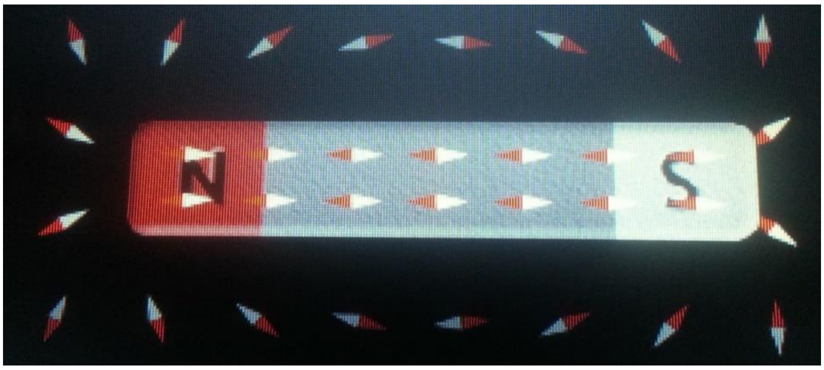


Figure 4.40 Screenshot from PhET simulations showing a bar magnet with its internal and external magnetic fields exposed

The next video presented to the learners was meant to enable learners to realise that there exists a magnetic field around every current-carrying coil (www.youtube.com/watch?v=MpOBu75MSj8). The following is a screenshot of a video showing the field lines around a current-carrying coil.

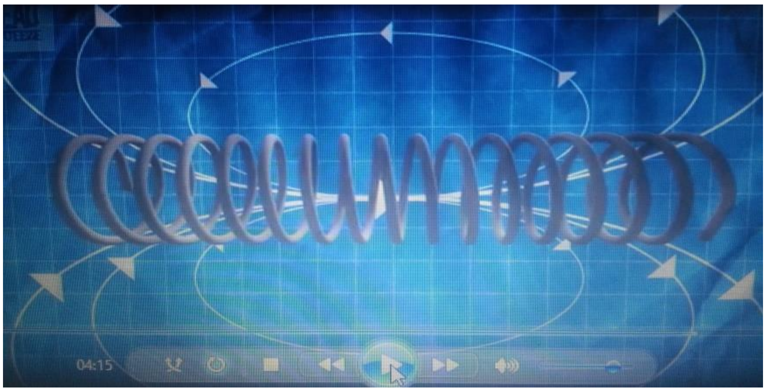


Figure 4.41 Screenshot from YouTube video showing the existence of a magnetic field and field lines around a current-carrying coil

The video presentation was followed by a CS which gave details of the current flow in relation to the magnetic field. The teacher also used the CS and video to explain that the direction of the magnetic field is predicted using the right-hand rule.

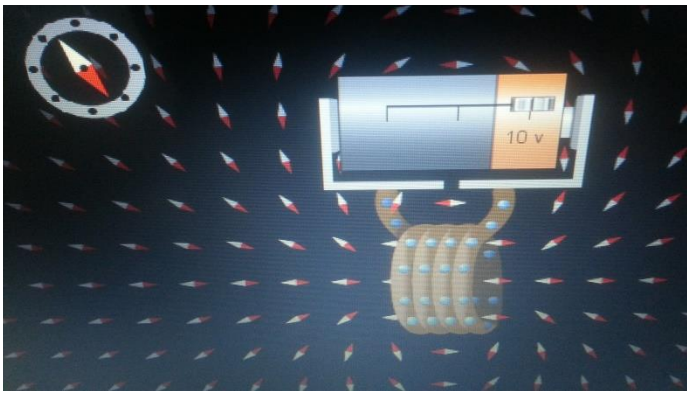


Figure 4.42 Screenshot from PhET simulations showing the existence of a magnetic field around a current-carrying coil

During his conclusion the teacher presented another video on electromagnets (www.youtube.com/watch?v=Gk5BhNY-IM). The video enabled learners to comprehend that when current flows through a coil that is wound around an ordinary iron nail, the nail will become a magnet.

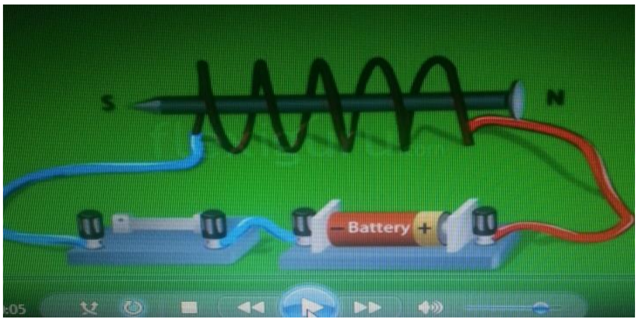


Figure 4.43 Screenshot from YouTube video showing how a simple electromagnet can be constructed

In another related video learners observed that the electromagnet made from winding insulated copper wire around an iron nail can attract ferromagnetic materials such as paper clips (www.youtube.com/watch?v=681t2haT2YI). Learners were really excited as they watched money clips being attracted by a nail which had a current-carrying coil around it.

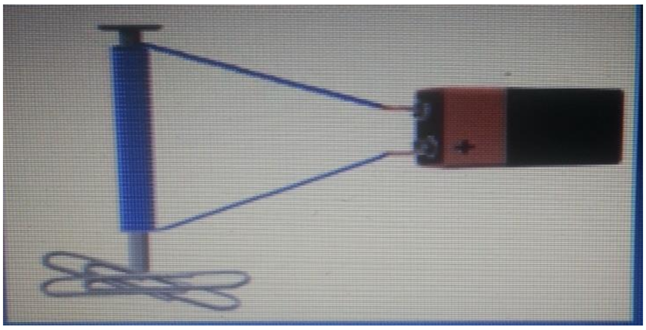


Figure 4.44 Screenshot from YouTube video showing paper clips being attracted by current-carrying coil around an iron nail

In his conclusion the teacher told learners that the nail becomes a temporary magnet. He went further to explain about temporary magnets. Learners were also given the opportunity to ask any clarity-seeking questions. The teacher then gave homework to learners to find out about the importance of electromagnets.

Table 4.12 Rating of Mr Y's lesson 2 using the RTOP monitoring instrument (see also Appendix B for RTOP)

Statement	RTOP SECTION CATEGORY																								
	C					D					E					F					G				
	Rating					Rating					Rating					Rating					Rating				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1					✓					✓					✓					✓					✓
2					✓					✓				✓					✓					✓	
3					✓					✓					✓					✓				✓	
4				✓					✓						✓					✓					✓
5					✓				✓						✓				✓						✓

Comment: Learners were actively involved during the lesson. During their group and class discussions learners were able to construct their own understanding of scientific ideas based on what they had observed.

4.4.2.3 Mr Y's Lesson 3

Mr. Y's lesson 3 objectives were almost the same as those of Mr W (see section 4.2.2.3). The only difference was that Mr Y used both interactive CS and videos as the intervention method.

Mr Y began by reviewing his previous lesson on magnetic field lines and the homework on electromagnets through a question-and-answer approach. Learners participated by responding to questions. The teacher then asked probing questions about the origin of magnets and magnetism. Very interesting answers were listed in groups by learners. Some learners suggested that "there is an inside force" that caused the existence of a magnet while others considered it as "pure magic". The teacher asked questions like: "What makes up elements? What makes up atoms? Why then is it that some elements make up magnets while others do not?" The answers to such questions were discussed first at group level. Then each group was given the opportunity to share its views. Again interesting answers were provided. One of the learners said that whether an element becomes a magnet or not "has to do with the number of protons and electrons". Another learner suggested that it "has to do with only electrons". Another one said it "has to do with how electrons are arranged in the valence shell". Yet another thought of it as “arrangement and electron movement in the ferromagnetic metals”. This gave the teacher the opportunity to explain the domain theory. The teacher presented a video to learners which he used to help him explain the domain theory (www.youtube.com/watch?v=QgwReDkpq6E).

(a) (b)

Figure 4.45 Screenshots from YouTube videos showing (a) randomised magnetic compasses representing unmagnetised material; (b) magnetic compasses representing aligned domains in a magnetised material

Learners were then tasked in their groups to use the domain theory to explain how ferromagnetic materials are magnetised by applying an external magnetic field. The teacher reinforced his explanations based on domain theory using a CS presentation.

(a) (b)

Figure 4.46 Screenshots from PhET simulations showing (a) randomly aligned domains before magnetisation; (b) aligned domains after magnetisation by using an external magnetic field

The learners were then shown another interactive PhET physics simulation in order to clarify the misconception associated with the origin of magnetic field lines. Figure 4.47 shows how magnetic field lines would appear as viewed from the inside.

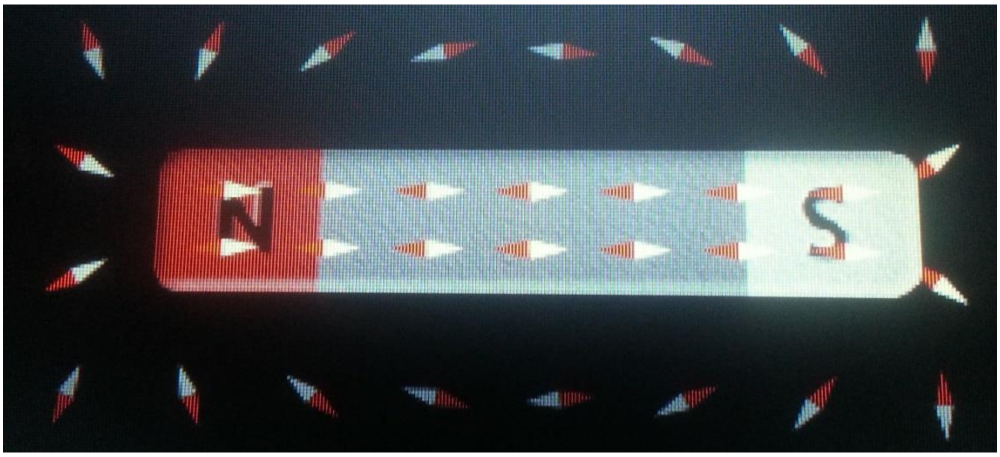


Figure 4.47 Screenshot from PhET simulations showing how a magnet and its aligned domains would appear from the inside

The teacher also used the interactive PhET physics simulation, of which a screenshot is shown in Figure 4.47, to guide learners to observe and accept that a magnetic field has no sources or sinks.

Learners also had to suggest why a permanent magnet can lose its magnetic properties after being dropped or hammered several times or heated strongly. To help learners grasp a picture of what he meant, the teacher presented a video of a magnet being heated as in the screenshot in Figure 4.48 (www.youtube.com/watch?v=1kqFuSqkcek).

(a) (b)

(c)

Figure 4.48 Screenshots from YouTube videos showing (a) a permanent magnet attracted to the head of an iron nail being heated strongly; (b) the magnet loses its magnetic properties and falls off; (c) magnet can no longer attract ferromagnetic materials because it has lost its magnetic properties forever

The teacher broke a small bar magnet into smaller pieces. The smaller pieces of the magnet were also magnets. He requested the learners in their groups to suggest a scientific explanation using the domain theory. The group discussions were followed by feedback to the entire class. The findings and discussion were quite interesting and thought provoking. One learner asked whether it was possible to completely separate the North Pole from the South Pole. The teacher threw back the question to the entire class. Heated arguments ensued but learners ended up realising that magnetic monopoles cannot exist after applying the domain theory.

The teacher concluded the lesson by directing learners to realise that magnetism is directly associated with charge movements and that electricity and magnetism are one thing. The learners were then given homework based on residual magnetism and also the everyday uses and applications of magnets.

Table 4.13 Rating of Mr Y’s lesson 3 using the RTOP monitoring instrument (see also appendix B for RTOP)

Statement	**RTOP SECTION CATEGORY**																								
	C					D					E					F					G				
	Rating					Rating					Rating					Rating					Rating				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1					✓					✓					✓				✓					✓	
2					✓					✓					✓				✓					✓	
3					✓					✓					✓					✓				✓	
4					✓					✓					✓				✓					✓	
5				✓						✓				✓						✓				✓	

Comment: The teacher taught the domain theory using both CS and videos interactively. The level of excitement and participation among learners was very high throughout the lesson.

4.4.2.4 Mr Y’s Lesson 4

Mr. Y’s lesson 4 objectives were almost the same as those of Mr W (see section 4.2.2.4). The only difference was that Mr Y used both interactive CS and videos as the intervention method.

In his fourth lesson Mr Y started by showing learners a video of the planet Earth as a typical example of a very large natural magnet (www.youtube.com/watch?v= kTZM9Se3EPo). He also indicated that iron is one of the most abundant metals in the earth’s crust. The same video was meant to highlight the importance of directions in navigation and how magnets are used in sensing directions.

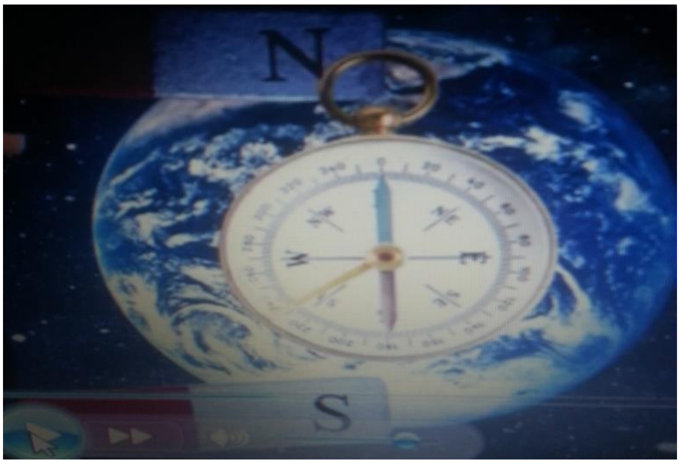


Figure 4.49 Screenshot from YouTube video showing how a gyromagnetic compass is used on planet Earth for navigation

The video also assisted the teacher to lead a class discussion on how magnets like gyromagnetic compasses are used in navigation systems. The teacher explained to the learners using the same video that a free-moving gyromagnetic compass aligns itself with the earth's magnetic field.

The teacher presented a CS to enable learners to see how magnets can be used in predicting the earth's North Pole.

Figure 4.50 Screenshot from PhET simulations showing a magnet aligned with the earth's magnetic field

The CS was used by the teacher to lead learners into understanding that the Arctic region is magnetic south and geographic north.

He also indicated that there are some natural phenomena like aurora borealis, magnetic storms and solar winds that are greatly affected by the earth's magnetic field. To better explain the natural phenomenon called aurora borealis the teacher presented another video (www.youtube.com/watch?v=fVsONc3OUY). This video also increased the level of excitement among the learners as they observed the colourful light, which their teacher also referred to as the northern lights.

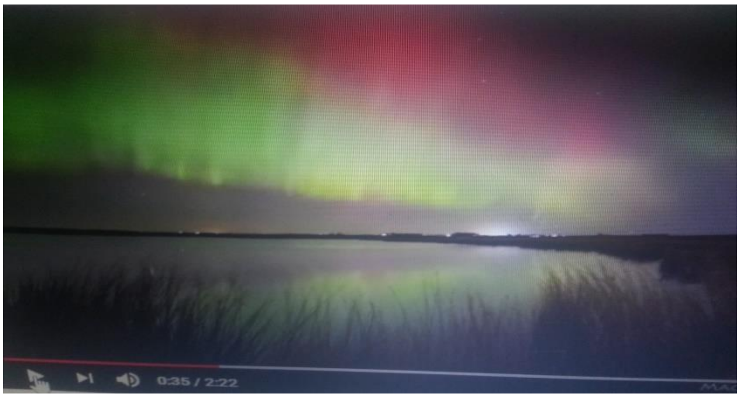


Figure 4.51 Screenshot from YouTube video showing the aurora borealis

The teacher used the video to allow learners to realise that auroras are formed when charged particles in the solar wind are trapped and experience a downward spiral into the field lines towards the poles. Another CS presentation was based on how the planet Earth's magnetic field protects us from solar winds.

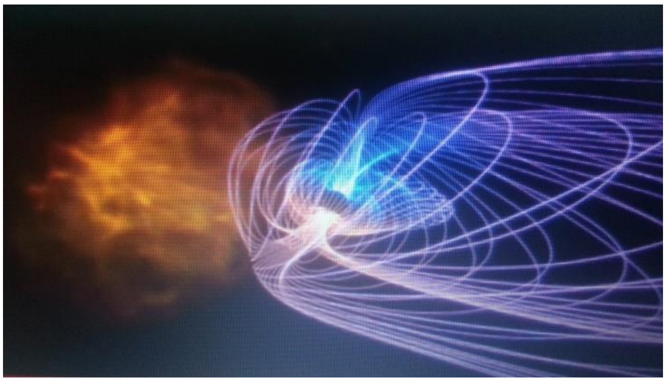


Figure 4.52 Screenshot from PhET simulations showing how a magnetosphere protects the earth from solar winds

A video was also presented to learners based on the protective nature of the magnetosphere against solar winds (www.youtube.com/watch?v=XXFVpwecixY).

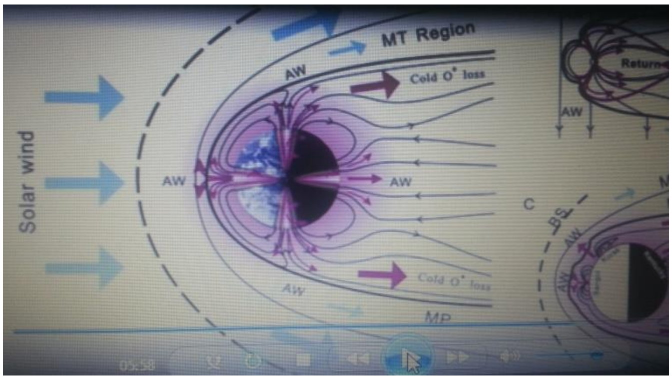


Figure 4.53 Screenshot from YouTube video showing the solar wind being deflected as it enters the earth's magnetic field

Mr Y used the video to explain that the magnetosphere protects the earth from the solar wind by forming an obstacle in the path of the solar wind, causing it to be deflected.

The teacher briefly explained the astrophysical future of the magnetosphere related to the earth's magnetic reversal. This caused a lot of enthusiasm and eagerness among the learners, who ended up asking questions such as: Will that not affect life, navigation and weather patterns? The teacher concluded the lesson by explaining that the earth was currently undergoing a magnetic reversal. He then gave learners homework based on the earth's magnetic reversal and how it will affect the future of the planet.

Table 4.14 Rating of Mr Y's lesson 4 using the RTOP monitoring instrument (see also Appendix B for RTOP)

Statement	RTOP SECTION CATEGORY																								
	C					D					E					F					G				
	Rating					Rating					Rating					Rating					Rating				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1				✓						✓					✓				✓					✓	
2					✓					✓			✓						✓					✓	
3				✓						✓				✓						✓				✓	
4					✓					✓				✓						✓				✓	
5				✓						✓				✓					✓						✓

Comment: The teacher taught aurora borealis, magnetic declination and solar winds using CS and videos interactively. This was quite a lively lesson where learners actively participated during class discussions. All the set objectives outlined in his lesson plan (see Appendix L3d) were achieved except one. The teacher did not use a permanent bar magnet to demonstrate how magnets are employed in navigation.

Table 4.15 General comments on Mr Y's lesson observations using RTOP

RTOP Section	LESSON			
	1	2	3	4
C	Lesson design and presentation were tailored to engage learners as members of the community.	Lesson preparation and design were meant to actively engage all learners.	Lesson preparation catered for learners and enabled them to observe, predict and apply the scientific concept of magnetic domain.	Lesson preparation catered for learners of all categories. The questions asked by the learners during teacher-led class discussions determined the direction of the lesson.
D	The lesson involved the fundamental concepts of the subject. Some elements of abstraction (i.e., symbolic representations of a magnetic field) were encouraged where it was important to do so.	The lesson involved the fundamental concepts of the field lines and magnetic effect of a current-carrying.	The lesson strongly promoted coherent conceptual understanding and had connections with electricity.	The teacher had a full grasp of the subject matter content of the lesson. Connections with other content disciplines like electricity were explored and valued.
E	Learners were quite active and reflective of their learning as they observed, predicted and hypothesised.	Learners were actively engaged in thought-provoking activity that often involved the critical assessment of procedures as they observed and made predictions.	Learners were also quite active and alert throughout as their attention was captured by the CS and video presentation.	Learners were active during this lesson. Intellectual rigour, constructive criticism and the challenging of ideas were valued. Learners demonstrated high levels of participation throughout the lesson.
F	Most of the communication occurred between learners as they discussed ideas	Learners were involved in the communication of their scientific ideas with others. The level	Learners were predominantly active in this lesson as they made predictions, estimations and/or	This was a learner-dominated lesson as they observed, predicted and asked clarity-seeking

	associated with their CS and video observations. Most of the questions came from and were answered by learners.	of excitement was very high as observed from the high levels of participation.	hypotheses and devised means for testing them.	questions.
G	Teacher's CS and video presentations influenced learners to actively participate in the lesson. Teacher acted as a resource person and initiated class discussions. This was a learner-centred lesson.	The teacher's CS and video presentation encouraged learners to observe and generate conjectures, alternative solution strategies, and ways of interpreting evidence. This was typical of a learner-centred lesson.	Active participation of learners was encouraged and valued. The teacher's CS and video presentations encouraged learners to observe, predict and generate conjectures, alternative solution strategies and ways of interpreting evidence. This was a learner-centred lesson.	The teacher acted as a resource person, working to support and enhance learners' investigations. Even though the teacher provided most of the explanations learners were quite attentive and inquisitive during the lesson. Learners influenced the pace and direction of the lesson.

According to Pestana et al (2016) a good lesson should focus on capturing learners' attention and interests in order to be motivational. This can be achieved through the consistently use of different ICT tools in teaching and learning. Anbalagan (2017) supports such a pedagogical approach by saying that learners should want to know more during and after the lesson. Usaini & Bakar (2015) also observe that no ICT tool is superior to another if used properly for teaching and learning purposes.

The lessons staged by Mr Y involved the interactive use of both CS and YouTube videos. All the lessons presented by Mr Y were accompanied by high levels of learner involvement. Most questions and ideas which could not be addressed by videos or CS alone were easily explained using the combination of the two. It was also easier for Mr Y to explain some concepts like the domain theory using both technologies as CS and videos complement each other. Unlike using CS and videos separately the interactive use of both resulted in an increased motivational spirit among learners as well as in creating eagerness to learn new knowledge. Furthermore, the level of participation in the inquisitive approach to learning was very high in all Mr Y's lessons.

Table 4.14 also confirms that Mr Y's lessons were learner-centred with a lot of interaction among learners.

4.5 SCHOOL G: NON-INTERACTIVE APPROACH – TEACHING AND LEARNING MAGNETISM WITHOUT USING CS OR VIDEOS

This was the only school where no computers were used to present lessons during the intervention period. The traditional method of teaching was used at School G.

4.5.1 Context of School G

The context of School G is almost the same as that of School D (see section 4.2.1). However, School G is located at Mooiplaas, about 5.7 km east of Elukwatini rural township along the R541. The school enrolled close to 750 learners from Grade 10 to 12 in 2018. There are 88 learners doing Physical Sciences in Grade 10. This makes them two classes, with 40 learners in the A class and 48 learners in the B class. Both classes were taught by the same teacher, Miss Z. The overall percentage pass rate of the school for 2017 was 50.07% and 35% in Physical Sciences.

In all the lesson presentations observed at this school, the teacher taught the topic of magnetism to the two classes using the chalkboard and learner textbooks. During the entire intervention period all lessons were handled in their usual classrooms at the school. The two Grade 10 classes taught by Miss Z were each having more than 40 learners. The following is a report of the four lessons on magnetism Miss Z taught without the use of CS or videos.

4.5.2 Miss Z'S non-interactive lessons, control group (traditional method)

Miss Z taught the topic in four lessons to each of the two Grade 10 Physical Sciences classes at this school. Each Physical Sciences period lasted 60 minutes. Miss Z is a young lady with three years' experience of teaching Physical Sciences and therefore felt comfortable in presenting her lessons in the presence of the researcher. The researcher managed to observe all the lessons on magnetism taught to the two classes by Miss Z during the intervention. The details of the observation of lessons outlined below are for Miss Z's lessons as extracted from her lesson plans and the researcher's field notes.

4.5.2.1 Miss Z's lesson 1

Miss Z's lesson 1 objectives were almost the same as those of Mr W (see section 4.2.2.1). The only difference was that Miss Z used the traditional approach.

In the first lesson, Miss Z began with a review on magnets as taught in Grade 9. She started by asking learners guiding questions which would enable them to explain in their own words what a magnet is.

The learners were then divided into four groups, each with at least 10 learners. Each group was given a permanent bar magnet and some materials such as paper clips, aluminium foil, copper metal teaspoon and a nail. Each group was required to classify in tabular form the materials according to whether they can be attracted on not by a magnet. Learners were able to do that while making use of the provided magnet. The teacher then explained to learners that ferromagnetic materials are those that can be attracted to a bar magnet. Those that cannot be attracted to a bar magnet are called non-ferromagnetic.

Learners were now requested to choose one ferromagnetic material, for example a nail, and bring it closer to but not into contact with a bar magnet by just giving it a slight push. Learners were to observe that when a nail reaches a particular point or distance from the magnet it will experience a magnetic force. Learners were to repeat the activity at various distances. Many groups concluded that when the distance from nail to magnet is very small the magnetic force experienced by the nail will be very high. The teacher then requested learners to turn to their *Study & Master Physical Sciences Grade 10 Learner's Book* in order to have a better view of the magnetic field. The teacher also used the textbook diagram to explain a magnetic field. Figure 4.54 below represents the way the demonstrations appeared on the paper. Figure 4.54 is adapted from *Study & Master Physical Sciences Grade 10 Learner's Book* (Kelder, 2012, p182).

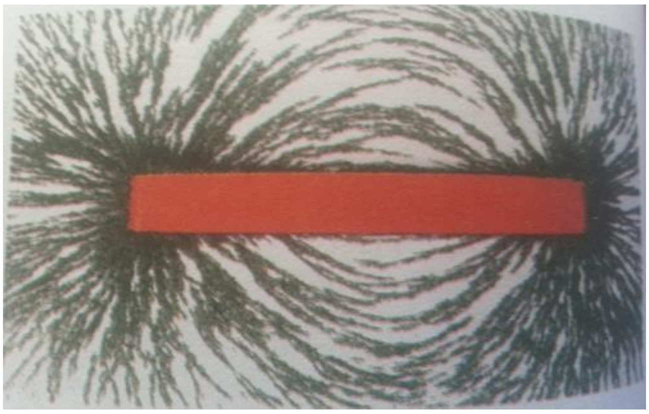


Figure 4.54 Magnetic field lines around a bar magnet (Kelder, 2012:182)

The activity made the teacher guide learners into defining a magnetic field in their groups. Each group first discussed and later on provided feedback on what they thought was the most probable definition to the entire class.

The teacher then concluded the lesson by asking recall questions about the activities of the lesson. A homework task based on the comparison of a magnetic field with an electrostatic and gravitational field was given at the end.

Table 4.16 Rating of Miss Z's lesson 1 using the RTOP monitoring instrument

Statement	**RTOP SECTION CATEGORY**																								
	C					D					E					F					G				
	Rating					Rating					Rating					Rating					Rating				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1				✓					✓				✓				✓						✓		
2				✓				✓				✓						✓				✓			
3		✓								✓			✓				✓						✓		
4		✓					✓					✓					✓					✓			
5	✓						✓							✓				✓			✓				

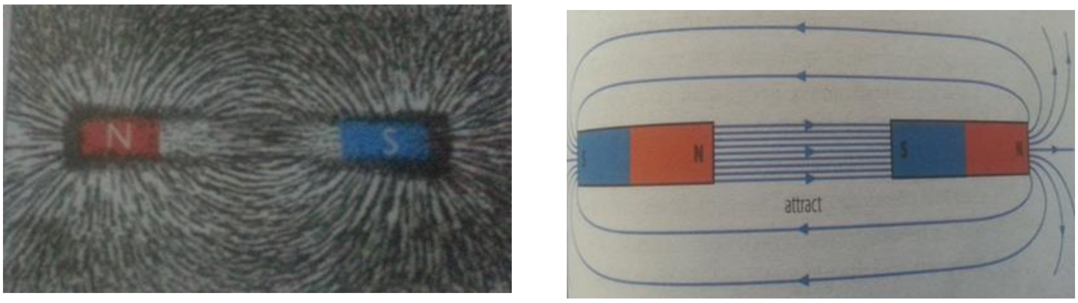
Comment: In this lesson, learners were generally not actively in involved. They mainly listened to and relied heavily on the verbal explanations from the teacher.

4.5.2.2 Miss Z's lesson 2

Miss Z's lesson 2 objectives were almost the same as those of Mr W (see section 4.2.2.2). The only difference was that Miss Z used the traditional approach as the intervention method.

Miss Z started the second lesson by reviewing her previous lesson on magnets through a question-and-answer approach. She then assigned learners to their groups. Each group was given a pair of permanent bar magnets, powdered iron filings and a blank page of A4 white paper. Each group was then asked to bring the end of a magnet painted blue closer to the end of another magnet also painted blue. The learners were to observe and record their observations. The learners were then to repeat the activity while bringing the blue end of the magnet closer to the red end of the magnet. The learners also recorded their findings. This activity was meant to guide learners into concluding that like poles repel and unlike poles attract. The next group activity involved spraying the iron filings on the A4 white paper provided while the two magnets with unlike poles were positioned below the paper. The learners were then requested to turn to *Study & Master Physical Sciences Grade 10 Learner's Book*, where further explanations and diagrams were given.

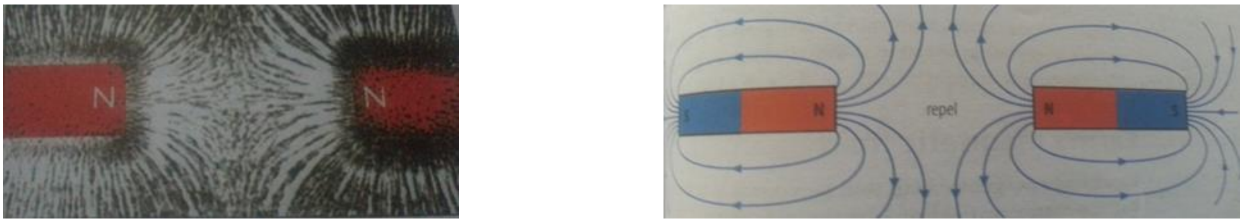
Figure 4.55 was adapted from *Study & Master Physical Sciences Grade 10 Learner's Book* (Kelder, 2012, p183).



(a) (b)

Figure 4.55 Magnetic field lines between unlike poles during attraction when using (a) iron filings and (b) sketch diagrams

The learners were then requested to draw the magnetic field lines formed by the iron filings. The teacher requested the learners to make use of their textbook, page 183, while drawing the diagrams. They repeated the activity with the same poles of the magnet facing each other being placed under the A4 white paper. The screenshot below shows the textbook image of how repulsion would be observed. Figure 4.56 was adapted from *Study & Master Physical Sciences Grade 10 Learner's Book* (Kelder, 2012, p183).



(a) (b)

Figure 4.56 Magnetic field lines between like poles during repulsion when using (a) iron filings, and (b) sketch diagrams

Each group was then tasked to discuss the properties of magnetic field lines while making use of their textbook diagrams. This was followed by a class discussion during which each group was to provide feedback. The teacher wrote notes on the chalkboard. During the class discussion the teacher also asked her learners about the origin of the magnetic field lines. Some learners suggested that the field lines were coming from the North Pole going to the South Pole. Others said that the field lines were originating from the South Pole and terminating at the North Pole. The teacher went on to conclude the lesson by giving homework on electromagnets.

Table 4.17 Rating of Miss Z's lesson 2 using the RTOP monitoring instrument (see Appendix B for RTOP)

Statement	RTOP SECTION CATEGORY																								
	C					D					E					F					G				
	Rating					Rating					Rating					Rating					Rating				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1					✓				✓				✓				✓						✓		
2				✓				✓			✓							✓				✓			
3		✓							✓			✓					✓						✓		
4		✓					✓					✓					✓					✓			
5	✓							✓					✓					✓			✓				

Comment: Learners were actively involved during their group discussions.

4.5.2.3 Miss Z's Lesson 3

Miss Z's lesson 3 objectives were almost the same as those of Mr W (see section 4.2.2.3). The only difference was that Miss Z used the traditional approach to teaching.

Miss Z began the third lesson by reviewing her previous lesson on magnetic field lines and the homework on electromagnets through a question-and-answer approach. Her learners participated by responding to questions. She then asked probing questions about the origin of magnets and magnetism. Very interesting answers were listed in the groups by learners. One learner suggested that there is an inside force that caused the existence of a magnet while another considered it as pure magic. The teacher went further to ask questions like: What makes up elements? What makes up atoms? Why then is it that some elements make up magnets while others do not? The answers to such questions were first discussed at group level. Then each group was given the opportunity to share their views. Again interesting answers were provided. One learner said that whether an element becomes magnet or not has to do with the number of protons and electrons. Another one suggested that it has to do with electrons only. Another said it has to do with how electrons are arranged in the valence shell. Another thought of it as the arrangement and electron movement in the ferromagnetic metals. This gave the teacher the opportunity to explain the domain theory. The teacher also requested learners to turn to their textbooks, *Study & Master Physical Sciences Grade 10 Learner's Book*, page 181, in order to have a better view of the magnetic domains.

(a)

(b)

Figure 4.57 Magnetic domains (a) randomly aligned in an unmagnetised material, and (b) aligned in a magnetised material after the application of a strong external magnetic field

Figure 4.57 was adapted from the *Study & Master Physical Sciences Grade 10 Learner's Book* (Kelder, 2012, p181). The teacher made use of the textbook to explain to learners how a ferromagnetic material becomes magnetised after the application of a strong external magnetic field. Learners were then tasked in their groups to use the domain theory to suggest why a permanent magnet can lose its magnetic properties after being dropped or hammered several times or heated strongly. The teacher then made use of the chalkboard to explain to learners that if a magnet is broken into smaller pieces, the smaller pieces of the magnet will be magnetic. The teacher also asked the learners whether it was possible to completely separate the North Pole from South Pole. She requested the learners to discuss this in their groups and suggest a scientific explanation using the domain theory. The group discussions were followed by feedback to the entire class. The findings and discussions were quite interesting. One learner thought it was possible while others said it was never possible to separate the poles. The teacher then explained and led the learners to realise that magnetic monopoles cannot exist after applying the domain theory.

The teacher concluded the lesson by directing learners to realise that magnetism is directly associated with charge movements, and that electricity and magnetism are one thing. Learners were then given homework based on residual or saturation magnetism and also the everyday uses and applications of magnets.

Table 4.18 Rating of Miss Z's lesson 3 using the RTOP monitoring instrument (see Appendix B for RTOP)

Statement	RTOP SECTION CATEGORY																								
	C					D					E					F					G				
	Rating					Rating					Rating					Rating					Rating				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1			✓						✓				✓				✓						✓		
2			✓					✓				✓						✓				✓			
3			✓							✓			✓				✓						✓		
4		✓						✓				✓					✓					✓			
5	✓						✓				✓								✓			✓			

Comment: Learners were not actively involved in the lesson. There was the minimum level of learner participation. The teacher provided most of the explanations of the concept of magnetic domain theory and its applications. Learners relied heavily on the textbook and the teacher's explanations.

4.5.2.4 Miss Z's lesson 4

Miss Z's lesson 4 objectives were almost the same as those of Mr W (see section 4.2.2.4). The only difference was that Miss Z used the traditional approach to teaching.

Miss Z began by explaining to learners the fact that our planet Earth is potentially a very large natural magnet. She also indicated that iron is one of the most abundant metals in the earth's crust. During her introduction she also highlighted the importance of directions in navigation and how magnets are used in sensing direction. The teacher demonstrated to the entire class how magnets can be used in predicting the earth's North Pole. She later requested learners to turn to their *Study & Master Physical Sciences Grade 10 Learner's Book* (Kelder, 2012, p185) for clarity of the diagram.

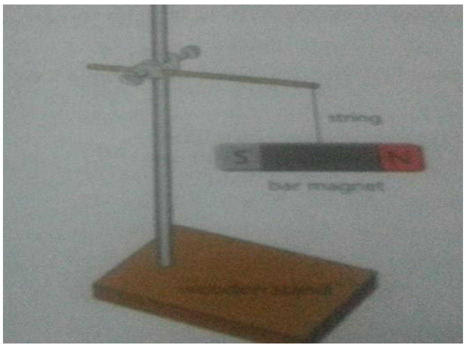


Figure 4.58 How to use a magnet to predict the earth's magnetic north and south pole

She also clarified the fact that the earth's geographical north pole does not exactly coincide with a permanent magnet's South Pole. They differ by a very small angle of around 24 degrees. This phenomenon is called magnetic declination. The diagram in Figure 4.59 extracted from the learners' textbook was also used by the teacher to explain magnetic declination. Figure 4.59 was adapted from *Study & Master Physical Sciences Grade 10 Learner's Book* (Kelder, 2012, p185).

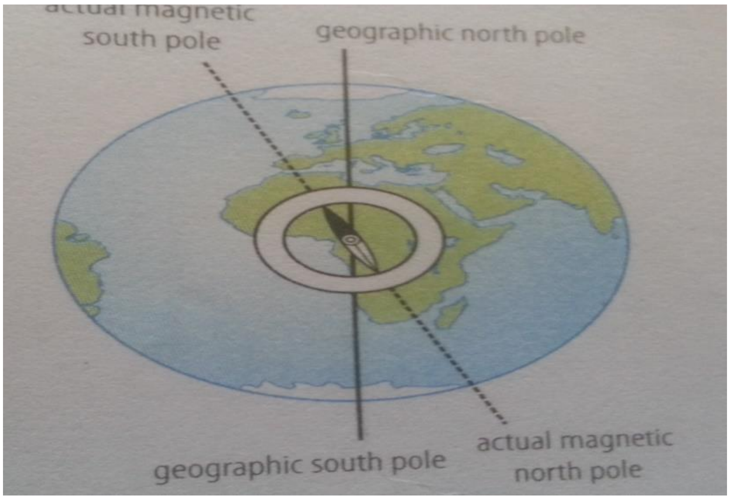


Figure 4.59 Difference between the actual magnetic north and south pole and the geographic north and south pole

The teacher led a general class discussion on how magnets, including gyromagnetic compasses, are used in navigation systems. She also used the Physical Sciences textbook (Kelder, 2012, p.186) to explain that there are some natural phenomena like aurora borealis and magnetic storms which are a result of the earth's magnetosphere. Figure 4.60 was adapted from *Study & Master Physical Sciences Grade 10 Learner's Book* (Kelder, 2012, p186).

Figure 4.60 The earth's magnetosphere exhibiting the northern lights (aurora borealis)

She explained while making use of the learner textbook that solar winds are greatly affected by the earth's magnetic field. Figure 4.61 was adapted from the Grade 10 textbook (Kelder, 2012, p185).

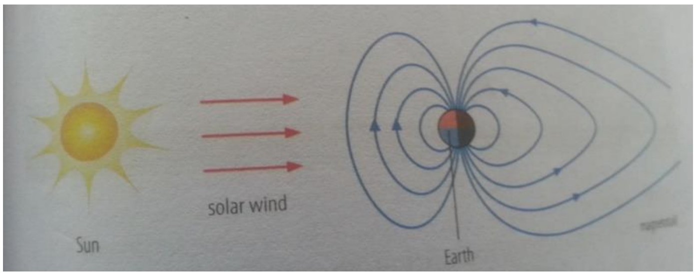


Figure 4.61 The solar wind being deflected by the earth's magnetic field

The teacher concluded the lesson by summing up the main ideas of the lesson. No homework was given.

Table 4.19 Rating of Miss Z's lesson 4 using the RTOP monitoring instrument (see Appendix B for RTOP)

Statement	RTOP SECTION CATEGORY																								
	C					D					E					F					G				
	Rating					Rating					Rating					Rating					Rating				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
1			✓					✓				✓					✓						✓		
2			✓					✓				✓						✓				✓			
3		✓							✓		✓						✓						✓		
4		✓					✓					✓					✓					✓			
5	✓						✓				✓								✓		✓				

Comment: The teacher taught the classes about the earth's magnetosphere using the traditional approach. Even though learners could observe the textbook diagrams and listened attentively to their teacher's explanations they were generally not active in this lesson. It was rather a teacher-centred lesson.

Table 4.20 General Comments on Miss Z's lesson observations using RTOP

RTOP Section	LESSON			
	1	2	3	4
C	Instructional strategies and activities respected learners' prior knowledge and the	This lesson did little to encourage learners to seek and value alternative modes	Even though prior knowledge was valued in the lesson plan, the lesson preparation was	This lesson did little to encourage learners to seek and value alternative modes of investigation or

	preconceptions inherent therein.	of investigation or problem-solving.	designed to engage learners as members of a learning community.	problem-solving.
D	The teacher had a solid grasp of the subject matter content inherent in the lesson.	Even though the teacher had a good command of the subject the lesson was teacher-centred since all relevant explanations were from the teacher aided with the textbook.	Even though the teacher had a solid grasp of the subject matter content inherent in the lesson the treatment of the fundamental concepts of domain theory was only through the teacher's explanations.	The lesson weakly promoted coherent conceptual understanding. Elements of abstraction (i.e., symbolic representations, theory building) were not emphasised in this lesson.
E	Learners were passively engaged in all activities of the lesson. The teacher did most of the talking.	Most of the explanations were provided by the teacher. Learners could not make predictions, estimations or hypotheses.	The engagement of learners during the lesson was passive and not thought-provoking.	Learners were passive recipients of knowledge as most of the information was generated by the teacher while being guided by the Grade 10 Physical Sciences textbook
F	The teacher did not trigger any thought-provoking questions and so learners were passively involved in the communication of their ideas to others.	The lesson was teacher-centred. The teacher determined the focus and direction of the lesson. Learner involvement in the lesson was very poor.	Even though there was a climate of respect for learner opinions there was a lower proportion of student talk and a significant amount of it was from the teacher.	The teacher did not put any thought-provoking questions during her presentation and so learners were passively involved in participation and in the communication of their ideas to others.
G	In general the teacher was not that patient with learners as she was targeting to complete the topic in specified time frame. The teacher did most of the talking.	Active participation of students was encouraged and valued. This was a teacher centred lesson.	In general the teacher was slightly patient with learners. The teacher acted like the source of all knowledge. Learners were not actively involved.	The teacher acted as a source of all knowledge while endeavouring to support and enhance student investigations. The lesson was teacher centred.

Egunsola (2014) points out that learners tend to gain significantly more knowledge and better achievement when being taught by a learner-centred approach. All four lessons taught by Miss Z were mainly teacher-centred. During the lessons the teacher would explain concepts using the chalkboard or the learners' textbooks. The teacher also taught using the chalkboard for illustrations. The learners were mainly inactive observers during the lessons since the teacher did most of the talking. Even during group activities, learners were almost whispering to each other to reduce noise levels. Experimental activities were few due to the limited availability of laboratory resources like permanent magnets. The concepts of domain theory, magnetic declination and solar winds were treated while using the textbook as the only source. The teacher's main priority was to finish the section on magnetism in line with the annual teaching plan.

4.6 General overview of the RTOP lesson observations

During the period of intervention the researcher observed four lessons per school. Each lesson was rated on a 5-point scale of the RTOP lesson observation tool. The total possible points per RTOP statement were 16. The total actual points obtained during class observations was then expressed as a percentage of the possible points in order to get the percentage rating for each statement. Table 4.21 is a summary of the RTOP observations rating for all the lessons obtained during the period of intervention.

Table 4.21 Summary of the analysis of the percentage rating RTOP lesson observations

	Statement	% rating				
		0	1	2	3	4
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.	0	0	12.5	12.5	75
2	The lesson was designed to engage students as members of a learning community.	0	0	12.5	37.5	50
3	In this lesson, student exploration preceded formal presentation.	0	12.5	6.25	68.75	12.5
4	This lesson encouraged students to seek and value alternative modes of investigation or of problem-solving.	0	18.75	12.5	50	18.75
5	The focus and direction of the lesson was often determined by ideas originating with students.	25	0	0	37.5	37.5
6	The lesson involved fundamental concepts of the subject.	0	0	6.25	18.75	75
7	The lesson promoted strongly coherent conceptual understanding.	0	0	25	12.5	62.5
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.	0	0	0	6.25	93.75
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.	0	18.75	6.25	50	25
10	Connections with other content disciplines and/or real world phenomena were explored and valued.	0	18.75	18.75	31.25	12.5
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.	0	6.25	18.75	50	50
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.	0	25	6.25	43.75	25
13	Students were actively engaged in thought-provoking a activity that often involved the critical assessment of procedures.	6.25	6.25	12.5	31.25	43.75
14	Students were reflective about their learning.	0	25	0	50	25
15	Intellectual rigour, constructive criticism and the challenging of ideas were valued.	12.5	0	6.25	75	6.25
16	Students were involved in the communication of their ideas to others using a variety of means and media.	0	25	0	43.75	31.25
17	The teacher's questions triggered divergent modes of	0	0	25	37.5	37.5

	thinking.					
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.	0	25	0	18.75	56.25
19	Student questions and comments often determined the focus and direction of classroom discourse.	0	25	0	56.25	18.75
20	There was a climate of respect for what others had to say.	0	0	6.25	43.75	50
21	Active participation of students was encouraged and valued.	0	0	25	25	50
22	Students were encouraged to generate conjectures, alternative solution strategies and ways of interpreting evidence.	0	25	0	68.75	6.25
23	In general the teacher was patient with students.	0	0	25	50	25
24	The teacher acted as a resource person, working to support and enhance student investigations.	0	25	0	68.75	6.25
25	The metaphor "teacher as listener" was very characteristic of this classroom.	18.75	6.25	18.75	37.5	18.75

A good teacher is one who diversifies his teaching styles to promote greater interaction among students (Egunsola, 2014). On the other hand, a good lesson is characterised by the active involvement of learners (Anbalagan, 2017).

Even though all the teachers apparently had the same qualifications, their approaches to teaching were varied.

Mr W taught all four lessons while being guided by the interactive use of CS. He only acted to guide the learners during the lessons. Mr W ensured that the questions which were put to him by his learners were mostly answered by other learners from his class. What determined the pace and direction of the lessons were the learners themselves. All Mr W's lessons were learner-centred, with the teacher acting as a good listener. Being a highly experienced teacher Mr W did not have any disciplinary problems related to class management. There were high levels of learner involvement and participation during all his classes on magnetism. The teacher managed to successfully complete and stage learner-centred lessons on magnetism using interactive CS. (See Table 4.5 for the RTOP summary of Mr W.)

Mr X's approach to teaching magnetism was different to that of Mr W. Instead of the interactive use of CS, Mr X resorted to the interactive use of videos to teach magnetism. All the videos which he used were taken from YouTube. His learners' level of participation was relatively higher than was the case in Mr W's lessons. Besides the guiding questions which he asked learners during his lessons, most of the questions were generated by learners during group activities. The answers to his questions as well as from other learners came from the learners themselves during the class discussions. The interactive use of YouTube videos was fully utilised during the lessons. Mr X was able to replay or pause the videos to help learners in conceptualising magnetism. Mr X, just like Mr W, also left the pace and direction of the lesson to be determined by the learners themselves. All of Mr X's lessons were associated with higher levels of learner involvement and participation than was the case in Mr W's lessons. (See Table 4.10 for the RTOP summary of Mr X.)

Mr Y's approach was different to that used by either Mr W or Mr X. Mr Y approached all four lessons by using both CS and videos interactively. The videos used in his lessons were all from YouTube, as was the case with Mr X. The interactive use of both CS and videos was associated with higher levels of learner involvement, motivation and participation than was the case with either Mr W's or Mr X's lessons. Another interesting fact also noted about Mr Y's lessons was his ability to use CS to answer a question that arose from the interactive use of videos. Mr Y also used his experience in all his lessons to allow learners to interact with each other. Even during class discussions Mr Y randomly selected individuals to either ask or respond to questions, to encourage the active participation of all learners. The interactive use of both CS and videos was primarily associated with high levels of active learner participation (see also Appendix P). Learner-to-learner interaction and the proportion of learner talk during the lesson were very high and most of the learner activities were thought-provoking. The focus and direction of the lesson in all experimental groups primarily emanated from the learners while the teacher acted as a resource person to facilitate learning. (See Table 4.15 for the RTOP summary of Mr Y.)

All the teachers demonstrated that they had sound content knowledge. This means that all the teachers had a solid grasp of subject content and were patient while executing their lessons and provided a good platform for learning to take place.

Nearly all the poor percentage ratings in Table 4.21 were contributed by School G, where the normal traditional methods of teaching were used. Furthermore, most of the class activities at School G were teacher-centred. Learners heavily relied on the teacher and their Physical Sciences textbook for explanations and information. The focus and direction of the lesson at School G was predetermined by the teacher while learners were merely passive recipients of knowledge (see Appendix P). (See Table 4.20 for the RTOP summary of Miss Z.)

4.7 QUALITATIVE PRESENTATIONS FROM QUESTIONNAIRE FINDINGS

4.7.1 Introduction

This section presents and qualitatively analyses data from the questionnaire instruments in order to address research question iv), which reads as follows:

- To what extent does the use of computer simulations and videos influence the teaching of magnetism in Grade 10?

A questionnaire was administered to the Grade 10 teacher participants of the four MST sampled schools. Five Grade 10 Physical Sciences teacher participants from the sampled schools completed the questionnaire. Four out of the five teachers requested hard copies and manually responded to the questionnaire using a pen. Only one teacher attached to School G requested an electronic copy and responded to the questionnaire electronically. There were three sections that emerged in the questionnaire (see Appendix C).

4.7.2 Section A: Background of sampled teachers

Teachers came from four different MST schools of differing sizes and geographically located in the Badplaas/Mashishila circuits of Mpumalanga Province. All four MST schools are in a rural setup. The teachers represented a broad spectrum of the profession and could be said to be as representative as possible of secondary Physical Sciences teachers.

The demographics of the teachers were captured in section A of the questionnaire. (See Table 4.22)

Table 4.22 Summary of the demographics of the Grade 10 teachers from the sampled schools

Teacher	Age range	Gender	Qualification	Teaching experience	Management experience	Physics contact time per week
W	40+	M	MEd	10+	5+	3/5
X	35-40	M	BEd +STD	5-10	0	4/5
Y	40+	M	BEd +STD	10+	5+	4/5
Z	25-30	F	BEd	0-5	0	5/5
unknown	25-30	M	BEd	0-5	0	5/5

With regard to age ranges, the Grade 10 Physics teachers from the sampled schools varied across the age range, from 21-30 to 51-60. The largest number, 3/5 or 60%, were in the 41-60 age range while 2/5 (40%) were in the 21-40 age range.

With regard to gender, only 1/5 (20%) of the sample were female teachers and 4/5 (80%) were male.

With regard to qualifications, 80% (4/5) of the teachers were holders of a Bachelor's degree. One male teacher (20% of the sample) had completed his Master's degree in physics education and is currently busy with his PhD studies.

With regard to teaching experience, the teachers ranged from three years to 32 years, with an average of 15.6 years. There were no teachers in their first or second year of teaching. The teachers in the sample were all involved in the teaching of Grade 10 Physical Sciences in secondary schools.

With regard to management, 2/5 (40%) of the Grade 10 Physics teachers were heads of the Natural Sciences department and also members of the school management team (SMT).

The amount of time they spent teaching Physical Sciences ranged from 60% (3/5 days per week) to 100% (5/5 days per week) of their total teaching commitment. The average time was 80% (4/5 days per week).

4.7.3 Section B: Computer knowledge and skills

There were 16 statements in section B of the questionnaire (see Appendix C). The statements in section B were presented on a six-point Likert scale, where 0 = not sure (NS) and 5 = strongly agree (SA). Table 4.23 summarises the responses of the sampled teachers based on section B of the questionnaire.

Table 4.23 Summary of teachers' responses to section B of the questionnaire

Statement		% response					
		0	**1**	**2**	**3**	**4**	**5**
1	I do use ICT (computer simulations and videos) to teach even before this research.	0	0	60	20	20	0
2	ICT usage captures learners' attention and increases their level of concentration in class.	0	0	0	0	20	80
3	ICT usage makes teaching Physics easier.	0	0	0	0	60	40
4	ICT usage should be integrated with traditional normal instructional methods in Physics (e.g. in magnetism).	0	0	0	20	20	60
5	Teachers should be work-shopped on how to use computer simulations and videos for teaching physical sciences concepts (e.g. magnetic domains & fields).	0	0	0	0	0	100
6	Use of a combination of computer simulations and videos in physics makes it easier to visualise the reality of imaginary concepts (e.g. magnetic domains & magnetic field lines).	0	0	0	0	0	100
7	Our school has a WIFI and DStv network and internet access which can potentially be used in Physics classes for computer simulations and video learning via YouTube & DVDs.	0	40	0	20	20	20
8	ICT usage helps in class control and management.	0	0	0	20	40	40
9	Physics is easy, fun, interesting and exciting when taught using both computer simulations and videos.	0	0	0	0	20	80
10	I think computer simulations, videos and DVDs are good learning tools when dealing with physics concepts (e.g. magnetic domains).	0	0	0	0	20	80
11	ICT usage makes teaching Physics easier and interesting.	0	0	0	0	0	100
12	ICT usage saves a lot of time used in drawing and labelling diagrams on the chalkboard.	0	0	0	0	0	100

13	ICT usage makes diagrams and graphical work clearer than drawing them on the chalkboard.	0	0	0	0	0	100
14	Use of computer simulations and videos in learning promotes higher order thinking skills and enables students to realise their full potential in physics.	0	0	0	0	40	60
15	Learners should be allowed to use their own smartphones or tablets via their school's WIFI network (through closely monitored school's gmail account) to download, watch and share physics simulations and videos.	0	20	20	0	0	60
16	Most of our schools have ICT infrastructure and tools but lack the know-how of integrating it into the curriculum as a teaching weapon.	0	0	20	40		40

From the results above the researcher deduced a great preference in support of statements S5, S6, S11, S12 and S13, as all the teachers indicated that they strongly agreed with the statement. This was followed by S2, S9, S10, where four out of the five teachers indicated that they strongly agreed with the statement. The statements which received the least support were S1, S7, S16 based on the percentage responses.

All the sampled teachers (100%) agreed that ICT usage makes teaching Physical sciences easier and interesting and also saves a lot of time wasted in drawing and labelling diagrams on the chalkboard. They also shared the view that the usage of ICT makes diagrams and graphical work clearer than drawing them on the chalkboard.

The majority of teachers (at least 80%) agreed that the teaching of abstract concepts like magnetic domain in Physical sciences can be easy, fun, interesting and exciting when taught using both computer simulations and videos.

Most teachers (about 60%) had their reservations regarding internet access in schools. Although the majority of teachers appreciated the potential of easy internet and WIFI access in the implementation of ICT in the physical sciences classroom, a lot needed to be done to unlock the potential of ICT in teaching and learning. The teachers reiterated that even though there was incontestable evidence of the potential of YouTube in the teaching and learning of physical sciences, good internet access was needed to enable teachers to select the videos that are of academic relevance. It was also emphasised in the teachers' responses that even though PhET simulations were considered as freely downloadable, internet and WIFI access in schools was not adequate.

Many teachers (60%) also pointed out that they rarely used ICT (computer simulations and videos) in their Physics classes due to a lack of technical know-how and the absence of an updated ICT infrastructure. Hence the sampled teachers (100%) all agreed that workshops on ICT skills and usage as a pedagogical tool should be conducted at least once every term.

Some teachers (40%) considered the use of smartphones and tablets by learners as controversial as it tends to create disciplinary problems. The other teachers (60%) on the other hand supported the idea that learners should be allowed to use their own smartphones or tablets via their school's WIFI network to download, watch and share physics simulations and videos. They emphasised that this had to be done through a closely monitored school's gmail account.

4.7.4 Section C: Responses related to ICT integration in the teaching and learning of Physical Sciences

In this section some sampled questionnaire responses of teachers are given. There were 14 structured questions presented in section C. The responses from section C also gave the researcher an overview of the teachers' thoughts and opinions about the intervention with ICT. The answers of the teachers were categorised in three categories namely positive, negative and neutral. This will provide a clear picture as well as create the overall impression of whether or not teachers are in support of the usage of ICT in the classroom.

In Appendix Q, the answers to the questions of section C of each of the teachers are presented. Table 4.24 is a summary of how the sampled teachers responded to section C of the questionnaire. From Table 4.24 a positive response implies that educators are in support of the ICT or witnessed positive results after the intervention. A negative response implies that educators are not in support of the statement. A neutral response means that the teacher is not quite sure or doesn't have substantial information to accept or disagree with the statement (see section 3.11).

Table 4.24 A summary of sampled teachers' responses to section C of the questionnaire

		NUMBER PER RESPONSE TYPE		
	QUESTION	**POSITIVE**	**NEUTRAL**	**NEGATIVE**
1	What is your perception of the use of ICT in teaching high school Physics?	**5**	**0**	**0**
2	How do you use computers for teaching at your school if there are enough for all learners in your class?	**2**	**2**	**1**
3	Do you think learners can learn Physics with ICT on their own? Explain briefly.	**2**	**1**	**2**
4	Explain how the timetable of the school could be adjusted to accommodate the use of ICT in teaching Physics.	**3**	**2**	**0**
5	What do you suggest should be done to improve learner performance through the interactive use of the DSTV learning Channel, DVD video discs and YouTube videos?	**4**	**1**	**0**
6	"Physics teachers should be ICT literate." What is your opinion?	**5**	**0**	**0**
7	From the study, do you think learners can be distracted by ICT when being taught Physics?	**3**	**2**	**0**
8	Explain the challenges that you would encounter when accessing the internet via WIFI in your school specifically for the direct benefit of Physics learners.	**0**	**5**	**0**
9	How often do you make use of the DSTV network and the computer laboratory with internet access during your Physics lesson execution?	**2**	**3**	**0**
10	What is your opinion on the statement that says, "Learners cannot learn Physics with ICT on their own"?	**4**	**1**	**0**
11	What do you suggest should be done by the SA government so that all Physics teachers can confidently make use of ICT tools in teaching and learning?	**5**	**0**	**0**
12	The PhET Learners can get access to free online software. i) How often do you use it / how comfortable are you using it for teaching Physics? ii) Do you think it is compatible with the South African CAPS syllabus?	 **2** **4**	 **2** **1**	 **1** **0**
13	How often should workshops on the interactive use of CS and videos in Physics be held to enable SA to be at par with digital 21st-century expectations?	**5**	**0**	**0**

14	Do you think that the interactive use of ICT resources can complement the shortage of laboratory equipment in your school? Explain briefly.	**5**	**0**	**0**

Most of the responses given by the sampled teachers were positive, indicating that they were in full support of ICT integration in teaching Physical sciences (see Qppendix Q). However, they pointed out some challenges hampering the successful integration of ICT in the teaching of Physical sciences. The following challenges were cited:

- 3/5 of teachers (60%) were not familiar with teaching using ICT resources like PhET simulations, videos, interactive smartboard or even PowerPoint. This was mainly due to poor computer literacy; hence they suggested that workshops related to the integration of ICT in Physical sciences teaching be held at least once per term (see Appendix Q).

- 5/5 of teachers (100%) agreed that the interactive use of ICT tools can compensate for the shortage of laboratory equipment and chemicals. The same sampled teachers complained about the serious shortage of laboratory equipment, something which they said was compromising learner performance, since experiments were mandatory in the CAPS syllabus (see section 2.2.5).

- 5/5 of the teachers (100%) also proposed that besides workshops, the Department of Education should equip them with ICT tools such as laptops or tablets in order to instil confidence in the usage of such appliances during teaching and learning.

- 3/5 of teachers (60) were of the view that even though the potential of the interactive use of CS and YouTube videos cannot be underestimated, such ICT tools cannot be implemented in the classroom if teachers were still ignorant of ICT.

4.8 SUMMARY

This chapter primarily focused on the research findings based on an analysis of questionnaire responses and lesson observations guided by the RTOP. The findings of the lesson observations and questionnaire analysis were intended to assist in answering the fourth research question (see section 5.12).

CHAPTER 5
PRESENTATION OF QUANTITATIVE DATA ANALYSIS, DISCUSSION & CONCLUSION

5.1 INTRODUCTION

Creswell (2003) defines quantitative research as a strategy that puts more emphasis on quantifying data collection and analysis. This basically implies that quantitative research refers to amounting something. Quantitative research method provides efforts of investigating answers to the "how many, how much, to what extend" type of research questions (Bryman, 2012). In other words, quantitative research method stresses more heavily on measurement of variables in the physical and social world.

The quantitative data obtained from this study and the associated analyses are presented in this chapter. The analysis of the data is meant to respond to the research questions, which also guided this study. The four research questions were:

(i) Does the interactive use of computer simulations have an impact on the Grade 10 learners' performance in magnetism?
(ii) Does the interactive use of videos have an impact on the Grade 10 learners' performance in magnetism?
(iii) Does the interactive use of the combination of computer simulations and videos have an impact on the performance of Grade 10 learners in magnetism?
(iv) To what extent does the use of computer simulations and videos influence the teaching of magnetism in Grade 10?

The data obtained after the administration of the pre-post-tests to the experimental and control groups (see section 3.5) was analysed quantitatively using statistical instruments (see section 3.10).

In order to fully address the research questions, the following null hypotheses were formulated:

H_{01}: There is no significant difference in the performance in magnetism of Grade 10 learners exposed to the interactive use of computer simulations compared to the traditional approach to teaching.

H_{02}: There is no significant difference in the performance in magnetism of Grade 10 learners exposed to the interactive use of videos compared to the traditional approach to teaching.

H_{03}: There is no significant difference in the performance in magnetism of Grade 10 learners exposed to the interactive use of a combination of computer simulations and videos if compared to the traditional approach to teaching.

To find the answers to the research questions a pre-test and the same post-test (magnetism achievement test) were distributed to the Grade 10 learners. The data from the magnetism pre-post-tests was analysed quantitatively using SPSS 24.0 software.

The scores of the pre-test were initially analysed using the independent t-test to determine the equivalence of the four groups (see section 5.3). To determine whether the difference between the pre-test and the post-test scores for each of the four groups was statistically significant, a paired independent t-test was conducted. This analysis was used to ascertain whether the null hypotheses should be accepted or rejected (see section 5.5). A cross-tabulation analysis of achievement level versus intervention approach was also conducted. Additionally a chi-square analysis was carried out to assess the relationship between achievement level and intervention approach (see section 5.7).

The effect of the interactive use of CS, videos, and CS and videos as intervention approaches was also descriptively analysed using the one-way analysis of variance (ANOVA) approach (see section 5.8). Furthermore, in order to predict the effectiveness of the intervention methods, Hake's normalised gain was conducted for the four groups – three experimental and one control (see section 5.9).

A presentation of the results of the data follows.

5.2 EQUIVALENCE OF THE FOUR GROUPS

A pre-test was conducted before the teaching intervention to establish whether or not the experimental and control groups were at the same level or comparable in terms of the topic of magnetism.

Table 5.1 Independent sample test results of pre-test scores of control and experimental groups by school

School	Experiment Condition	Interven-tion	N	Mean	SD	df	t-statistic	p-value
D	EXPTAL	CS	50	20.920	8.649	103	-0.480	0.632
	CONTR	traditional	55	20.218	6.226			
E	EXPTAL	videos	38	21.579	6.931	82	-0.432	0.667
	CONTR	traditional	46	20.913	7.114			
F	EXPTAL	CS + videos	60	20.973	7.833	114	-0.068	0.946
	CONTR	traditional	56	20.857	9.449			
G	CONTR	traditional	88	21.786	9.740	86	-0.457	0.758

Parametric independent samples tests were conducted at 5% level of significance to test for a significant difference in pre-test performance in magnetism of Grade 10 learners before being exposed to each of the following:

- the interactive use of computer simulations compared to the traditional approach to teaching;
- the use of videos compared to the traditional approach to teaching;
- the use of both videos and interactive computer simulations compared to the traditional approach to teaching;
- the use of traditional teaching.

From Table 5.1 above the following is observed:

- There was no significant difference in the pre-test performance in magnetism of Grade 10 learners before exposure to the interactive use of computer simulations compared to the traditional approach to teaching at p-value >0.05 [**t**(103) = –0.48, p-value = 0.632]. The mean (mean = 20.920) of the experimental group in School D was similar to the mean (mean = 20.218) of the control group in the same school. Therefore, before intervention the learners in the school were of the same ability.

- There was no significant difference in the pre-test performance in magnetism of Grade 10 learners before being exposed to the use of videos compared to the traditional approach to teaching at p-value >0.05 [**t**(82) = –0.432, p-value = 0.667]. The mean (mean = 21.579) of the experimental group in School E was similar to the mean (mean = 20.913) of the control group in the same school. Therefore, before the intervention the learners in the school were of the same ability.

- There was no significant difference in the pre-test performance in magnetism of Grade 10 learners before being exposed to both computer simulations and videos compared to the traditional approach to teaching at p-value >0.05 [**t**(114) =–0.068, p-value = 0.946]. The mean (mean = 20.973) of the experimental group in School F was similar to the mean (mean = 20.857) of the control group in the same school. Therefore, before intervention the learners in the school were of the same ability.

- There was no significant difference in the pre-test performance in magnetism of Grade 10 learners before exposure to the interactive use of computer simulations compared to the traditional approach to teaching at p-value >0.05 [**t**(136)= –0.481, p-value = 0.632]. The mean (mean = 20.92) of the experimental group in School D was similar to the mean (mean = 21.59) of the traditional group in School G. Therefore, before intervention the learners in the groups were of the same ability.

- There was no significant difference in the pre-test performance in magnetism of Grade 10 learners before being exposed to the interactive use of videos compared to the traditional approach to teaching at p-value >0.05 **[t**(124) = –0.432, p-value = 0.667]. The mean (mean = 21.58) of the experimental group in School E was similar to the mean (mean = 21.79) of the traditional group in School G. Therefore, before intervention the learners in the groups were of the same ability.

- There was no significant difference in the pre-test performance in magnetism of Grade 10 learners before exposure to the interactive use of both computer simulations and videos compared to the traditional approach to teaching at p-value >0.05 [**t(**146) = –0.457, p-value = 0.758]. The mean (mean = 20.97) of the experimental group in School F was similar to the mean (mean = 21.79) of the traditional group in School G. Therefore, before intervention the learners in the groups were of the same ability.

5.3 PRE-POST-TESTS COMPARISON BETWEEN GROUPS

To ascertain whether there was a statistically significant difference in the performance of the groups between the pre-test and post-test, the mean was calculated for each group. The results were tabulated as shown in Table 5.2 and mean comparison was conducted as shown in Figure 5.1.

Table 5.2 A summary of pre-post-test means for control and experimental groups

GROUP		**Intervention**	**PRE-TEST/100**			**POST-TEST/100**		
			N	Mean	SD	N	Mean	SD
D	EXPTAL	CS	50	20.920	8.69	50	77.280	12.194
	CONTR	Traditional	55	20.218	6.226	55	65.527	10.270
E	EXPTAL	Videos	38	21.579	6.931	38	77.000	12.509
	CONTR	Traditional	46	20.913	7.114	46	67.261	7.331
F	EXPTAL	CS + videos	60	21.733	7.859	60	79.867	9.409
	CONTR	Traditional	55	20.857	9.449	55	70.571	8.204
G	CONTR	Traditional	43	20.372	8.742	43	67.814	11.074
	CONTR	Traditional	45	23.200	9.820	45	68.311	9.908

The data presented in Table 5.2 can be graphically represented in the form of a bar graph, as shown in Figure 5.1.

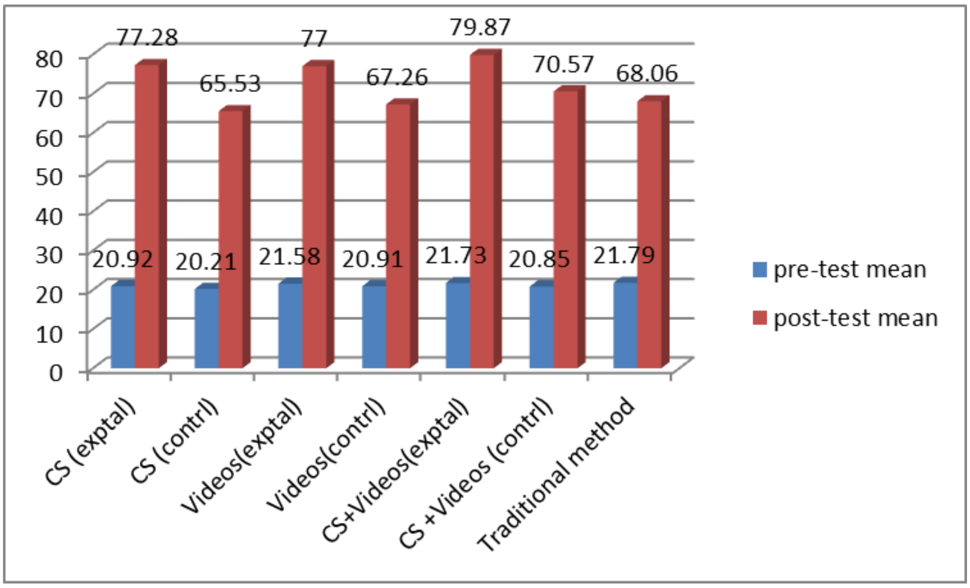


Figure 5.1 Comparison of pre-post-test means between experimental and control groups

From Figure 5.1 it can be observed that there is a significant difference between the pre-test mean and post-test mean for the CS group, pre-test mean and post-test mean for the videos group, and the pre-test and post-test means for the CS and videos group. The CS and videos group achieved a significantly higher post-test mean (mean = 79.87) than CS only (mean = 77.28) and videos only (mean = 77). The group without any ICT intervention had a mean of 68.06. The greater significant difference between the pre-test and post-test means provides uncontested evidence that ICT intervention had a great positive impact on the performance of learners in magnetism. This concurs with the literature (see sections 2.4.1-2.5.2).

5.4 THE USE OF THE INDEPENDENT T-TEST IN HYPOTHESIS TESTING

A t-test statistical significance shows whether or not there is a most likely real difference between two groups sampled from the same population (Hinkle et al., 2003). An independent t-test was used in the study to test the null hypotheses **H_o1, H_o2** and **H_o3** to evaluate whether there was a statistically significant difference in performance between the experimental group and control group per school, as well as between experimental schools and control school (see section 3.10.1).

The scores of the pre- and post-tests were analysed quantitatively using the independent t-test to determine the equivalence of the four groups and to determine whether the difference in the performance of the groups was statistically significant.

5.4.1 The independent t-test for School D using CS in the experimental group

The scores of the pre-tests and post-tests were analysed quantitatively using the independent t-test in School D, where the experimental group used computer simulations.

Table 5.3 Summary of quantitative data used to conduct the independent t-test at School D

School	Experiment Condition	Intervention	N	Mean	SD	df	t-statistic	p-value
D	Control	Traditional	55	48,33	10,546	103	-13,043	0.000
	EXPTAL	Computer simulations	50	77,28	12,194			

From Table 5.3 we observe the following:

- There is a significant difference in the post-test performance in magnetism of Grade 10 learners exposed to the interactive use of computer simulations compared to the traditional approach to teaching at p-value <0.05 [**t**(103) = –13,043, p-value = 0.000]. This suggests that the research null hypothesis $\mathbf{H_0 1}$ cannot be accepted. However, learners exposed to the interactive use of computer simulations (mean = 77,28) performed better than learners exposed to the traditional approach (mean = 48,33).

5.4.2 Independent t-test for School E using videos in the experimental group

The scores of the pre- and post-tests were analysed quantitatively using the independent t-test in School E, where the experimental group used videos.

Table 5.4 Summary of quantitative data used to conduct the independent t-test at School E

School	Experiment Condition	Intervention	N	Mean	SD	df	t-statistic	p-value
E	Control	Traditional	46	41,83	14,229	82	-11.903	0.000
	EXPTAL	Videos	38	77,00	12,509			

From Table 5.4 we observe the following:

- There is a significant difference in the post-test performance in magnetism of Grade 10 learners exposed to the use of videos compared to the traditional approach to teaching at p-value <0.05 [**t**(82) = –11.903, p-value = 0.000]. The results suggest that the research null hypothesis $\mathbf{H_02}$ cannot be accepted. However, learners exposed to the interactive use of videos (mean = 77) performed better than learners exposed the traditional approach (mean = 41.83).

5.4.3 Independent t-test for School F using videos in the experimental group

The scores of the pre- and post-tests were analysed quantitatively using the independent t-test in School F, where the experimental group used CS and videos.

Table 5.5 Summary of quantitative data used to conduct the independent t-test at School F

School	Experiment Condition	Intervention	N	Mean	SD	df	t-statistic	p-value
F	Control	Traditional	56	70,57	8,204	114	-5,620	0.000
	EXPTAL	CS + videos	60	79,90	9,563			

From Table 5.5 we observe the following:

- There is a significant difference in the post-test performance in magnetism of Grade 10 learners exposed to the use of both computer simulations and videos compared to the traditional approach to teaching at p-value <0.05 [**t**(114) = –5,620, p-value = 0.000]. The results suggest that the research null hypothesis $\mathbf{H_03}$ cannot be accepted. However, learners exposed to the interactive use of CS and videos (mean = 79.90) performed better than learners exposed to the traditional approach (mean = 70.57).

5.5 COMPARISON OF POST-TEST SCORE OF EXPERIMENTAL GROUPS AT SCHOOLS AND THE CONTROL GROUP AT SCHOOL G

The post-test results from Schools D, E and F's experimental groups were also compared to the post-test results from School G, which was primarily using the traditional method during the intervention period. The data presented in Table 5.6 was then used to test the null research hypotheses **$H_0$1, $H_0$2** and **$H_0$3.**

Table 5.6 Independent sample test results of post-test scores of control group at School G and experimental groups at Schools D, E and F

School	Experiment Condition	Intervention	N	Mean	SD	df	t-statistic	p-value
D	EXPTAL	Computer simulations	50	77.28	12.194	136	4.685	0.000
G	CONTROL	Traditional	88	68.07	10.436			
E	EXPTAL	Videos	38	77.00	12.509	124	4.147	0.000
G	CONTROL	Traditional	88	68.07	10.436			
F	EXPTAL	CS and videos	60	79.90	9.563	146	7.002	0.00
G	CONTROL	Traditional	88	68.07	10.436			

The independent samples test is a parametric test and was conducted at 5% level of significance to test for a significant difference in post-test performance in magnetism of Grade 10 learners.

From Table 5.6 the following can be observed:

- There is a significant difference in the post -test performance in magnetism of Grade 10 learners exposed to the use computer simulations compared to the traditional approach to teaching at p-value <0.05 [**t**(136) = 4.685; p-value = 0.000]. The results suggest that the research null hypothesis **$H_0$1** cannot be accepted. However, learners exposed to the interactive use of CS (mean = 77.28) performed better than learners exposed to the traditional approach (mean = 68.07).

- There is a significant difference in the post-test performance in magnetism of Grade 10 learners exposed to the interactive use of videos compared to the traditional approach to teaching at p-value <0.05 [**t**(124) = 4.147, p-value = 0.000]. The results suggest that the research null hypothesis **$H_0$2** cannot be accepted. However, learners exposed to the interactive use of videos (mean = 77.00) performed better than learners exposed to the traditional approach (mean= 68.07).

- There is a significant difference in the post-test performance in magnetism of Grade 10 learners exposed to the interactive use of both computer simulations and videos compared to the traditional approach of teaching at p-value <0.05. [**t**(146) = 7.002, p-value = 0.000]. The results suggest that the research null hypothesis **$H_0$3** cannot be accepted. However, learners exposed to the interactive use of CS and videos (mean = 79.90) performed better than learners exposed to the traditional approach (mean = 68.07) to teaching.

Hence a statistically significant difference in learner performance is observed between the experimental group subjected to CS; videos; CS and videos combined compared to the control group subjected to the traditional method in Grade 10 on the topic of magnetism.

5.6 THE RELATIONSHIP BETWEEN POST-TEST ACHIEVEMENT LEVEL AND THE INTERVENTION APPROACH

The post-test results from the experimental groups were also compared to the post-test results from School G, which was using the traditional method during the intervention period. The data presented in Table 5.7 was then used to compare learner performance in terms of achievement levels (see Table 3.5 and 3.6).

Table 5.7 Cross-tabulation of post-test achievement level versus intervention approach

		Intervention approach									
		Computer simulations		Videos		Computer simulations and videos		Traditional		Total	
		N	%	N	%	N	%	N	%	N	%
Achieve-ment level (Post-test)	Below average	0	0.0%	0	0.0%	0	0.0%	4	100.0%	4	100.0%
	Average	4	17.4%	6	26.1%	0	0.0%	13	56.5%	23	100.0%
	Above average	46	22.0%	32	15.3%	60	28.7%	71	34.0%	209	100.0%

From Table 5.7 we observe the following:

- Among the four intervention approaches used, the majority of the learners who performed below average (100%) in the post-test were exposed to the traditional teaching approach.
- Out of the four intervention approaches used the majority of the learners who achieved average performance in the post-test were exposed to the traditional teaching approach (56.5%) while none of the learners exposed to the combined use of computer simulations and videos (0.0%) achieved an average performance.
- Of the four intervention approaches used the majority of the learners who performed above average were exposed to the traditional teaching approach (34%). However, all the learners exposed to the use of computer simulations; videos, and computer simulations and video teaching approaches performed above average.

5.7 CHI-SQUARE TEST FOR THE RELATIONSHIP BETWEEN THE POST-TEST ACHIEVEMENT LEVEL AND THE INTERVENTION APPROACH

Hypotheses

H_N: There is no significant relationship between post-test achievement level and intervention approach.

H_A: There is a significant relationship between post-test achievement level and intervention approach.

Table 5.8 Chi-square test of post-test achievement level and intervention approach

		Intervention approach
Post-test achievement level	Chi-square	18.089
	df	6
	Sig.	0.006

A non-parametric chi-square test was carried out to test for the significant relationship between the post-test achievement level and the intervention at 5% level of significance. Table 5.8 shows a significant relationship between the post-test achievement level and the intervention approach at p-value less than 0.05 [chi-square (6) = 18.089, p-value = 0.006] Therefore H_N is rejected at 5% level of significance. Thus in this sample, the intervention approach does differ significantly in the likelihood on achievement level in the post-test.

5.8 THE EFFECT OF INTERVENTION APPROACHES ON POST-TEST SCORES

The effect of the interactive use of CS, videos, CS and videos as intervention approaches was also descriptively analysed using the analysis of variance (ANOVA) approach. The ICT intervention approach was then compared with the traditional method. The ANOVA results were also obtained using SPSS software.

Table 5.9 Post-tests score descriptive statistics by intervention approach

					95% confidence interval for mean			
Intervention approach	N	Mean	Std Deviation	Std Error	Lower Bound	Upper Bound	Minimum	Maximum
Computer simulations	50	77.28	12.194	1.725	73.81	80.75	54	96
Videos	38	77.00	12.509	2.029	72.89	81.11	50	96
Computer simulations and videos	60	79.90	9.563	1.235	77.43	82.37	60	96
Traditional	88	68.07	10.436	1.113	65.86	70.28	36	88
Total	236	74.47	12.021	0.783	72.92	76.01	36	96

ANOVA (Analysis of variance)

Hypotheses

$\mathbf{H_N}$: The average performance of Grade 10 learners in the post-test on magnetism is the same for all four intervention approaches, namely computer simulations, videos, videos and computer simulations, and traditional, that is, the intervention approaches have no significant effect on the average performance in the post-test.

$\mathbf{H_A}$: The average performance of Grade 10 learners in the post-test on magnetism is not the same among the four intervention approaches, namely computer simulations, videos, videos and computer simulations, and traditional, that is, the intervention approaches have a significant effect on the average performance in the post-test.

Table 5.10 ANOVA results on the effect of intervention approaches on the post-test

ANOVA					
	Sum of squares	**df**	**Mean square**	**F**	**p-value**
Between groups	6013.658	3	2004.553	16.641	0.000
Within groups	27947.071	232	120.462		
Total	33960.729	235			

A one-way ANOVA was conducted at 5% level of significance to test the hypothesis, namely that the average performance of Grade 10 learners in the post-test on magnetism is not the same among the four intervention approaches – computer simulations, videos, videos and computer simulations, and traditional – that is, the intervention approaches have a significant effect on the average performance in the post-test. Table 5.10 shows that there is a significant effect on the average performance in the post-test at p-value <0.05 for the four intervention approaches [F (3,232) = 16.641, p-value = 0.000]. The null hypothesis ($\mathbf{H_N}$) is therefore rejected at 5% level of significance.

5.9 HAKE'S AVERAGE NORMALISED GAIN

Hake's average normalised gain was used to measure the effectiveness of interactive CS, videos and the combination of CS and videos since it strongly differentiated between teaching methods.

Hake's average normalised gain provides a rough measure of the effectiveness of an interactive teaching method in enhancing conceptual understanding (McKagan et al., 2017).

Table 5.11: A summary of Hake's average normalised gain for the four groups after intervention

School	Experimental	<g>	Classification
School D	CS	0.713	High gain
School E	Videos	0.706	High gain
School F	CS + videos	0.743	High gain
School G	Traditional	0.592	Medium gain

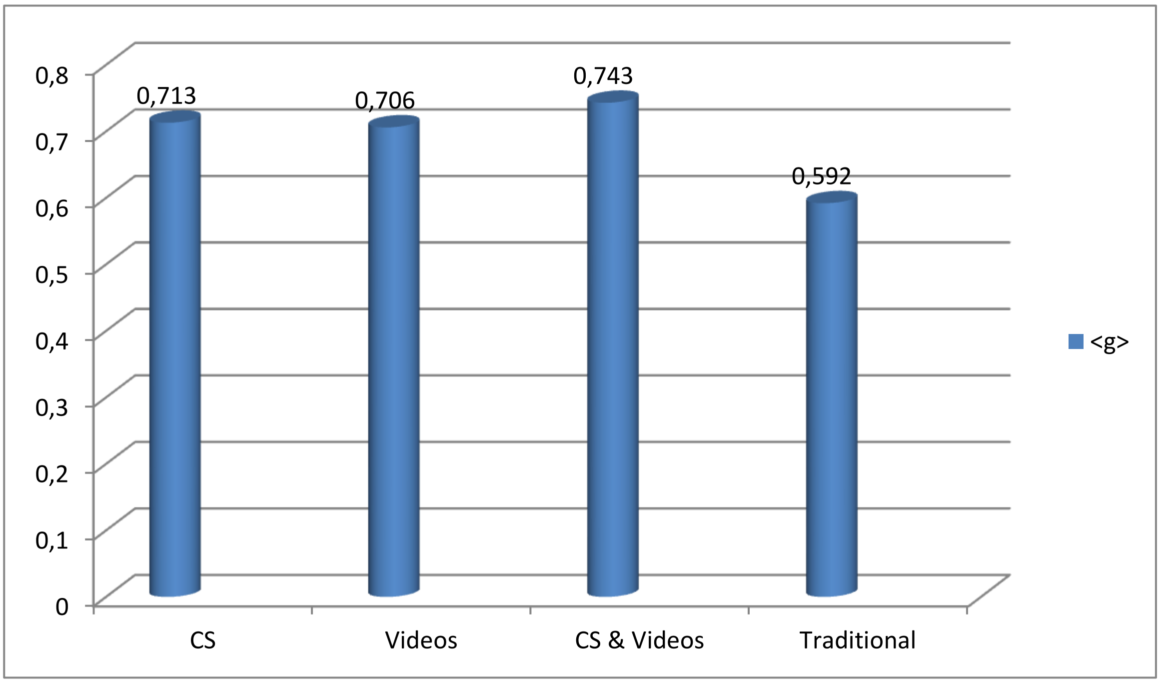


Figure 5.2 Comparison of average normalised gain between the four groups

According to the classifications suggested by Hake (1998), low-<g> values are related with traditional models of teaching (see section 3.10.3). The high values of <g> represented ICT interactive-engagement methods while the medium values of <g> represented both traditional methods and the interactive-engagement methods of teaching (McKagan et al., 2017).

Based on the average normalised gain (<g>) shown in Figure 5.2, it can be observed that the value of g is above 0.7 in all the experimental groups that were exposed to ICT intervention methods and 0.3<g>7 in the control group, which was only subjected to the traditional method. It was also observed that the interactive use of the combination of CS and videos had the highest value of normalised gain (g = 0.743) if compared to that of CS and videos. Even though the control group had an average normalised gain greater than 0.3 (g = 0.592) after intervention using the traditional method, the gain from the experimental groups by far surpassed that of the control group.

The next section (section 5.10) provides the details of the findings situated in TPACK.

5.10 FINDINGS OF THE STUDY SITUATED IN THE TPACK FRAMEWORK

The successful integration of ICT in the classroom requires a proper understanding of the pedagogical attributes and affordances of the new learning technologies (Thornburg, 2000). The theoretical framework of the study is based on the TPACK model rooted in the constructivist approach (see section 2.7).

This study adopted the constructivist teaching method through the utilisation of ICT resources to facilitate learners' active engagement in technological devices while focusing on magnetism (see section 4.6 and 4.7). The findings of the study showed that the teachers in the sampled schools had sufficient content knowledge as 82% of them had at least a B.Ed. degree (see Table 4.22). Moreover, all the sampled Grade 10 teachers had at least a year of teaching experience (see section 4.7).

In terms of technology, the teachers did not have what technology was available to use in the classroom (TK) (see section 4.7.4), or the necessary skills how to use the technology (TCK) (see section 4.7.4) or the skills to teach with technology (TPK) (see section 4.7.4).

Furthermore, the three experimental groups appreciated the need to integrate ICT in their classes as part of their pedagogical content knowledge (TPACK) (see section 4.7). They experienced how to use technology interactively in the physical sciences classroom to facilitate the understanding of magnetism.

The questionnaire responses expressed the need to equip schools with ICT resources to enable teachers to develop technological content knowledge (TCK) (see section 4.7). Even though the teachers from sampled schools were comfortable with the traditional methods of teaching, findings from RTOP lesson observations and questionnaire responses showed that the effective integration of ICT as a pedagogical approach requires technological know-how before implementation (see sections 4.2 to 4.4).

In addition, the research findings showed that the interactive use and manipulation of CS, videos and the combination of CS and videos provided teachers with TCK as a pedagogical incentive to the PCK, which most teachers exhibited before intervention (see section 4.6 and 4.7).

The impact of TPACK (developing teaching in the skills of technology and how to use it interactively in the classroom to facilitate understanding) in the study was associated with a better performance by Grade 10 learners from the experimental groups compared with those in the control group in the topic of magnetism (see section 5.8 & 5.9). The immense potential of integrating technology in the teaching of Grade 10 magnetism also led to active learner involvement and higher levels of learner participation during the lessons (see section 4.6).

SUMMARY

This above sections (5.1 to 5.9) presented the statistical data analysis of the pre-post-test results. The paired t-test, chi-square tests and Hake`s normalised gain were also used in data analysis. Section 5.10 was primarily focusing on findings situated in TPACK.

5.11 DISCUSSION OF RESEARCH FINDINGS

5.11.1 INTRODUCTION

The following sections (5.11 to 5.12) present the research findings and discussion based on interactive use of CS, YouTube videos, CS and YouTube videos. The sub-sections (5.11.2 to 5.12.2) also attempt to respond to the research questions prescribed in section 1.5.1.

5.11.2 FINDINGS OF STUDY BASED ON THE INTERACTIVE USE OF CS

The literature suggests that a problem-solving approach to teaching and learning when used in conjunction with PhET computer simulations will result in a remarkable improvement in learner performance (Kaheru, 2014).

An analysis of the pre-post-test in Table 5.3 shows that CS greatly increased the conceptual understanding of magnetism in the experimental group D compared to all the control groups. The calculated Hake's normalised gain for experimental group D was <g> = 0.7127 and 0.568 for the control group D in the same school, while it was 0.587 for control group G (see Figure 5.2). From the ANOVA results in Table 5.10, the indication is that the interactive use of CS has a significant effect on the average performance in the post-test on magnetism if compared to the traditional method. The independent t-test results in Tables 5.3 and 5.4 further suggest a significant difference between the experimental CS and control group.

USING AVAILABLE DATA TO ANSWER THE FIRST RESEARCH QUESTION

The 1st research question read as follows:

- Does the interactive use of computer simulations have an impact on the Grade 10 learners' performance in magnetism?

The findings of the study revealed that there was a statistical significant increase in the performance in post-test than in pre-test by learners who were exposed to the interactive use of CS when compared with those exposed to traditional methods after intervention in the topic of magnetism (see Table 5.3 and 5.4). This was also found by other researchers (Kaheru, 2014; Kotoka, 2012; Dega, 2016 & Kunnath, 2018). Furthermore, statistical results of the chi-square test as well as ANOVA results in the study showed that there was a significant increase in the average performance in magnetism of Grade 10 learners exposed to the interactive use of CS when compared with those exposed only to the traditional method of teaching magnetism (see Table 5.6 and 5.8). From the classroom observation report in section 4.2 the interactive use of CS in teaching had a positive influence in the learning of magnetism. Learners were active participants during their lessons, observing, predicting and discussing concepts of magnetism via teacher-guided CS. These findings also concur with those of Byers, Mahat, Liu, Knock and Imms (2018). These results provided support to the research findings of studies conducted by Kaheru (2014) who noted that there was a remarkable improvement in learner performance in grade 11 topic of optical geometrics. Kotoka (2012) in his master's thesis based on grade 11 electromagnetism also concluded that interactive use of CSs using the PhET software resulted in improved learner performance. The effective of interactive use of CS was confirmed by Kapartizianis (2014) in electricity with TVET college students in Cyprus. Dega (2013) on the concept of electric potential energy to undergraduate students in Ethiopia confirmed in his research in that CS was an effective pedagogical tool which enhances learner performance. This also concurred with Kapartzianis & Kriek (2014) who predicted a greater learner performance in physics topics if CS was adopted as pedagogy. This study was an extension of the above-named research predecessors which was based on the SA grade 10 physics topic of magnetism. The findings from this study also concurred and revealed that using CS was an effective pedagogical tool in teaching physical sciences topics such as magnetism in grade 10.

5.11.3 FINDINGS OF STUDY BASED ONTHE INTERACTIVE USE OF YOUTUBE VIDEOS

According to Thelwall (2012) there was still a lack of reliable supporting research to reveal the overall impact of YouTube videos on learner performance in magnetism. By 2012 there was no documented research evidence pointing towards the use of Youtube videos in the classroom. That is why it was suggested that any approach to lesson execution could possibly be reformulated using the video approach to enable learners to understand physical concepts (Muller et al., 2012).

An analysis of the pre-post-test in Table 5.3 shows that video greatly increased learner performance in magnetism in the experimental group E compared to all the control groups. The calculated Hake's normalised gain for experimental group E was <g> = 0.7067 and 0.586 for the control group E in the same school, while it was 0.596 for control group G (see Figure 5.2). There was a general increase in the performance of individual learners in the post-test compared to the pre-test (see Table 5.2). From the ANOVA results in Table 5.10, the indication is that the interactive use of videos has a significant effect on the average performance in the post-test on magnetism if compared to the traditional method. The independent t-test results in Tables 5.3 and 5.4 further suggest a significant difference between the experimental video and control group. From the classroom observation report in section 4.2 the interactive use of videos in teaching had a positive influence on the learning of magnetism. The use of videos triggered high levels of learner involvement and active participation during the lessons, with learners observing, predicting and discussing concepts of magnetism via teacher-guided videos. Learners were actively involved in the construction of their own comprehension of scientific ideas while being bounded by the framework of their existing knowledge (see also Appendix 0). These findings concur with the recommendations from literature (see section 2.5.1).

USING AVAILABLE DATA TO ANSWER THE SECOND RESEARCH QUESTION

The 2nd research question read as follows:

- Does the interactive use of videos have an impact on the Grade 10 learners' performance in magnetism?

The statistical analysis of data based on the study findings positively contributed to the educational field since no research had been conducted prior to this study on the interactive use of YouTube videos in Grade 10 on the topic of magnetism . Furthermore, the chi-square test as well as ANOVA results also confirmed a statistical significant increase in the average performance of Grade 10 learners exposed to the interactive use of videos when compared with those exposed only to the traditional method in magnetism (see Table 5.6 and 5.8). The study also revealed that there was not a significant difference in performance between the experimental groups exposed to CS when compared with the group exposed to videos only in Grade 10 magnetism (see Table 5.9). The performance of learners exposed to CS if compared to those exposed to Youtube videos in the topic of magnetism has no known previous research history. Hence the findings of this study contributed to research gap.

The findings of this study further revealed that there was a significant increase in the performance of Grade 10 learners who were exposed to the interactive use of Youtube videos when compared to those exposed to traditional methods after the intervention in magnetism (see section 5.8 & 5.9). These results provided support to the research findings of studies conducted by Wilson (2015) at the university of Toronto where he cited lack of awareness by educators on the potential of using YouTube as a pedagogical tool. June et al (2015) observed the potential of videos and not necessarily YouTube, for presenting experimental details to schools without access to laboratory equipment. Del Campo et al., (2012) also observed notable improvements of undergraduate student performance in electromagnetism after a video intervention method was utilised if compared to traditional method. The potential of Youtube in the classroom was given an initiative by Muller et al (2012) when they invented the veritasium collection of Youtube physics videos. This suggested that using Youtube videos could be an effective pedagogical tool in teaching physics topics such as magnetism. Hence the findings of this study concurred with predictions of previous research since there was increased performance in learners exposed to interactive use of Youtube videos in SA grade 10 magnetism compared to those exposed to the traditional method.

5.11.4 FINDINGS OF STUDY BASED ON THE INTERACTIVE USE OF CS AND VIDEOS

Bramowicz et al. (2014) reveal that limited research had been done so far in the physics of magnetism due to a lack of advanced laboratory equipment that can sense magnetism, a phenomenon that can easily be observed if a combination of CS and Youtube videos is used. Kotoka & Kriek (2014) recommend that the integration of ICT as pedagogical tools in physics education can help a great deal in improving learners' performance and achievement.

An analysis of the pre-post test in Table 5.3 shows that the interactive use of CS and videos greatly increased learner performance in magnetism in the experimental group F compared to all the control groups. The calculated Hake's normalised gain for experimental group F was <g> = 0.74529 and 0.628 for the control group F in the same school, while it was 0.596 for control group G (see Figure 5.2). The normalised gain (g = 0.74) for experimental group F was the highest value obtained in this study and surpassed all other experimental groups. The performance of individual learners in the post-test was better by far compared to the pre-test (see also Appendix M). From the ANOVA results in Table 5.10, the indication is that the interactive use of CS and videos has a significant effect on the average performance in the post-test on magnetism when compared to the traditional method. The independent t-test results in Tables 5.3 and 5.4 further suggest a significant difference between the experimental (CS and videos) and control group.

From the classroom observation report in section 4.2 the interactive use of CS and videos in teaching had a significant positive influence in the learning of magnetism. Learners were alert, attentive and active participants during their lessons, observing, predicting and discussing concepts of magnetism via teacher-guided CS and videos. Learners were actively involved in the construction of their own comprehension of scientific and innovative ideas while being bounded by the framework of their existing knowledge (see also Appendix O). The findings of this study also concur with the recommendations from the literature (see section 2.5.2).

USING AVAILABLE DATA TO ANSWER THE THIRD RESEARCH QUESTION

The 3rd research question read as follows:

- Does the interactive use of the combination of computer simulations and videos have an impact on the performance of Grade 10 learners in magnetism?

The findings of this study provided evidence that the interactive use of CS, videos as well as a combination of CS and videos had a greater positive impact on the performance of learners in Grade 10 in the topic of magnetism if compared to those exposed to the traditional approach (see Table 5.6 and Figure 5.2). Furthermore, the findings also sealed a research gap since no research had been conducted prior to this study on the interactive use of CS and videos in the Grade 10 topic of magnetism (see section 2.4.1 to 2.4.4; 2.5.1 and 2.5.2). The chi-square test as well as ANOVA results also confirmed a statistical significant increase in the average performance of Grade 10 learners exposed to the interactive use of CS, videos and the combination of CS and videos when compared with those exposed only to the traditional method in the topic of magnetism (see Table 5.6 and 5.8). The findings of the study also revealed that the performance of Grade 10 learners who were exposed to a combination of the interactive use of CS and videos increased significantly after the intervention in the topic of magnetism (see Figure 5.1). Furthermore Grade 10 learners exposed to a combination of the interactive use of CS and videos performed significantly better than those exposed separately to CS and videos in the topic of magnetism (see Table 5.4). This further tally with the study by Wilson-Strydom & Thomson (2005) which also revealed that in many disadvantaged SA schools, teachers are beginning to embrace and explore the possible ways of pedagogical integration of ICTs (like CS and videos) Furthermore, the three experimental groups appreciated the need to integrate ICT in their classes as part of their pedagogical content knowledge (TPACK) (see section 4.7). They experienced how to use technology interactively in the physical sciences classroom to facilitate the understanding of magnetism.

The questionnaire responses expressed the need to equip schools with ICT resources to enable teachers to develop technological content knowledge (TCK) (see section 4.7). Even though the teachers from sampled schools were comfortable with the traditional methods of teaching, findings from RTOP lesson observations and questionnaire responses showed that the effective integration of ICT as a pedagogical approach requires technological know-how before implementation (see sections 4.2 to 4.4).

In addition, the research findings showed that the interactive use and manipulation of CS, videos and the combination of CS and videos provided teachers with TCK as a pedagogical incentive to the PCK, which most teachers exhibited before intervention (see section 4.6 and 4.7).

5.12 THE IMPACT OF USING ICT IN TEACHING AND LEARNING

This section provides the research based on RTOP lesson observations (section 5.12.1) and findings from questionnaires (section 5.12.2). The section goes further to attempt to respond to the 4th research question (see section 1.5.1)

5.12.1 FINDINGS OF STUDY BASED ON RTOP CLASS OBSERVATIONS

The constructivist strategy demands that the teacher's strategy be that of facilitator in the construction of knowledge rather than spoon-feeding learners with knowledge (Balachandran, 2016). A constructivist teacher is one who also provides learners with opportunities to experience ways of scientific thinking and acquire expert skills in scientific argumentation and reasoning in the course of knowledge construction (Barak, 2011).

From class observations based on experimental groups, it was noted that learners were actively involved during the lessons as they were able to construct their own knowledge through observations, predictions and discussions (see Tables 4.5, 4.10, 4.15, 4.20 and 4.21). The interactive use of CS, videos, and CS and videos allowed greater communication among learners, hence promoting the learner-centred approach advocated by literature's constructivist school of thought (see Appendix Q).

It was also found during class observations that teachers were incompetent in using computer simulation software for lesson presentations. Teachers lacked training in using computers effectively for teaching (see section 4.7).

The research also showed that teachers revert to the traditional or familiar ways of teaching if they are not accustomed to using the new methodologies and practices of teaching when using computer technology (see section 4.7).

The findings of the study also further substantiated what was noted in the literature with regard to motivation when learners are introduced to technological tools (see section 2.3.1). The level of motivation and inspiration was high, and this was found throughout all the experimental groups from the sampled schools (see Table 4.21). Learners from the control group ended up telling the researcher (after the intervention) that they liked the lessons with ICT more (see section 4.7). This was after they had been exposed to CS and videos.

5.12.2 FINDINGS OF STUDY BASED ON QUESTIONNAIRE RESPONSES

Previous and documented research indicates that integrating ICT into teaching and learning could be far more effective for learners (Hassler et al., 2016). Hence teachers perceive ICT in physical sciences education to be useful since it makes teaching and learning easier (Mereku et al., 2015).

USING AVAILABLE DATA TO ANSWER THE FOURTH RESEARCH QUESTION

The 4th research question read as follows:

- To what extent does the use of computer simulations and videos influence the teaching of magnetism in Grade 10?

Using CS, videos and a combination of CS and videos interactively to teach magnetism had a positive influence and enhanced a learner-centred teaching approach, as indicated in Table 4.21. In all the experimental groups where CS and videos were used, the teacher's effort to assist learners in gaining conceptual understanding was due to the supportive learning environment (see section 4.2 – 4.4 and 4.6). The high level of learner participation was a common feature of all three experimental groups (see Appendix P). The interactive use of ICT also provided learners with an opportunity to observe, provide critical analysis, make predictions and communicate ideas among themselves (see section 4.2 – 4.4 and 4.6). Learners were also free to ask questions during the lessons. Learners in all three experimental groups were able to demonstrate critical thinking when confronted with the teacher's thought-provoking questions (see Appendix P). The interactive use of CS and videos greatly assisted teachers in dealing with higher order concepts like repulsion, attraction, domain theory and the basic physics of the magnetosphere (see Appendix P). The concept of navigation and the interesting physics of the earth's magnetosphere held the attention of nearly all learners throughout the lessons.

From the analysis of the questionnaires the general view of the teachers was that they were in full support of the integration of ICT with traditional methods of teaching (see Appendix Q). Teachers agreed that using ICT as a pedagogical tool would help in tackling higher order concepts in magnetism as well as in other sections of Physical sciences (see Table 4.24). The interactive use of YouTube videos in Physical sciences received the greatest support among teachers (see Table 4.23 and 4.24). Teachers reiterated that the interactive use of YouTube videos proved to be quite an effective ICT educational tool since most of the videos featured the experiments which are difficult to carry out in under-resourced laboratories in rural South Africa (see Appendix Q). Teachers expressed a strong positive feeling that the interactive use of YouTube videos can promote mobile learning when the learners are enabled to login to YouTube via their school's gmail account for easy monitoring (see Table 4.23 and 4.24). This concurs with what is suggested by the literature (see section 2.4.4).

Teachers further agreed that the interactive use of CS and videos in teaching was quite compatible with CAPS (see Appendix Q). The teachers also unanimously agreed that CS and video tools should always be used interactively since they help compensating for the shortage of laboratory equipment. Teachers also had the positive view that the integration of ICT together with the traditional method saved a lot of time which was usually wasted in drawing and labelling chalkboard diagrams.

5.13 LIMITATIONS OF THE STUDY

Literature suggests that qualitative as well as quantitative research findings can be generalised to the whole (if not) fraction of population provided a large randomly selected sample is involved (Denzin et al., 2002). Besides the sampling methods used in a study, there is reduced time consumption during quantitative analysis of data since it makes use of the statistical software such as SPSS (Bryman, 2012). Furthermore, qualitative research methods are known to provide some detailed description of respondents' opinionated feelings and direct experiences and, therefore provide some scholarly interpretation of the meanings hidden in their actions (Richardson, 2012).

In this study, learners were assigned to one of two conditions, namely control or experimental, based on the random assignment of the entire period of study. The study was performed using interactive computer simulations and videos based on the topic of magnetism. At the end of the intervention learner participants from the selected schools voluntarily responded to the pre-post-tests, while teacher participants also voluntarily responded to the questionnaire.

However the following limitations were discovered and captured for this study:

- This study quantitatively and qualitatively just investigated and estimated the pedagogical potential of interactively using CS and YouTube videos. The potential and effectiveness of using CS and YouTube videos intervention methods cannot possibly be concluded through use of the data collection methods which were employed in this study.
- The measurements of variables in this study were done at a specific moment in time and to a specific sample, and disregarded whether the same results would be achieved in the distance future in a completely different set up.
- This study only targeted and engaged a sampled number of MST schools (4) to test statistical significance. Therefore, it is hardly possible to take deep and conclusive information from the outcome of the study for the generalizability over all the MST schools in Mpumalanga province.
- It is not easy to qualitatively extend the study findings to larger populations with the same degree of certainty that quantitative analysis can. This can be due to the fact that the findings obtained during RTOP lesson observations and questionnaires cannot be tested to verify if they are statistically significant or it is just by mere chance.
- Qualitatively, the researcher does not wish claim wider generalization of the RTOP and questionnaire findings to the entire MST population in SA due to the small sample size that was used in this study.
- The qualitative analysis of the RTOP lesson observation and questionnaires took a considerable amount of space and time, thus bringing the issue of generalizability of such findings to a larger MST population group in a very limited way.

- The YouTube videos were all selected from the internet. There are many videos on YouTube that are related to magnetism and, most of them are not appropriate for the grade 10 learners. The selection of appropriate and relevant YouTube videos related to grade 10 magnetism was time consuming and needed careful considerations.
- Further limitations of this study were mainly due to the small sample size, which was mainly due to time constraints, limited research funds and ethical procedures to be followed.
- The sample selection was limited to Grade 10 learners enrolled in the four MST high schools in the Badplaas/Mashishila circuits of Mpumalanga Province. This might have negatively affected the validity, credibility and generalisability of the research findings.
- Furthermore, the study only involved Grade 10 physics teachers and learner participants of the 2018 academic year in the Badplaas/Mashishila circuits. This might as well make the generalisation of the research findings to be prohibitive over the years.

5.14 GENERAL RECOMMENDATIONS

The findings from this research show that if teachers are given necessary support, ICT integration can be effected successfully. A study by Wilson-Strydom and Thomson (2005) has also shown that in many disadvantaged SA school teachers are beginning to embrace and explore the possible ways of pedagogical integration of ICTs in physical sciences classes. However, the widespread under-utilisation of ICTs in physical sciences classes is primarily due to PK and TCK needed to effect the integration (Songer, 2007).

To enable learners to visualise the basics of the intrinsic quantum mechanical properties of magnetism requires the pedagogical use of CS and videos to complement each other. When teachers integrate CS and videos in their classes, learners can easily concretise and conceptualise the physics behind the magnetisation process of non-ferromagnetic and ferromagnetic materials and why the latter can easily be magnetised. This could also assist to clear the possible misconceptions associated with the intimate relationship between electricity and magnetism.

The findings of this study suggest that the good performance of learners in magnetism is possibly attributed to using different ICT tools. The findings suggest that consistent interactive use of ICT tools like CS and videos when teaching abstract concepts in physical sciences, such as magnetism, can increase learner performance in physical sciences. Since in the South African context, the physical sciences background for Grade 12 learners is traced back to Grade 10, there is a need to employ good ICT teaching strategies even in Grade 10 (see section 2.3.1**)**. The use of ICT tools such as CS and videos can help to promote the digital education enhancement programme (DEEP) especially in rural areas (see section 2.3.2). Furthermore, no teacher teaching in the 21st century can ignore the integrating of ICT as a pedagogical tool in their classes. The findings of this study strongly recommend the interactive use of CS and videos concurrently in order to improve learner performance in the physics topic of magnetism.

However, there is a need to equip teachers to use ICT. Focused workshops need to be organised by the Department of Education, where teachers have the opportunity to gain hands-on experience in using ICT in their subject topics. This means that before these professional development interventions, a selection of computer simulations and videos need to be made. Therefore, a platform on the DoE website needs to be created where videos and computer simulations can be accessed to provide teachers with the necessary ICT tools for teaching and learning.

The department of education also needs to update and upgrade the infrastructure in schools in order to enhance easy implementation of ICT pedagogies in line with 21^{st} century teaching and learning. The deductions from the questionnaire responses showed that the computers available in most MST schools were very old. The software was not upgraded and was prone to viral infection, dysfunctional, with a low processing speed and poor internet/WIFI connections (see Appendix Q). Hence teachers who might want to use ICT for teaching use their own laptops and gain internet access at their own expense.

The CAPS syllabus makes it mandatory that experiments be executed as part of formal and non-formal assessments. Many schools especially in the rural areas have been reported by NEIMS (2016) not to have adequate laboratory facilities. The findings of this study suggest that using CS and videos can help to complement, substitute and represent real laboratory equipment such as ferromagnetic materials. Even if CS and videos may not enable learners to directly manipulate the equipment they assist in reproducing experiments. Besides, it is impossible to visualise all the details such as those of magnetic domains and their behaviour in real experiments.

Most of the rural high schools in SA do not have access to the much-needed laboratory equipment. The possible reason being that laboratory equipment are expensive. Hence a combination of CS and videos is analogous to real laboratory experiments in MST rural high schools.

The alternative conceptions held by learners, and in some instances even teachers, about the behaviour of charged particles in a magnetic field, the causes of magnetic polarity and how magnets are made could be demonstrated through the provision of accurate experimental illustrations of highly visual and dynamic representations.

The 21st-century teaching and learning style is engraved in ICT usage. It is therefore suggested that teachers should adopt interactive video usage when teaching physical sciences since it has the potential to increase motivation and inspire improved performance levels if adopted for a transformative learner-centred approach. The interactive use of videos is also one of the ways of enhancing learning for learners at risk as well as for hard-to-reach learners like those in the Badplaas/Mashishila circuits of Mpumalanga.

From the findings of this study, interactive use of videos was also observed to inspire and motivate learners. The researcher therefore suggests the use of CS and videos prior to giving learners a project or research. This can provide them with the main ideas of a project or research and how to realise and present them.

Based on the findings of this study, it can be recommended (although to a limited extend) to rather choose interactive videos than CSs if given such option. Interactive videos provide visual representation of real physical phenomena.

Considering the outcome of the RTOP observations and questionnaires (see section 4.6 to 4.8), there is a need for the government and other stakeholders to provide the necessary computer training to physical sciences teachers, especially in the use of PhET CS in their classes, providing a list of good physical sciences videos and, characteristics of choosing good videos for their classes. This will also go a long way in promoting the idea of ICT integration at classroom level and map the way to better education goals. Furthermore, physical sciences teachers should be fully equipped with the necessary ICT tools and internet access facilities to enable them to execute their duties as classroom practitioners.

The researcher also recommends that the Department of Education facilitates frequent ICT workshops (at least once per term) in order to clarify knowledge and awareness of how to integrate ICT as a pedagogical tool.

The findings from the questionnaire revealed that even though teachers appreciated the positive impact brought about through the use of ICT tools like CS and videos, they rarely used them (see Appendix Q). Many teachers lack adequate and up to date ICT infrastructure, ICT knowledge and familiarisation, internet access and proper training, hence their reason for not integrating ICT in teaching (see section 4.7). Inadequate ICT infrastructure deprived teachers of chances to integrate ICT as a pedagogical tool. Three out of the five teachers (60%) cited computer security risks as among the problems in schools hampering the effectiveness of ICT integration in their classrooms (see section 4.7). Even though the teachers indicated that they used computer technology for the recording and analysis of learner performance, they did not consider using computers to teach and make a difference in the understanding of their learners (see section 4.7.4). The available computer resources in a school were mainly used for administrative and assessment purposes by the school clerks and members of the SMT (see Table 4.23 and 4.24).

5.15 RECOMMENDATIONS FOR FURTHER STUDIES

The pre-selection of technology tools to be used in the physical sciences classroom is not easy (Kriek & Coetzee, 2016). It is therefore suggested for future potential researchers to explore easy ways in which YouTube videos can be pre-selected to match the requirements of the physical sciences CAPS curriculum.

Large sample size should be considered so as to get valid and credible results that can be generalised to a larger population, (Bryman, 2012). The researcher recommends that further studies (on investigating the interactive use of CS and videos in the teaching of grade 10 magnestism), be conducted while making use a large sample for easy generalizability over a larger population as suggested by literature.

The researcher recommends further studies to be conducted on the potential usage of mobile devices such as smartphones and tablets by learners together with YouTube in teaching topics selected from the grade 10 physical sciences CAPS curriculum.

It should be acknowledged that some challenges still exist when it comes to implementing YouTube interactively and that ICT intervention method can be deemed more superior than another (Muller, 2008). It should therefore be recommended that another follow-up research study be done to investigate the effects of language and gender on the performance of learners in grade 10. Furthermore, the researcher recommends that investigations of the interactive use of CS and videos be extended to other physical sciences topics in grade 10.

5.16 CONCLUSION

Countries in the developing world like SA are in the verge of upgrading their Educational systems from traditional to innovative teaching /learning approaches (Mirana, 2016). This study investigated the impact of the interactive use of CS and Youtube videos when teaching magnetism to grade 10 learner`s at selected MST schools in Mpumalanga province. Four MST high schools in Badplaas/Mashishila circuits of Gert Sibande district in Mpumalanga province were used as case study. Three schools were used as experimental groups while the fourth school was utilised as the control group. The first group was taught using CSs while the second group was taught using pre-selected YouTube videos. The third group was taught using both CSs and pre-selected YouTube videos and the fourth group was taught using normal traditional methods. Using the pre-post test non-equivalent control group design, it was found that the interactive use of CS in teaching and learning can help to improve learner performance in Grade 10 magnetism, and so does the interactive use of Youtube videos. However, when CS and videos are used concurrently and interactively there will be a greater improvement in the performance of learners in magnetism at Grade 10 level. This was observed from the greater performance of learners at school F in the post-test compared to the other groups used in the study. Furthermore, it was also found out that the interactive use of YouTube videos is an effective tool in teaching and learning as it compensates for the shortage of laboratory apparatus in many rural schools.

5.17 Summary of the Study

Magnetism is one of the physical sciences concepts most misconstrued by learners especially at Grade 10 level. This is because comprehending the intrinsic quantum mechanical properties of the magnetic behaviour of ferromagnetic materials requires computational complexity (see section 2.2.7), which is why many students find it difficult to visualise and bring into the imagination the concept of magnetism (see section 1.4). The topic of magnetism forms the foundation of electromagnetism, a topic which is poorly understood by many learners (see section 1.2.1). This research suggests that teaching with the interactive use of computer simulations, videos, and CS and videos combined can have benefits for the teaching and learning of magnetism (see section 2.3.2 and 2.5.2). Hence, the main aim of the study was to investigate the interactive use of computer simulations and videos in teaching magnetism in Grade 10: A case study of four high schools in Mpumalanga Province

LIST OF REFERENCES

Adams, W. K., Reid, S., Lemaster, R., Mckagan, S. B., Perkins, K. K., & Dubson, M. (2008a). A Study of Simulations Part 1: Engagement and Learning. *Journal of Interactive Learning Research, 19*(3), 397-419.

Adams, W.K. (2010). *Student engagement and learning with PhET interactive simulations.* Il Nuovo Cimento, 1-12.

Aina, J.K. (2013). Effective teaching and learning in science education through Information and Communication Technology [ICT]. *IOSR Journal of Research and Method in Education, 2*(5), 43-47.

Aina, J.K. (2013). Integration of ICT into physics learning to improve students' academic achievement: Problems and solutions. *Open Journal of Education, 1*(4), 117-121.

Alev, N. (2003). *Integrating information and communications technology (ICT) into pre-service science teacher education: The challenges of change in a Turkish faculty of education.* PhD Thesis, School of Education, University of Leicester. https://lra.le.ac.uk/bitstream/2381/4668/1/nedimalevtez.pdf

Anbalagan, S. (2017). Impact of school environment on academic achievement of secondary school students in Madurai district. *International Journal of Applied Research, 3*(5), 732-737.

Ashcraft, D., Treadwell, T., & Kumar, V. (2008). Collaborative Online Learning: A Constructivist Example. *MERLOT Journal of Online Learning and Teaching*.

Asparouhov, T., & Muthén, B. (2006). *Robust chi square difference testing with mean and variance adjusted test statistics.* Matrix 1:1-6.

Bada, S.O. (2015). Constructivism learning theory: A paradigm for teaching and learning. *IOSR Journal of Research & Method in Education (IOSR-JRME), 5*(6) ,2320–737.

Badri, M., Al Mazroui, K., Al Rashedi, A., & Yang, G. (2016). Variation by gender in Abu Dhabi high school: Students' interests in physics. *Journal of Science Education and Technology, 25*(2), 232-243.

Balachandran, S. (2016). *Students' reasoning with haptic technologies: A qualitative study in the electromagnetism domain*. Doctoral dissertation, Purdue University.

Balasubramanian, B., Manchanda, P., Skomski, R., Mukherjee, P., Valloppilly, S.R., Das, B., Hadjipanays, G.C., & Sellmyer, D.J. (2016). *High-coercivity magnetism in nanostructures with strong easy-plane anisotropy*. Applied Physics Letters, 108(15), 152406.

Barak, M., Nissim, Y., & Ben-Zvi, D. (2011). *Aptness between teaching roles and teaching strategies in ICT-integrated Science lessons. Interdisciplinary Journal and Learning Objects, 7. Bayesian Data Analysis.* Third edition. New York: CRC Press.

Baydas, O. (2013). Enablers and barriers to the use of ICT in primary schools in Turkey: A comparative study of 2005 and 2011, *Computers and education, 68*, 211-222.

Beaufils, D. (2005). *The computer laboratory in physics tool: What transpositions,* Lyon : INRP.

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., & Miller, M. (2012). Defining 21st century skills: *Assessment and teaching of 21st century skills,* 17-66, 2012

Bramowicz, M., Kulesza, S., & Mrozek, G. (2014). Changes in magnetic domain structure of maraging steel studied by MFM, *Technical Sciences, 17*(4), 371-379.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How People Learn: Brain, Mind, Experience, and School*. Washington DC: National Academic Press.

Bryman, A. (2012). Social research methods. New York: Oxford University Press.

Buskulic, D., & Maurin, G. (2014). No magic wand for teaching physics. *Proceedings of Science, Frontiers of Fundamental Physics 14*, 15-18 July 2014, Aix Marseille University (AMU), Saint-Charles Campus, Marseille, France.

Byers, T., Mahat, M., Liu, K., Knock, A., & Imms, W. (2018). A systematic review of the effects of learning environments on student learning outcomes. *Innovative Learning Environments and Teachers Change.*

Chigona .A, (2014). Educators' motivation on integration of ICTs into pedagogy: case of disadvantaged Areas, *South African Journal of Education, 34*(3), 8 pages.

Chikasha, S., Ntuli, M., Sundarjee, R., & Chikasha, J. (2014). ICT integration in teaching: An uncomfortable zone for teachers: A case of schools in Johannesburg. *Education as change, 18*(1), 137-150.

Christian, W., & Esquembre, F. (2007). Modelling physics with easy java simulations. *The Physics Teacher*, 45(8), 475.

Christine, A. (2013). *The American heritage dictionary of idioms*. Houghton Mifflin Harcourt.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education*. New York: Routledge.

Creswell, J.W., & Clark, V.L.P. (2007). *Designing and conducting mixed methods research.* Sage Publications, United Kingdom.

Creswell, J. W. (2003). *Research Design: Qualitative, Quantitative and Mixed Method Approaches.* Sage Publications, United Kingdom.

David, B., & Resnik, J.D. (2015). *What is ethic and why is it important? National Instituteof Environment and Health Science,* Research Triangle Park, USA.

Dawson, V. (2007). Use of information communication technology by early career science. *International Journal of Science Education, 30*(2), 203 — 219.

Dawson, V., Forster, P., & Reid, D. (2006). Information communication technology (ICT) integration in a science education unit for pre service science teachers: Students' perceptions of their ICT skills, knowledge and pedagogy, *International Journal of Science and Mathematics Education, 4*, 345Y363. http://www.informaworld.com/smpp/title~content=t716100724

Dede, C. (2000). Emerging influences of information technology on school curriculum.

Journal of Curriculum Studies, 32, 281-303.

Dega, B.G., Kriek, J., & Mogese, T.F. (2013). Students' conceptual change in electricity and magnetism using simulations: A comparison of cognitive perturbation and cognitive conflict. *Journal of Research in Science Teaching, 50*(6), 677-698.

Del Campo, D., Amante, B., & Martínez, M. (2012). June. Multidisciplinary study of tutoring using virtual characters and Second Life. Information Technology Based Higher Education and Training (ITHET), *2012 International Conference,* 1-5, IEEE.

Denzin, N.K., & Lincoln, Y.S. (2011). *Strategies of qualitative inquiry.* London: Sage Publications.

Denzin, N. K., & Lincoln, Y. S. (2002). *The qualitative inquiry reader*. London: Sage Publications.

Department of Basic Education. (2015). *Annual Performance Plan for 2014/2015.* Pretoria: Department of Basic Education.

Department of Basic Education.(2015). *Investigation into the implementation of maths, science and technology*. Pretoria: Department of Basic Education.

Department of Basic Education. (2016). *Mpumalanga Provincial Education Department diagnostic report*. Bayesian Data Analysis Vol. 2. Boca Raton, FL: CRC press.

Department of Basic Education. (2017). *2016 National Senior Certificate Examination: National Diagnostic Report.* Pretoria: Department of Basic Education.

Department of Basic Education. (2017). *2016 National Senior Certificate Examination School Performance Report.* Pretoria: Department of Basic Education.

Department of Education (DOE). (2004). *White paper on e-education: Transforming learning and teaching through information and communication technologies*. Available from http://www.info.gov.za/whitepapers/2003/e-education.pdf

Department of Education. (2011). *National Curriculum and Assessment Policy*

Statement: Grades 10-12 (General) Physical Sciences content. Pretoria. Department of Education.

Department of Basic Education. (2012b). *National Senior Certificate Examinations Schools Subject Report.* Pretoria: Department of Basic Education.

Department of Basic Education. (2013). *2012 National Senior Certificate Examination Schools Subject Report.* Pretoria: Department of Basic Education.

Department of Basic Education. (2014). *2013 National Senior Certificate Examination: National Diagnostic Report.* Pretoria: Department of Basic Education.

Draper.K, (2010). *Understanding science teachers‘use and integration of ICT in a developing country context.* PhD thesis, Faculty of Education, University of Pretoria.

Du Plessis, A. (2014). Student-teachers' pedagogical beliefs: learner-centred or teacher- centred when using ICT in the science classroom? *Journal of Baltic Science Education, 15*(2), 140-158.

Dzansi, D.Y., & Amedzo, K. (2014). Integrating ICT into rural South African Schools: possible solutions for challenges. *International Journal of Educational Sciences, 6*(2), 341-348.

Eib B.J. (2015). Best practices of professional development. *Journal of asynchronous learning network, 16*(2), 163-175.

Egunsola, A.O.E. (2014). Influence of home environment on academic performance of secondary school students in agricultural science in Adamawa State, Nigeria. *Journal of Research & Method in Education, 4*(4), 46-53.

Esquembre, F. (2005). Computers in physics Education. *Computer Physics Communications, 147*, 13-18.

Fu, J.S. (2013). ICT in education: A critical literature review and its implications. National institute of Education, *International Journal of Education and Development Using Information and Communication Technology, 9*(1). 112-125.

Gay, L.R., & Airasian, P. (2003). *Educational Research: Competencies for analysis and application (7th ed.).* Columbus, Merrill: Prentice Hall.

Gelman, A., Carlin, J.B., Stern, H.S., Dunson, D.B., Vehtari, A., & Rubin, D.B. (2014). Quantitave Research Methods, *International journal of research methods, 78*(1), 49-65.

Goosen, L., & Van der Merwe, R. (2015). June. E-Learners, teachers and managers at e-schools in South Africa. *In Proceedings of the International Conference on e-Learning, ICEL:* 127-134.

Graziano, J.K., Foulger, T. S., Crawford, D.S., & Slykuis, D.A., (2017). Teacher educator technology competencies, *Journal of technology and teacher education, 25*(4), 413-448.

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics, 66*(1), 64-74.

Halloun, I.A., & Hestenes, D. (1985). “Common Sense Concepts About Motion”. *American Journal of Physics, 53* (11), 1056-1065.

Har, L.B. (2013). *Constructivist Learning and Teaching. The Active Classroom,* Hong Kong Institute of Education.

Hassler, B., Major, L., & Hennessy, S. (2016). Tablet use in schools: a critical review of the evidence for learning outcomes. *Journal of Computer Assisted Learning, 32*(2), 139-156.

Hekkenberg, A. (2012). *Addressing misconceptions about electric and magnetic fields: A variation theory analysis of a lecture’s learning space.* North-West University, Potchefstroom, South Africa.

Hennessy, S., Harrison, D., & Wamakote, L. (2010). Teacher factors influencing classroom use of ICT in Sub-Saharan Africa. *Itupale Online Journal of African* *studies, 2*(1), 39-54.

Henschel, S. & Roick, T. (2017). Relationships of mathematics performance, control and value beliefs and reflective math anxiety. *Learning and individual differences, 55,* 97-107.

Hinkle, D.E., Wiersma, W., & Jurs, S.G. (2003). *Applied statistics for the behavioral sciences.* Houghton Mifflin.

Honebein, P.C. (1996). *Seven goals for the design of constructivist learning environments. In Constructivist Learning Environments: Case Studies in Instructional Design.* Brent G. Wilson (ed.). Englewood Cliffs: Educational Technology Publications: 11-24.

Hussain, A., Azeem, M., & Shakoor, A. (2011). Physics teaching methods. Scientific inquiry vs traditional lecture. *International Journal of Humanities and Social Sciences, 1*(19), 269-276.

Jeschke, S., Thomsen, C., Richter, T., & Scheel, H. (2007). On remote and virtual experiments in e-learning in statistical mechanics and thermodynamics. *Fifth Annual IEEE international conference on pervasive computing and communications workshops, (Perm comW`07),* 153-158.

Jodl, H. J., Eckert, B., & Altherr, S. (2004). Multimedia in teacher training, *Quality development in teacher education and training*, 467, 2004.

Jonassen, D.H. & Murphy L-O, R. (1999). Activity theory as a framework for designing constructivist learning environments. *Educational Technology Research and Development, 47*(1), 61-79.

Johnston, W. (2012). In-service teachers` attitude towards ICT usage. *Eurasian journal of education research, 19*, 15-34.

June, S., Yaacob, A. & Kheng, Y.K. (2014). Assessing the use of YouTube videos and interactive activities as a critical thinking stimulator for tertiary students. *An action research. International Education Studies, 7*(8), 56.

Kaheru, S.J.M. (2014). *The use of computer simulations for cognitive load change and acquisition of knowledge and skills in geometrical optics.* PhD thesis, University of South Africa, Pretoria, South Africa.

Kapartzianis, A., & Kriek, J. (2014). Conceptual change activities alleviating misconceptions about electric circuits. *Journal of Baltic Science Education, 13*(3), 298–315.

Kelder, K.H. (2012). *Study & master Physical Sciences Grade 10 learner's book,* Cambridge University Press, RSA.

Khalid, A., & Azeen, M. (2012). Constructivist vs traditional effective instructional approach in teaching, *Journal of problems of education in the 21st century, 57*, 141-152.

Kirstein, J., & Nordmeier, V. (2007). Multimedia representation of experiments in physics, *European journal of physics,* iopscience.

Koehler, M.J. (2012). *The seven components of TPACK*. Available from http://www.matt-koehler.com/tpack/tpack-explained/

Koehler, M. J., Mishra, P., Akcaoglu, M., & Rosenberg, J. (2013). *The technological pedagogical content knowledge framework for teachers and teacher educators. ICT integrated teacher education:* A resource book, 2-7.

Koh, L., Hwee, J., Chai, C.S., Benjamin, W., & Hong, H. Y. (2015). *Technological Pedagogical Content Knowledge (TPACK) and Design Thinking: A Framework to Support ICT Lesson Design for 21st Century Learning,* De La Salle University.

Koh, J.H.L., Chai, C.S., Benjamin, W., & Hong, H. (2015). Technological pedagogical content knowledge and design thinking: A framework to support ICT learning. *The Asia Pacific Education Researcher, 24*(3), 535-543.

Kola, A.J., & Gbenga, O. A. (2015). The effectiveness of teachers in Finland: Lessons for the Nigerian teachers. *American Journal of Social Sciences, 3*(5), 142-148.

Koopman, M. (2014). Step-by-step approach: The integration of ICT in the classroom in rural African schools. *In e-Challenges e-2014, 2014 Conference,* 1-8, IEEE.

Korateng, K. (2012). *Access and use of information and communication technology for teaching and learning amongst schools in under-resourced communities in the Western Cape.* PhD thesis, Cape Peninsula University of Technology. Cape town.

Kothari, C.R. (2004). *Research methodology: methods and techniques*. New Age International.

Kotoka, J.K., & Kriek, J. (2014). The impact of computer simulations as interactive demonstration tools on the performance of Grade 11 learners in electromagnetism. *African Journal of Research in Mathematics, Science and Technology Education, 18*(1), 100-110.

Kotoka, J. (2012). *The impact of computer simulations as interactive demonstration tools on the performance of Grade 11 learners in electromagnetism.* Master's thesis, Department of Mathematics, Science & Technology Education, University of South Africa, Pretoria.

Kriek, J., & Coetzee, A. (2016). Development of a technology integrated intervention in tertiary education. *Journal of Baltic Science, 15*(6), 712-724.

Law, N., & Chow, A. (2008). *Pedagogical Orientations in Mathematics and Science and the use of ICT. Findings from the IEA SITES 2006 Study,* Hong Kong: Springer.

Lee, K.C., Carson, L., Kinnin, E., & Patterson, V. (1989). The Ashworth scale: a reliable and reproducible method of measuring spasticity. *Journal of Neurologic Rehabilitation, 3*(4), 205-209.

Leendertz, V., Blignaut, A.S., Nieuwoudt, H.D., Els, C.J., & Ellis, S.M. (2013). Technological pedagogical content knowledge in South African mathematics classrooms: A secondary analysis of SITES 2006 data. *Pythagoras, 34*(2), Art.

#232, 9 pages. http://dx.doi. org/10.4102/pythagoras. v34i2.232

Leliaert, J. (2016). *Magnetic disorder and thermal fluctuations in domain wall motion and nanoparticle dynamics.* PhD thesis, Department of Solid State Sciences, Faculty of Sciences, Ghent University, Belgium.

Lister, R., & Leaney, J. (2003). Introductory Programming, criterion-referencing, and bloom. SIGCSE '03: *Proceedings of the 34th SIGCSE Technical Symposium on Computer Science Education,* ACM Press: 143-147.

Lofciu, F., Miron, C., Dafinei, M., Dafinei, A., & Antohe, S. (2012). Murphy-multimedia tool for advanced physics concept approach: giant magnetoresistance GMR. *Romanian Reports in Physics, 64*(3), 841-852.

Lord, C., Abedi, J., & Hofstetter, C. (1998). *Impact of selected background variables on students NAEP math performance.* Center for the study of evaluation, University of California, Los Angeles.

Madlela, B. (2015). ICT opportunities and threats in implementing teaching practice programmes, *Universal Journal of Educational Research*, 3(6), 351-358.

Magana, A.J., Sanchez, K.L., Shaikh, U.A.S., Jones, M.G., Tan, H.Z., & Guayaquil, A.B. (2017). Exploring multimedia principles for supporting conceptual learning of electricity and magnetism with visuohaptic simulations. *Computers in Education Journal*, 8(2), 8-23.

Magnus, I., Desmet, P., Gielen, S., & Rianne, L. (2016). Teacher motivational practices and student attitude in relation to proficiency, *Vigo international journal of applied linguistics.*

Martinez, K.L.S. (2013). *Investigating the impact of visuohaptic simulations for conceptual understanding in electricity and magnetism*. Doctoral dissertation, Purdue University.

Mathevula, M.D., & Uwizeyimana, D.E. (2014). The challenges facing the integration of

ICT in teaching and learning activities in South African rural secondary schools. *Mediterranean Journal of Social Sciences*, 5(20), 1087.

Maxwell, J.A. (2012). *Qualitative research design: An interactive approach*, 41, Sage Publications.

McCord, K., Reese, S., & Waalls, K. (2015). Strategies for teaching technology. *Journal of educational technology, 27*(1), 122-136.

McDowell, I., & Newell, C. (1987). *Measuring health: a guide to rating scales and questionnaires.* New York: Oxford University Press.

McKagan, S., Sayre, E., & Madsen, A. (2017). *Introduction to normalised gain, supporting physics teaching with research-based resources*. PhysPort.

McLinden, M., & McCall, S. (2016). *Learning through touch: Supporting children with visual impairments and additional difficulties*. Routledge.

McMillan, J.H., & Schumacher. (2010). *Research in education*. New Jersey: Pearson Education.

Mereku, D.K., & Mereku, C.W.K. (2015). Congruence between the intended, implemented, and attained ICT curricula in Sub-Saharan Africa. *Canadian Journal of Science, Mathematics and Technology Education*, *15*(1), 1-14.

Miller, J. S. (2004). Problem-based learning in organizational behavior class: Solving students‘ real problems. *Journal of Management Education, 28*(5), 578-590.

Mirana V.P. (2016). Effects of computer simulations and constructivist approach on students' epistemological beliefs, motivation and conceptual understanding in physics. *International Conference on Research in Social Sciences, Humanities and Education (SSHE-2016) May 20-21*, 2016. Cebu, Philippines.

Mishra, P., & Koehler, M. (2009). Too Cool for School? No Way! Using the TPACK Framework: You Can Have Your Hot Tools and Teach with Them, Too. *Learning & Leading with Technology, 36*(7), 14-18.

Mishra, P., & Koehler, M.J. (2006).Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record, 108*(6):1017-1054.

Muller, D., Sharma, M., Lindstrøm, C., & Kuan, N. (2012). Embedding research principles into multimedia teaching and learning tools. *In Proceedings of The Australian Conference on Science and Mathematics Education,* formerly UniServe Science Conference.

Muller, D.A. (2008). *Designing Effective Multimedia for Physics Education*. PhD thesis, School of Physics, University of Sydney: Australia.

Muller, D. A., Sharma, M. D., & Reimann, P. (2008). Raising Cognitive Load with Linear Multimedia to Promote Conceptual Change. *Science Education, 92*(1), 278-296.

Nancheva, A. (2017). *Simulations as a tool for visualization of the phenomenon Magnetic hysteresis*. Aleksandrova University of Rousse

NEIMS. (2016). *School infrastructure standard report June 2016 from Department of Basic Education:* http://www.education.gov.za. Retrieved 9 June 2017.

Nguyen, N., Williams, J., & Nguyen, T. (2012). The use of ICT in teaching tertiary physics: Technology and pedagogy. In *Asia-Pacific Forum on Science Learning & Teaching, (13)*2.

Niess, M.L., Lee, J.K., & Kajder, S.B. (2007). *Guiding Learning with Technology. Hoboken*: John Willy & sons.

Nousiainen, M., & Koponen, I.T. 2017. pre-service physics teachers' content knowledge of electric and magnetic field concepts: Conceptual facets and their balance. *European Journal of Science and Mathematics Education*, 5(1), 74-90.

Osborne, J., & Hennessy, S. (2003). *Literature Review in science education and the role of ICT: Promise, problems and future directions [Electronic Version].* NESTA Futurelab Series, from http://www.futurelab.org.uk/resources/documents/lit_reviews/Secondary_Science_Review.pdf

Paul. A., Podolefsky, N., & Perkins, K. (2013). Guiding without feeling guided: Implicit scaffolding through interactive simulation design. *Proceedings of the 2012 Physics education research conference, 1513*(1), 302-305.

Perkins, K., Adams, W., Dubson, M., Finkelstein, N., Reid, S., Wieman, C., & LeMaster, R. (2006). PhET: Interactive simulations for teaching and learning physics. *The Physics Teacher*, *44*(1), 18-23.

Piburn, M. D., & Sawada, D. (2000). *Quantitative measure of the degree to which teaching is reformed.* Arizona State University, National Science Foundation, Arlington, VA.

Pinar, R. (2004). Reliability and validity of the Turkish version of multidimensional quality of life scale - Cancer version 2 in patients with cancer. *Cancer Nursing 27*, 252-257.

Pintrich, P.R., Smith, D.A., Garcia, T., & McKeachie, W.J. (1993). Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire MSLQ. *Educational and psychological measurement*, *53*(3), 801-813.

Priemer, V. (2010). Innovation of education using technology, *Journal of technology and information education, 2*(2), 40.

Puente, S.M.G., Koning, J.J., & Mulders, H.C.J. (2014). Physicist of the future: multiphysics simulation models in engineering assignments. *44th SEFI Conference, 12-15 September 2016*, Tampere, Finland.

Republic of South Africa. (1996). *Constitution of the republic of South Africa,* ISBN 978-0-621-39063-6.

Resnick, L.B. (1987). *Education and learning to think*. Committee on Mathematics, Science and Technology Education: Commission on Behavioral and Social Sciences & Education. National Research Council, Washington, DC: The

National Academies Press.

Ramnarain, U., & Moosaa, S. (2017). The Use of Simulations in Correcting Electricity Misconceptions of Grade 10 South African Physical Sciences Learners, *International Journal of Innovation in Science and Mathematics Education, 25*(5), 1–20.

Rashid, J., & Khalid, M. (2005). *Effectiveness of guided inquiry for the teaching of physics*, The electronic library.

Reynolds, R. (2012). *Technological pedagogy and education*. Taylor & Francis.

Richardson, A. J. (2012). Paradigms, theory and management accounting practice: A comment on Parker (forthcoming) "Qualitative management accounting research: Assessing deliverables and relevance". *Critical Perspectives on Accounting, 23*(1), 83-88. http://dx.doi.org/10.1016/j.cpa.2011.05.003.

Rodgers, P. (2008). *Educational technology integration and implementation principles, Designing instructions for technology enhanced learning,* 56-70, springer.

Sanchez, K., Magana, A.J., Sederberg, D., Richards, G., Jones, M.G., & Tan, H. (2013). Investigating the impact of visuohaptic simulations for conceptual understanding in electricity and magnetism. *In 120th ASEE Annual Conference & Exposition.* Atlanta, GA.

Santos, J.R.A. (1999). Cronbach's alpha: A tool for assessing the reliability of scales. *The Journal of Extension*, *37*(2), 1-5.

Sanvito, S., Oses, C., Xue, J., Tiwari, A., Zic, M., Archer, T., Tozman, P., Venkatesan, M., Coey, M., & Curtarolo, S. (2017). Accelerated discovery of new magnets in the Heusler alloy family. *Science Advances, 3*(4).

Sawada, D., Piburn, M.D., Judson, E., Turley, J., Falconer, K., & Benford, R. (2002). Reformed teaching Observation Protocol (RTOP). *Journal of science education and technology, 13*(1), 51-66.

Scheurman, F. (1998). Bridging to the future of education, *European journal of vocational training.*

Sentongo, J., Kyakulaga, R., & Kibirige, I. (2013). The Effect of Using Computer Simulations in Teaching Chemical Bonding: Experiences with Ugandan Learners. *International Journal of Educational Sciences, 5*(4), 433-441.

Shabiralyani, G., Hasan, K.S., Hamad, N., & Iqbal, N. (2015). Impact of visual aids in enhancing the learning process case research: District Dera Ghazi Khan. *Journal of Education and Practice*, *6*(19):226-233.

Shaikh, U.A.S., Magana, A.J., Neri, L., Castillejos, D.E., Noguez, J., & Benes, B. (2017). Undergraduate students' conceptual interpretation and perception of haptic-enabled learning experience. *International Journal of Educational Technology in Higher Education,* DOI: 10, 1186/s41239-017-00053-2.

Sharma, A. (2008). Making (Electrical) Connections: Exploring Student Agency in a School in India. *Science Education, 92*, 297-319.

Shubha, S., & Meera, B.N. (2015). Students' perception of vector representation in the context of electric force and the role of simulation in developing an understanding. *World Academy of Science, Engineering and Technology, International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering*, 9(2), 501-509.

Shulman, L. S. (1987). Knowledge and Teaching: Foundations of the New Reform. *Harvard Educational Review, 57*(1), 1-22.

Sprague,M., & Dede, C. (1999). The effects of ICT on teaching and learning, *Journal of science and technology, 18*(4), 301-304.

Songer, N.B. (2007). *Digital resources versus cognitive tools. A discussion of learning science with technology*. Handbook of research on science education (pp. 471–491). NewYork: Routledge.

Stickel, M. (2014). Teaching electromagnetism with the inverted classroom approach: Student perceptions and lessons learned. *American Society for Engineering Education*, paper ID# 10572.

Stofflet , M. (1998). *Studies of educational reconstruction, Journal of science teacher education,* springer.

Swart, A.J. (2010). Evaluation of final examination papers in engineering: A case study using Bloom's taxonomy. *IEEE Transactions on Education, May 2010, 53*(2), 257-264.

Tasir, Z., Abour, K.M.E.A., Halim, N.D.A., & Harun, J. (2012). Relationship between teachers' ICT competency, confidence level, and satisfaction toward ICT training programmes: A case study among postgraduate students. *TOJET: The Turkish Online Journal of Educational Technology*, (11)1.

Thelwall, M. (2012). Mapping the network structure of science parks. An exploratory study of cross-sectoral interactions reflected on the web, *Aslib proceedings, 64(4),* 332-357.

Thomas, E. (2011). K-12 teachers` technology use and second level digital divide. *Journal of instructional psychology, 38*(3/4), 181.

Thornburg, R.A. (2002). Towards the inclusion of children with special education needs in ordinary schools. *Journal of Educational psychology, 20*(2), 191-212.

Tondeur, J., Krug, D., Bill, M., Smulders, M., & Zhu, C. (2015). Integrating ICT in Kenyan secondary schools: an exploratory case study of a professional development programme. *Technology, Pedagogy and Education*, *24*(5), 565-584.

Trochim, W.M. (2006). *Research Methods Knowledge Base*. http://www.socialresearch_ methods.net. Retrieved 7 April 2017.

UNESCO. (2002). *Information and Communication Technology in Education. A Curriculum for Schools and Programme of Teacher Development.* Paris: UNESCO.

Utterberg, M., Lundin, J., & Lindström, B. (2017). Conditions influencing mathematics teachers uptake of digital tools – a systematic literature review. *Society for Information Technology & Teacher Education International Conference* pp.

2016-2029. Association for the Advancement of Computing in Education, AACE.

Vilaythong, T. (2011). *Constructing physics education in different contexts, changing contexts and changing values*, researchgate, XIV10STE, 917.

Welman, .A.M. (2016). Considerations for Meaningful Learning, *2016-fundisa journals.ac.za*

Wenning, C.J. (2004). Repairing the Illinois High School Physics Teacher pipeline; Recruitment, preparation and retention of high school physics teachers. *Journal of physics teacher education online, 2*(2), 24-32.

Wieman, C. H., Perkins, K. K., & Adams, W. K. (2007). Oersted Medal Lecture: Interactive Simulations for teaching Physics: What works, what doesn't and why. *American Journal of Physics, 76,* 393-399.

Willmot, P., Bramhall, M., & Radley, K. (2012). *Using digital video reporting to inspire and engage students*. ResearchGate.

Wilson, A. (2015). *YouTube in the classroom.* Master's thesis, Ontario Institute for Studies in Education of the University of Toronto.

Wilson-Strydom. M. Thomson, J., & Hodginson-Williams, C. (2005). Understanding ICT integration in South African classrooms. *Perspectives in Education*, *23*(4), 71-85.

World Economic Forum, (2016). *The Global Competitiveness Report 2015–2016:* World Economic Forum framework of The Global Competitiveness and Benchmarking Network, Geneva.

Yoshimura, Y., Kim, K.J., Taniguchi, T., Tono, T., Ueda, K., Hiramatsu, R., Takahiro, M., Keisuke, Y. , Yoshinobu, N. & Teruo, O. (2016). Soliton-like magnetic domain wall motion induced by the interfacial Dzyaloshinskii-Moriya interaction. *Nature Physics*, *12*(2), 157-161.

Zacharia, Z. C. (2003). Beliefs, Attitudes and Intentions of Science Teachers Regarding the Educational Use of Computer Simulations and Inquiry-Based Experiments in

Physics. *Journal of Research in Science Teaching, 40*(8), 792-823.

Zoller, U. (2000). Teaching tomorrow's college science courses. Are we getting it right? *Journal of College Science Teaching,* 29(6), 409-414.

APPENDICES

APPENDIX A:

PHYSICS GRADE 10: MAGNETISM PRE-POST TEST

1.1 A group of magnetically aligned atoms is called a

A. Range

B. Lattice

C. Domain

D. Crystal

1.2 Magnetic flux through a wire loop in a magnetic field does not depend on

A. The area of the loop

B. The magnitude of the magnetic field

C. The shape of the loop

D. The angle between the plane of the loop and the field direction

1.3 A current is flowing east along a power line. If the earth`s magnetic field is neglected, then the direction of the magnetic field below it will be to the

A. North

B. South

C. West

D. East

1.4 A permanent magnet does not exert a force on

A. An unmagnetised iron bar

B. A magnetized iron bar

C. A moving electric charge

D. A stationary electric charge

1.5 The magnetic field of a magnetized iron bar when strongly heated

A. Is unchanged

B. Reverses in Direction

C. Becomes stronger

D. Becomes weaker

1.6 The magnetic field of a bar magnet most closely resembles the magnetic field of

A. Straight current-carrying conductor

B. A horse shoe magnet

C. A stream of electrons moving parallel one another

D. A current-carrying wire loop

1.7 The term magnetic declination refers to which of the following?

A. angle between Earth's magnetic field and Earth's surface

B. tendency for Earth's field to reverse itself

C. angle between directions to true north and magnetic north

D. angle between Earth's magnetic field and Earth's rotational axis .

1.8 All magnetic fields originate from

A. Moving electric charges

B. Iron atoms

C. Magnetic domains

D. Permanent magnets

1.9 The quantity of magnetism retained by a magnetic material after withdrawal of magnetizing force is called

A. Left-over magnetism

B. Hysteresis

C. Residual magnetism

D. Coercivity

1.10 The branch of engineering which deals with the magnetic effect of electric current is known as

A. Magnetism
B. Electronic engineering
C. Electromagnetism
D. Metallurgical engineering

FROM 1.11 up to 1.20 you are required to explain the choice of your answer

1.11 How can you show that electricity creates a magnetic field?

A. Use a compass near a wire with current flowing through it

B. Move wire through an electric field

C. Move wire through a magnetic field

D. Connect a battery to the magnetic field

Explain: ____

1.12 Electrical charges and magnetic poles have many similarities. ONE difference is:

A. one magnetic pole cannot create magnetic poles in other materials.

B. a magnetic pole cannot be isolated.

C. magnetic poles do not produce magnetic fields.

D. magnetic poles produce only alternating fields.

Explain: ____

1.13 When a ferromagnetic substance is inserted in a current-carrying solenoid, the magnetic field is

A. Greatly decreased

B. Slightly increased

C. Slightly decreased

D. Greatly increased

Explain: ____

1.14 The magnetic domains in a non-magnetized piece of iron are characterized by which orientation?

A. parallel to the magnetic axis

B. anti-parallel (opposite direction) to the magnetic axis

C. random

D. perpendicular to the magnetic axis

Explain: ____

1.15 A current in a long, straight wire produces a magnetic field. The magnetic field lines:

A. go out from the wire to infinity.

B. form circles that pass through the wire.

C. form circles that go around the wire.

D. are parallel to the wire.

Explain: ____

1.16. All of the following are ferromagnetic materials EXCEPT

A. Nickel

B. Steel

C. Chromium

D. Cobalt

Explain: ____

1.17 All of the following statements are false EXCEPT

A. Unlike poles repel

B. Magnetic field is a scalar field

C. Electromagnets are typical examples of temporary magnet

D. Magnetic monopoles exist at sub-atomic level.

Explain: ____

1.18 When an external magnetic force is applied on a non-ferromagnetic material

A. Magnetic domains in the non-ferromagnetic material will align themselves in one direction resulting in a strong magnet.

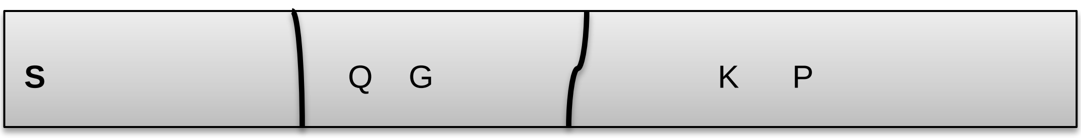
B. All subatomic particles will align themselves

C. Magnetic domains in the non-ferromagnetic material will remain randomly aligned.

D. The material becomes ferromagnetic since it will be attracted to a magnet

Explain: ____

1.19. If a permanent magnet is broken down as shown below where **S** represents South Pole:



The polarity of **G** and **P** will respectively be

A. North pole and North pole

B. South pole and south pole

C. North pole and South pole

D. South pole and North pole

Explain: ____

1.20 If a North Pole of another permanent magnet is brought closer to the side of the broken piece marked **K** (in 1.19 above) then there will be

A. Attraction

B. Repulsion and attraction

C. Repulsion

D. Charges will be transferred

Explain____

2.1 Explain what happens if an electron travelling eastwards enters a magnetic field directed upwards:

____

2.2 An unmagnetised nail will not attract an unmagnetised paper clip. However, if one end of the nail is in contact with a strong permanent magnet, the other end of the nail will attract a paper clip. Fully explain why. -

____

____

____

2.3 Ferromagnetic materials like iron can be magnetized. Explain how this magnetisation process occurs. (Diagrams may be used to aid your explanation).

____

____

____

2.4 Where do magnetic field lines begin? Where do they end? Explain.

____

____

____

APPENDIX B:

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A: **BACKGROUND INFORMATION**
EDUCATOR NAME:
ANNOUNCED OBSERVATION:
TEACHING EXPERIENCE:
SCHOOL NAME:
NAME OF CIRCUIT:
DISTRICT / PROVINCE:
GRADE/CLASS:
DATE OF OBSERVATIONS:
SUBJECT:
TOPIC:
NAME OF OBSERVER:

SECTION B:	**CONTEXTUAL BACKGROUND AND ACTIVITIES**	
TIME (minutes)	DESCRIPTION OF EVENTS	
	Teacher activities	Students activities
0 – 10		
10 – 20		
20 – 30		
30 – 40		
40 – 50		
50 - 60		

SECTION C:	LESSON PLAN/DESIGN & IMPLEMENTATION						
	CRITERIA	RATING					Descriptive Comments
		0	1	2	3	4	
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.						
2	The lesson was designed to engage students as members of a learning community.						
3	In this lesson, student exploration preceded formal presentation.						
4	This lesson encouraged students to seek and value alternative modes of investigation or of problem solving						
5	The focus and direction of the lesson was often determined by ideas originating with students.						

SECTION D:	**CONTENT (Propositional Knowledge)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
6	The lesson involved fundamental concepts of the subject.						
7	The lesson promoted strongly coherent conceptual understanding.						
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.						
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.						
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.						
SECTION E:	**CONTENT (Procedural Knowledge)**						
	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.						
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.						
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.						
14	Students were reflective about their learning.						
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.						
SECTION F	**CLASSROOM CULTURE (Communicative Interactions)**						
	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
16	Students were involved in the communication of their ideas to others using a variety of means and media.						
17	The teacher's questions triggered divergent modes of						

	thinking.						
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.						
19	Student questions and comments often determined the focus and direction of classroom discourse.						
20	There was a climate of respect for what others had to say.						

SECTION G: CLASSROOM CULTURE (Teacher /Student Relationships

	CRITERIA	RATING					Descriptive comment
		0	1	2	3	4	
21	Active participation of students was encouraged and valued.						
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.						
23	In general the teacher was patient with students.						
24	The teacher acted as a resource person, working to support and enhance student investigations.						
25	The metaphor “teacher as listener” was very characteristic of this classroom.						

APPENDIX C:

A QUESTIONNAIRE FOR PHYSICS TEACHERS ON INTERACTIVE USE OF ICT IN TEACHING AND LEARNING PHYSICS

Instructions: Please tick or fill in where necessary.

For the purpose of this questionnaire Information and Communication Technology (ICT) is defined as a range of technologies for gathering, storing, retrieving, processing, analyzing and transmitting information like computers, projectors and internet.

SECTION A: Background/Personal Information:

1. Name of teacher: ____

2. Gender:

MALE		FEMALE	

3. Age group

20 – 25 YEARS	
25 – 30 YEARS	
30 – 35 YEARS	
35 – 40 YEARS	
+ 40 YEARS	

4. QUALIFICATIONS

ACADEMIC	PROFESSIONAL	OTHER

4. Teaching experience:

0 – 5 YEARS	
5 – 10 YEARS	
+10 YEARS	

SUBJECT(S) TAUGHT	GRADE(S)

5. Name of school: ____

6. Type of School:

	RURAL	URBAN
MST SCHOOL		
NON-MST SCHOOL		

7. Circuit: ____

8. District/Province: ______________________________ ____________________

Instructions: For sections B,and C choose and use the codes given, by writing the code (e.g. 0, 1, 2, 3, 4 or 5) of your choice against the questions. The interpretation of codes is as follows:

Rating	0	1	2	3	4	5
Meaning	Not Sure	Strongly disagree	Disagree	Partially Agree	Agree	Strongly agree
Code	NS	SD	D	PA	A	SA

SECTION B: TEACHERS VIEWS ON INTERACTIVE USE CS AND VIDEOS WHEN TEACHING MAGNETISM							
	STATEMENT	Rating					
		NS	SD	D	PA	A	SA
		0	1	2	3	4	5
1	I do use ICT (computer simulations and videos) to teach even before this research.						
2	ICT usage captures learners' attention and increases their level of concentration in class						
3	ICT usage makes teaching Physics easier						
4	ICT usage should be integrated with traditional normal instructional methods in Physics (e.g in magnetism).						
5	Teachers should be work-shopped on how to use computer simulations videos for teaching physical sciences concepts (e.g magnetic domains & fields).						
6	Use of a combination of both computer simulations & videos in physics makes it easier to visualize the reality of imaginary concepts (e.g. magnetic domains & magnetic field lines).						
7	Our school has a WIFI and DSTV network and internet access which can potentially be used in physics classes for computer simulations and video learning via youtube & DVDs.						
8	ICT usage helps in class control and management.						
9	Physics is easy, fun, interesting and exciting when taught using both computer simulations & videos.						
10	I think computer simulations, videos & DVDs are good learning tools when dealing with physics concepts (e.g magnetic domains).						

11	ICT usage makes teaching Physics easier and interesting.						
12	ICT usage saves a lot of time used in drawing and labeling diagrams on chalk board.						
13	ICT usage makes diagrams and graphical work clearer than drawing them on the chalk board.						
14	Use of Computer simulations and videos in learning promotes high order thinking skills & enables students to realize their full potential in physics.						
15	Learners should be allowed to use their own smartphones or tablets via their school`s WIFI network (through closely monitored school`s gmail account) so as to download, watch and share physics simulations and videos.						
16	Most of our schools have ICT infrastructure and tools but lacks the know-how of integrating it into the curriculum as a teaching weapon.						

SECTION C: Factors that may influence the successful integration of ICT in teaching Physics.

1. Whats your perception on the use ICT in teaching high school Physics?

   ____

   ____

2. How do you use Computers for teaching your school are enough for all learners in my class?

   ____

   ____

3. Do you think learners can learn Physics with ICT on their own? Explain briefly.

   ____

   ____

4. Explain how the timetable of the school could be adjusted to accommodate the use of ICT in teaching Physics.

   ____

   ____

5. What do you suggest to be done so as improve learner performance through interactive use of DSTV learning Channel, DVD video discs and youtube videos?

   ____

   ____

6. “Physics teachers should be ICT literate.” What is your opinion?

____

____

7. From the study do you think Learners can be distracted by ICT when teaching Physics?

____

____

8. Explain the challenges that you would encounter when accessing internet via WIFI in your school specifically for the direct benefit of the physics learners.

____

____

9. How often do you make use of the DSTV network as well as computer laboratory with internet access during your physics lesson execution?

____

____

10. What is your opinion on the statement that says “Learners cannot learn Physics with ICT on their own”?

____

____

11. What do you suggest should be done by SA government so that all physics teacher can confidently make use of ICT tools in teaching/learning?

____

____

____

12. The PhET Learners can get access to free online software can be accessed for free online.

    iii) How often do you use it/ comfortable are you using it for teaching physics?

    ____

    ____

    ____

    iv) Do you think its compatible with the South African CAPS syllabus?

    ____

    ____

    ____

13. How often should workshops on interactive use of CS and videos in physics be held to enable SA to be at par with digital 21st century expectations?

____

____

14. Do you think that interactive use of ICT resources can complement shortage of laboratory equipment in your school? Explain briefly

____

____

____

APPENDIX: D

ATTENTION: HEAD OF DEPARTMENT

MPUMALANGA PROVINCIAL EDUCATION DEPARTMENT
PRIVATE BAG X11341
NELSPRUIT
1200
GOVERNMENT BOULEVARD
RIVERSIDE PARK
BUILDING 5
MPUMALANGA PROVINCE.

FROM

Principal Researcher	Mr. LM DZIKITI
Department	Science Education
Address	Stand 1237 ELUKWATINI 1192,
Phone	0787510784
E-mail	listerdz@yahoo.com

DEAR SIR/MADAM

RE; REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN HIGH SCHOOLS

I am **LISTER MUNODAWAFA DZIKITI**, a full time Physical Sciences teacher as well as Head of Natural Sciences Department at Hlabangemehlo Secondary School in Badplaas circuit under Gert Sibande district **(Persal: 82709254).** I am also currently enrolled with University of South Africa (UNISA) for an MSC Physics Education programme **(student number: 43529712)**. As a requirement for the award of a Master of Science degree in Physics, Mathematics and Technology Education, I am **investigating the impact of interactive use of computer simulations and videos on the teaching and learning of magnetism in grade 10 Physics.**

I would therefore like to humbly request for your permission to use computer simulations and videos to teach learners in Grade 10 Physics in your schools, This study involves integrating computer simulations and videos in teaching magnetism, administer a pre-test, post-test and questionnaires so as to collect data from the Grade 10 Physical Science learners with the help of their physics teachers.

TARGET CIRCUITS: Badplaas and Mashishila.

There would be no interruption of all normal school programmes, I would follow the normal school timetables. The grade 10 Physical Science teachers would use the computer simulation and videos to teach magnetism in the computer lab while a control group will be taught using the traditional (normal) teaching methods. After the intervention, I would collect data by learners answering a post-test and a questionnaire. Teachers on the other hand will only answer a questionnaire. The data collected will strictly be treated with confidentiality. The names of all schools, the teachers and the learners will not be used in the analysis of the data.

I would greatly appreciate it if you can grant me the permission and opportunity to proceed with my studies as outlined above. Please do not hesitate to contact me should there be need for any further clarifications.
I have also attached instruments that I shall be making of use to collect data during this study. I have also attached proof of registration with UNISA.
Regards
Mr LISTER M. DZIKITI
Cell:0787510784 // 0712670033
Email: listerdz@yahoo.com
Alternative email: munodadz@gmail.com

APPENDIX E:

ATTENTION: THE CIRCUIT MANAGER:

:BADPLAAS/ MASHISHILA CIRCUIT, (GERT SIBANDE DISTRICT).
MPUMALANGA PROVINCIAL EDUCATION DEPARTMENT
MPUMALANGA PROVINCE, SA.

FROM

Principal Researcher	Mr. LM DZIKITI
Department	Science Education
Address	Stand 1237 ELUKWATINI 1192,
Phone	0787510784
E-mail	listerdz@yahoo.com

DEAR SIR/MADAM

RE; REQUEST FOR PERMISSION TO CONDUCT RESEARCH.

I am **LISTER MUNODAWAFA DZIKITI**, an MSC Physics post-graduate student with the University of South Africa (UNISA), **(student number: 43529712)**. As a requirement for the award of a Master of Science degree in Physics, Mathematics and Technology Education, I am **investigating the impact of interactive use of computer simulations and videos on the teaching and learning of magnetism in grade 10 Physics.**

I would therefore like to humbly request for your permission to use computer simulations and videos to teach learners in Grade 10 magnetism in your circuit, This study involves interactive use of computer simulations and videos in teaching magnetism, administer a pre-test, post-test and questionnaires so as to collect data from the Grade 10 Physical Science learners with the help of their physics teachers.

NB: There shall be no interruption of all normal school programmes, I would follow the normal school timetables. The grade 10 Physical Science teachers would use the computer simulation and videos to teach magnetism in the computer lab while a control group will be taught using the traditional (normal) teaching methods. After the intervention, I would collect data by learners answering a post-test. Teachers on the other hand will only answer a questionnaire. The data collected will strictly be treated with confidentiality. The names of all schools, the teachers and the learners will not be used in the analysis of the data.

If your circuit agrees to voluntarily participate, please sign the form below.

I would greatly appreciate it if you can grant me the permission and opportunity to proceed with my studies as outlined above. Please do not hesitate to contact me should there be need for any further clarifications.

Regards

Mr LISTER M. DZIKITI

Cell:0787510784 // 0712670033

Email: listerdz@yahoo.com

CONSENT FORM:

I ………………………………………………………….. acknowledge that the content of this research study has been thoroughly explained to me and any questions have been answered. I understand that my circuit can withdraw from this study at any time or omit certain aspects if they so ever find it necessary.

I have read the letter provided by LISTER DZIKITI and my circuit has agreed to participate in the research study described.

Name (Printed): _________________________ Designation: _________________

Signature: _____________________________Date________________________

APPENDIX F:

ATTENTION: THE PRINCIPAL:

:HEAD OF NATURAL SCIENCES DEPARTMENT
MPUMALANGA PROVINCIAL EDUCATION DEPARTMENT
MPUMALANGA PROVINCE, SA.

FROM

Principal Researcher	Mr. LM DZIKITI
Department	Science Education
Address	Stand 1237 ELUKWATINI 1192,
Phone	0787510784
E-mail	listerdz@yahoo.com

DEAR SIR/MADAM

RE; REQUEST FOR PERMISSION TO CONDUCT RESEARCH.

I am **LISTER MUNODAWAFA DZIKITI**, an MSC Physics post-graduate student with the University of South Africa (UNISA), **(student number: 43529712)**. As a requirement for the award of a Master of Science degree in Physics, Mathematics and Technology Education, I am **investigating the interactive use of computer simulations and videos on the teaching and learning of magnetism in grade 10 Physics.**

I would therefore like to humbly request for your permission to use computer simulations and videos to teach learners in Grade 10 magnetism in your school, This study involves interactive use of computer simulations and videos in teaching magnetism, administer a pre-test, post-test and questionnaires so as to collect data from the Grade 10 Physical Science learners with the help of their physics teachers.

TARGET CIRCUITS: Badplaas and Mashishila.

NB: There shall be no interruption of all normal school programmes, I would follow the normal school timetables. The grade 10 Physical Science teachers would use the computer simulation and videos to teach magnetism in the computer lab while a control group will be taught using the traditional (normal) teaching methods. After the intervention, I would collect data by learners answering a post-test. Teachers on the other hand will only answer a questionnaire. The data collected will strictly be treated with confidentiality. The names of all schools, the teachers and the learners will not be used in the analysis of the data.

If your school agrees to voluntarily participate, please sign the form below.
I would greatly appreciate it if you can grant me the permission and opportunity to proceed with my studies as outlined above. Please do not hesitate to contact me should there be need for any further clarifications.

Regards
Mr LISTER M. DZIKITI
Cell:0787510784 // 0712670033
Email: listerdz@yahoo.com

CONSENT FORM:
I ……………………………………………………..acknowledge that the content of this research study has been thoroughly explained to me and any questions have been answered. I understand that my school can withdraw from this study at any time or omit certain aspects if they so ever find it necessary.
I have read the letter provided by LISTER DZIKITI and my school has agreed to participate in the research study described.

Name (Printed): ________________________ Designation: _________________

Signature: ____________________________Date_______________________

APPENDIX G:

Letter of Participation and Consent

Date: August 20, 2017

Principal Researcher	Mr. LM DZIKITI
Department	Science Education
Address	Stand 1237 ELUKWATINI 1192,
Phone	0787510784
E-mail	listerdz@yahoo.com

Dear PHYSICAL SCIENCES EDUCATOR (Grade 10):

I am currently a graduate student enrolled for Master of Sciences in Physics Education programme with the University of South Africa. This is entirely a research study.

With this research I am to **Investigate the interactive use of Computer Simulations and Videos in teaching /learning of magnetism in grade 10.**

The findings of this study will be used solely for this thesis in which a final paper and presentation will be completed. Your name and institution will not be used in the final paper or presentation. It is important to note that all information provided will be confidential and if you so choose to omit certain aspect of the questionnaire, you will be accommodated.

I am humbly inviting you to take part in a research study. During this study your learners will be taught MAGNETISM & DOMAIN THEORY using a risk free COMPUTER SIMULATIONS & VIDEOS approach.

Your expected time commitment for this study is two weeks, within which your learners may be expected to avail themselves to respond to pre-post tests while you will only respond to a structured questionnaire.

Please feel free to ask me if there is anything that you may not be clear of or if you need more information pertaining to this study.

If you agree to voluntarily participate, please sign the form below.

I greatly appreciate your participation in this research study.

Sincerely,

LISTER MUNODAWAFA DZIKITI

listerdz@yahoo.com

I acknowledge that the content of this research study has been thoroughly explained to me and any questions have been answered. I understand that I can withdraw from this study at any time or omit certain aspects of the questionnaire if I so ever find it necessary.

I have read the letter provided by LISTER DZIKITI and have agreed to participate in the research study described.

Name (Printed): ________________________ Designation: ________________________

Signature: ______________________________. Date: _________________________

APPENDIX H:

Letter of Participation and Consent

SCHOOL D (Experimental)

Date: November 09, 2017

Principal Researcher	Mr. LM DZIKITI
Department	Science Education
Address	Stand 1237 ELUKWATINI 1192,
Phone	0787510784
E-mail	listerdz@yahoo.com

Dear Parent/Guardian

I am currently a graduate student enrolled for Master of Sciences in Physics Education programme with the University of South Africa. This is entirely a research study. With this research I am to **Investigate the impact of interactive use of Computer Simulations and Videos in teaching /learning of magnetism in grade 10.**

The findings of this study will be used solely for this thesis in which a final paper and presentation will be completed. The name of your child and that of the institution will not be used in the final paper or presentation. It is important to note that all information provided will be confidential. The learner has the right to withdraw from the study without any penalty.

I am humbly requesting for your consent to allow your grade 10 child to take part in this research study. During this study the grade10 learners from your school shall act as the EXPERIMENTAL GROUP D. During this study your child will be taught MAGNETISM & DOMAIN THEORY using a risk free COMPUTER SIMULATIONS approach.

The expected time commitment for this study is two weeks, within which your child may be expected to avail himself/herself to respond to pre-post tests. Please feel free to ask me if there is anything that you may not be clear of or if you need more information pertaining to this study.

If you agree to allow your child to voluntarily participate, please sign the form below.

I greatly appreciate your child`s participation in this research study.

Sincerely,

LISTER MUNODAWAFA DZIKITI

listerdz@yahoo.com

CONSENT FORM

I …………………………………………. parent/guardian of ………………………...
acknowledge that the content of this research study has been thoroughly explained to me and any questions have been answered.

I am aware of the fact that my child can only fully appreciate how he/she can directly benefit from this study through attending all the sessions.

I understand that my child`s participation in this study is voluntary. I also understand that my child can withdraw from this study at any time or omit certain aspects of the pre-post tests if he/she so ever find it necessary and, my child will not be penalized for failing to take part in this study.

I also understand that I can withdraw my child from this study at any time without any penalty being rendered to my child afterwards.

I have read the letter provided by LISTER DZIKITI and have agreed to allow my child to participate in the research study described.

Signature: ______________________________Date________________________

Letter of Participation and Consent <u>**SCHOOL E (experimental)**</u>

Date: November 09, 2017

Principal Researcher	Mr. LM DZIKITI
Department	Science Education
Address	Stand 1237 ELUKWATINI 1192,
Phone	0787510784
E-mail	listerdz@yahoo.com

Dear Parent/Guardian

I am currently a graduate student enrolled for Master of Sciences in Physics Education programme with the University of South Africa. This is entirely a research study.
With this research I am to **Investigate the impact of interactive use of Computer Simulations and Videos in teaching /learning of magnetism in grade 10.**

The findings of this study will be used solely for this thesis in which a final paper and presentation will be completed. The name of your child and that of the institution will not be used in the final paper or presentation. It is important to note that all information provided will be confidential. The learner has the right to withdraw from the study without any penalty.
I am humbly requesting for your consent to allow your grade 10 child to take part in this research study. During this study the grade10 learners from your school shall act as the EXPERIMENTAL GROUP E. Your child will be taught MAGNETISM & DOMAIN THEORY using a risk free VIDEOS approach. The results of the entire study shall also be shared with your child`s teacher.
The expected time commitment for this study is two weeks, within which your child may be expected to avail himself/herself to respond to pre-post tests. Please feel free to ask me if there is anything that you may not be clear of or if you need more information pertaining to this study.
If you agree to allow your child to voluntarily participate, please sign the form below.
I greatly appreciate your child`s participation in this research study.

Sincerely,

LISTER MUNODAWAFA DZIKITI

listerdz@yahoo.com

CONSENT FORM:

I ………………………………………… parent/guardian of …………………………………
acknowledge that the content of this research study has been thoroughly explained to me and any questions have been answered.

I am aware of the fact that my child can only fully appreciate how he/she can directly benefit from this study through attending all the sessions. I understand that my child`s participation in this study is voluntary. I also understand that my child can withdraw from this study at any time or omit certain aspects of the pre-post tests if he/she so ever find it necessary and, my child will not be penalized for failing to take part in this study.

I also understand that I can withdraw my child from this study at any time without any penalty being rendered to my child afterwards.
I have read the letter provided by LISTER DZIKITI and have agreed to allow my child to participate in the research study described.

Signature: ____________________________Date_______________________

Letter of Participation and Consent

School F (Experimental)

Date: November 09, 2017

Principal Researcher	Mr. LM DZIKITI
Department	Science Education
Address	Stand 1237 ELUKWATINI 1192,
Phone	0787510784
E-mail	listerdz@yahoo.com

Dear Parent/Guardian

I am currently a graduate student enrolled for Master of Sciences in Physics Education programme with the University of South Africa. This is entirely a research study. With this research I am to **Investigate the impact of interactive use of Computer Simulations and Videos in teaching /learning of magnetism in grade 10.**

The findings of this study will be used solely for this thesis in which a final paper and presentation will be completed. The name of your child and that of the institution will not be used in the final paper or presentation. It is important to note that all information provided will be confidential. The learner has the right to withdraw from the study without any penalty.

I am humbly requesting for your consent to allow your grade 10 child to take part in this research study. During this study the grade10 learners from your school shall act as the EXPERIMENTAL GROUP F. Your child will be taught MAGNETISM & DOMAIN THEORY using a risk free COMPUTER SIMULATIONS & VIDEOS approach. The results of the study shall also be shared with their teacher.

The expected time commitment for this study is two weeks, within which your child may be expected to avail himself/herself to respond to pre-post tests. Please feel free to ask me if there is anything that you may not be clear of or if you need more information pertaining to this study.

If you agree to allow your child to voluntarily participate, please sign the form below.

I greatly appreciate your child`s participation in this research study.

Sincerely,

LISTER MUNODAWAFA DZIKITI

listerdz@yahoo.com

<u>CONSENT FORM</u>

I ……………………………..parent/guardian of ……………………………….acknowledge that the content of this research study has been thoroughly explained to me and any questions have been answered.
I am aware of the fact that my child can only fully appreciate how he/she can directly benefit from this study through attending all the sessions. I understand that my child`s participation in this study is voluntary. I also understand that my child can withdraw from this study at any time or omit certain aspects of the pre-post tests if he/she so ever find it necessary and, my child will not be penalized for failing to take part in this study.

I also understand that I can withdraw my child from this study at any time without any penalty being rendered to my child afterwards.
I have read the letter provided by LISTER DZIKITI and have agreed to allow my child to participate in the research study described.

Signature: ______________________________Date_________________________

Letter of Participation and Consent : **SCHOOL: G (control)**

Date: November 09, 2017
Principal Researcher Mr. LM DZIKITI
Department Science Education
Address Stand 1237 ELUKWATINI 1192,
Phone 0787510784
E-mail listerdz@yahoo.com

Dear Parent/Guardian

I am currently a graduate student enrolled for Master of Sciences in Physics Education programme with the University of South Africa. This is entirely a research study. With this research I am to **Investigate the impact of interactive use of Computer Simulations and Videos in teaching /learning of magnetism in grade 10.**

The findings of this study will be used solely for this thesis in which a final paper and presentation will be completed. The name of your child and that of the institution will not be used in the final paper or presentation. It is important to note that all information provided will be confidential. The learner has the right to withdraw from the study without any penalty.
I am humbly requesting for your consent to allow your grade 10 child to take part in this research study. During this study the grade10 learners from your school shall act as the CONTROL GROUP G. Your child will be taught MAGNETISM using the usual teaching methods aided with DEMONSTRATIONS. Your child shall afterwards benefit because the researcher shall share the results of this study with his/her teacher. The researcher shall also ensure that all learners from your school are exposed to the risk free COMPUTER SIMULATIONS & VIDEOS approach after the study.
The expected time commitment for this study is two weeks, within which your child may be expected to avail himself/herself to respond to pre-post tests. Please feel free to ask me if there is anything that you may not be clear of or if you need more information pertaining to this study.
If you agree to allow your child to voluntarily participate, please sign the form below.
I greatly appreciate your child`s participation in this research study.

Sincerely,

LISTER MUNODAWAFA DZIKITI

listerdz@yahoo.com

CONSENT FORM

I ………………………………parent/guardian of ……………………………acknowledge that the content of this research study has been thoroughly explained to me and any questions have been answered.

I am aware of the fact that my child can only fully appreciate how he/she can directly benefit from this study through attending all the sessions. I understand that my child`s participation in this study is voluntary. I also understand that my child can withdraw from this study at any time or omit certain aspects of the pre-post tests if he/she so ever find it necessary and, my child will not be penalized for failing to take part in this study.

I also understand that I can withdraw my child from this study at any time without any penalty being rendered to my child afterwards.

I have read the letter provided by LISTER DZIKITI and have agreed to allow my child to participate in the research study described.

Signature: ______________________________Date________________________

APPENDIX I:

Letter of Participation and Consent

SCHOOL: D (Experimental)

Date: November 09, 2017

Principal Researcher	Mr. LM DZIKITI
Department	Science Education
Address	Stand 1237 ELUKWATINI 1192,
Phone	0787510784
E-mail	listerdz@yahoo.com

Dear (Learner participant)

I am currently a graduate student enrolled for Master of Sciences in Physics Education programme with the University of South Africa. This is entirely a research programme. With this research I am to **Investigate the impact of Interactive Computer Simulations and Videos in teaching /learning of magnetism in grade 10.**

The findings of this study will be used solely for this thesis in which a final paper and presentation will be completed. Your name and institution will not be used in the final paper or presentation. It is important to note that all information provided will be confidential and if you so choose to omit certain aspect of the pre-post tests, you will be accommodated.

I am humbly inviting you to take part in a research study. During this study the grade10 learners from your school shall act as the EXPERIMENTAL GROUP D. You will be taught MAGNETISM using a risk free COMPUTER SIMULATIONS approach. The results and benefits of the entire study shall also be shared with your teacher.

Your expected time commitment for this study is two weeks, within which you may be expected to avail yourself to respond to pre-post tests. Please feel free to ask me if there is anything that you may not be clear of or if you need more information pertaining to this study.

If you agree to voluntarily participate, please sign the consent form below.

I greatly appreciate your participation in this research study.

Sincerely,

LISTER MUNODAWAFA DZIKITI

listerdz@yahoo.com

CONSENT FORM

I ……………………………………of ……………………………high school acknowledge that the content of this research study has been thoroughly explained to me and any questions have been answered. I am aware of the fact that I can only fully appreciate how I can directly benefit from this study through attending all the sessions. I understand that my participation in this study is voluntary. I also understand that I can withdraw from this study at any time or omit certain aspects of the pre-post tests if I so ever find it necessary and, I will not receive any penalty.
I have read the letter provided by LISTER DZIKITI and have agreed to participate in the research study described.

Signature: ___________________Grade: ____ Date__________________

Letter of Participation and Consent

SCHOOL E (Experimental)

Date: November 09, 2017

Principal Researcher Mr. LM DZIKITI
Department Science Education
Address Stand 1237 ELUKWATINI 1192,
Phone 0787510784
E-mail listerdz@yahoo.com

Dear (Learner participant)

I am currently a graduate student enrolled for Master of Sciences in Physics Education programme with the University of South Africa. This is entirely a research programme. With this research I am to **Investigate the impact of Interactive Computer Simulations and Videos in teaching /learning of magnetism in grade 10.**

The findings of this study will be used solely for this thesis in which a final paper and presentation will be completed. Your name and institution will not be used in the final paper or presentation. It is important to note that all information provided will be confidential and if you so choose to omit certain aspect of the pre-post tests, you will be accommodated.

I am humbly inviting you to take part in a research study. During this study the grade10 learners from your school shall act as the EXPERIMENTAL GROUP E. You will be taught MAGNETISM using a risk free VIDEOS approach. The results of the entire study shall also be shared with your physical sciences teacher.

Your expected time commitment for this study is two weeks, within which you may be expected to avail yourself to respond to pre-post tests. Please feel free to ask me if there is anything that you may not be clear of or if you need more information pertaining to this study.

If you agree to voluntarily participate, please sign the consent form below.

I greatly appreciate your participation in this research study.

Sincerely,

LISTER MUNODAWAFA DZIKITI

listerdz@yahoo.com

CONSENT FORM

I ……………………………………..…… of …………………………………………high school acknowledge that the content of this research study has been thoroughly explained to me and any questions have been answered. I am aware of the fact that I can only fully appreciate how I can directly benefit from this study through attending all the sessions. I understand that my participation in this study is voluntary. I also understand that I can withdraw from this study at any time or omit certain aspects of the pre-post tests if I so ever find it necessary, and I won't be penalized for such actions.
I have read the letter provided by LISTER DZIKITI and have agreed to participate in the research study described.

Signature: ____________________Grade: _____ Date_________________

Letter of Participation and Consent

SCHOOL F (Experimental)

Date: November 09, 2017

Principal Researcher Mr. LM DZIKITI
Department Science Education
Address Stand 1237 ELUKWATINI 1192,
Phone 0787510784
E-mail listerdz@yahoo.com

Dear (Learner participant)

I am currently a graduate student enrolled for Master of Sciences in Physics Education programme with the University of South Africa. This is entirely a research programme. With this research I am to **Investigate the impact of Interactive Computer Simulations and Videos in teaching /learning of magnetism in grade 10.**

The findings of this study will be used solely for this thesis in which a final paper and presentation will be completed. Your name and institution will not be used in the final paper or presentation. It is important to note that all information provided will be confidential and if you so choose to omit certain aspect of the pre-post tests, you will be accommodated.

I am humbly inviting you to take part in a research study. During this study the grade10 learners from your school shall act as the EXPERIMENTAL GROUP F. You will be taught MAGNETISM using usual methods aided with DEMONSTRATIONS and, then afterwards using risk free COMPUTER SIMULATIONS & VIDEOS approach. The results and benefits of the entire study shall also be shared with your physical sciences teacher.

Your expected time commitment for this study is two weeks, within which you may be expected to avail yourself to respond to pre-post tests. Please feel free to ask me if there is anything that you may not be clear of or if you need more information pertaining to this study.

If you agree to voluntarily participate, please sign the consent form below.

I greatly appreciate your participation in this research study.

Sincerely,

LISTER MUNODAWAFA DZIKITI

listerdz@yahoo.com

CONSENT FORM

I …………………………………………..of ………………….…………..high school acknowledge that the content of this research study has been thoroughly explained to me and any questions have been answered. I am aware of the fact that I can only fully appreciate how I can directly benefit from this study through attending all the sessions. I understand that my participation in this study is voluntary. I also understand that I can withdraw from this study at any time or omit certain aspects of the pre-post tests if I so ever find it necessary. I won't be penalized for not taking part in this study.
I have read the letter provided by LISTER DZIKITI and have agreed to participate in the research study described.

Signature: ___________________Grade: _________. Date____________

Letter of Participation and Consent.

SCHOOL G (Control)

Date: November 09, 2017

Principal Researcher	Mr. LM DZIKITI
Department	Science Education
Address	Stand 1237 ELUKWATINI 1192,
Phone	0787510784
E-mail	listerdz@yahoo.com

Dear (Learner participant)

I am currently a graduate student enrolled for Master of Sciences in Physics Education programme with the University of South Africa. This is entirely a research programme. With this research I am to **Investigate the impact of Interactive Computer Simulations and Videos in teaching /learning of magnetism in grade 10.**

The findings of this study will be used solely for this thesis in which a final paper and presentation will be completed. Your name and institution will not be used in the final paper or presentation. It is important to note that all information provided will be confidential and if you so choose to omit certain aspect of the pre-post tests, you will be accommodated.

I am humbly inviting you to take part in a research study. During this study the grade10 learners from your school shall act as the CONTROL GROUP G. You will be taught MAGNETISM using usual methods aided with DEMONSTRATIONS. After the study your teacher shall expose you to the risk free COMPUTER SIMULATIONS & VIDEOS approach based on magnetism.

Your expected time commitment for this study is two weeks, within which you may be expected to avail yourself to respond to pre-post tests. Please feel free to ask me if there is anything that you may not be clear of or if you need more information pertaining to this study.

If you agree to voluntarily participate, please sign the consent form below.

I greatly appreciate your participation in this research study.

Sincerely,

LISTER MUNODAWAFA DZIKITI

listerdz@yahoo.com

CONSENT FORM

I ………………………………………………..……of …………………………….high school acknowledge that the content of this research study has been thoroughly explained to me and any questions have been answered. I am aware of the fact that I can only fully appreciate how I can directly benefit from this study through attending all the sessions. I understand that my participation in this study is voluntary. I also understand that I can withdraw from this study at any time or omit certain aspects of the pre-post tests if I so ever find it necessary. I won't be penalized for not taking part in this study.
I have read the letter provided by LISTER DZIKITI and have agreed to participate in the research study described.

Signature: __________________Grade: _____   Date_________________

APPENDIX J: PERMISSION LETTER TO USE RTOP (FROM PROF M.D. PIBURN)

RE: Request for copyrights permission to use RTOP in Physics education Research

Michael Piburn <mike.piburn@asu.edu>

Nov 7 at 4:33 PM

To: Lister Munoda

Lister,

Please feel free to use the RTOP in its original form and with proper acknowledgements.

The RTOP is a copyrited instrument, and modifications are not allowed. If the RTOP does not suit you in its current form, you will need to create a new instrument.

Good luck with your work.

Mike piburn

Sent from my Verizon, Samsung Galaxy Tablet

-------- Original message --------

From: Lister Munoda <listerdz@yahoo.com>

Date: 11/6/17 5:13 PM (GMT-07:00)

To: Michael Piburn <mike.piburn@asu.edu>

Subject: Request for copyrights permission to use RTOP in Physics education Research

Hi Prof.

I hope I find you well.

I am LISTER DZIKITI, an MSC PHYSICS EDUCATION RESEARCH STUDENT with the University of South Africa.

I am hereby humbly requesting for RTOP copyrights permissions.

Please find attached a formal letter for this request as well as my MSC proposal within which the RTOP will be used.

I hope you will find everything in order. Thank you for your attention

Regards

LISTER DZIKITI. (MSC Education student)

APPENDIX K: PERMISSION LETTER TO USE QUESTIONNAIRE (from KOTOKA JK)

Mr JK Kotoka
P O Box 23814
Gezina
0031
0734639661
Kotokajk@gmail.com

7th November 2017

Mr. LM DZIKITI
Science Education
Stand 1237 ELUKWATINI 1192,
0787510784
listerdz@yahoo.com

Dear Mr. Dzikiti

RE; PERMISSION TO ADOPT/MODIFY PARTS OF MY MSC QUESTIONNAIRE IN ORDER TO CONDUCT RESEARCH IN MPUMALANGA HIGH SCHOOLS

I **Jonas Kwadzo Kotoka**, acknowledged that I have received a written request from Mr LM Dzikiti to allow him to use my research questionnaire which I used in my MSc studies at UNISA.

I am happy to inform you that the request is granted, and you may use the said questionnaire for the purposes of your studies.

I therefore wish you success in your studies.

Kind regards.

Kotoka JK.

APPENDIX L.

APPENDIX L1a: MR W`S LESSON PLANS ON THE INTERACTIVE USE OF CS IN GRADE 10 MAGNETISM.

LESSON PLAN : 1

TOPIC: MAGNETISM

CONTENT TO BE COVERED: Ferromagnetic & non-ferromagnetic materials; magnetic field

LESSON OBJECTIVES: After the lesson the learners should be able to:

- State Iron (Fe); Nickel (Ni) & Cobalt (Co) as examples of ferromagnetic materials.
- Classify materials as ferromagnetic & non-ferromagnetic
- Define and simulate magnetic field.
- Compare the magnetic field with the electric & gravitational fields
- Simulate magnetic behavior of ferromagnetic materials

ASSUMED PRIOR KNOWLEDGE: Learners have seen a permanent magnet before.

TEACHING/LEARNING RESOURCES: Interactive computer simulations using laptop; data projector and white screen.

TIME ALLOCATION	MAIN ACTIVITY	TEACHER ACTIVITIES	LEARNER ACTIVITIES
0----5MINS	INTRODUCTION	Teacher starts off by reviewing lessons on magnets taught in grade 9. He asks learners guiding questions which would enable them to explain what a magnet is in their own words.	Learners to pay attention and respond to questions.
		The teacher to assign learners into groups.	Each group is given some materials such as nail paper clips, copper and Al wires and a permanent bar magnet. Each group is required to classify materials according to whether they can be attracted on or not attracted by a magnet. Learners were successfully able to do that.
		The teacher to guide learners while making use of PhET simulations into identifying ferromagnetic materials as those that can be attracted to a bar magnet.. The simulations also to involve bringing the iron nail closer to but not in conduct with a bar magnet by just giving it a slight push. The simulation to be repeated at various distances after which the teacher asks the learners to make their own conclusion.	The learners to view some ferromagnetic materials like iron nails and money clips as ferromagnetic materials. The learners to observe that when a nail reaches a particular point or distance from the magnet it will experience a magnetic force.
		The activity made the teacher to guide learners into defining magnetic field as individuals . The teacher consolidate the ideas of the learners by explaining while using	There was time for feedback on what the learners thought was the most probable definition of magnetic field. learners to make their

		another simulation presentation.	conclusion based on observing that when the distance from nail to magnet is very small the magnetic-force experienced by nail will be very high.
50----60MINS	CONCLUSIONS	Teacher then sums up the lesson through asking recall questions about all the entire activities of the lesson.	Learners to pay attention and respond to questions.
ASSESSMENT: A homework based on the comparison of magnetic field with electrostatic and gravitational field was given at the end.			

APPENDIX L1b: MR W`S LESSON PLANS ON THE INTERACTIVE USE OF CS IN GRADE 10 MAGNETISM.

LESSON PLAN : 2

TOPIC: MAGNETISM

CONTENT TO BE COVERED:

- Laws of magnetism
- Properties of magnetic field lines
- magnetic field around a coil-carrying current
- electromagnets.

LESSON OBJECTIVES: After the lesson the learners should be able to:

- State the laws of magnetism
- Outline the properties of magnetic field lines.
- Draw magnetic field lines around a permanent bar magnet
- Demonstrate that like poles repel and that unlike poles attract.
- Demonstrate the existence of a magnetic field around a coil carrying current.
- Identify an electromagnet as a temporary magnet.

ASSUMED PRIOR KNOWLEDGE: Learners are able to:

- classify materials as ferromagnetic and non-ferromagnetic;
- define magnetic field as a region of space around a magnet where a ferromagnetic material experiences a magnetic force..

TEACHING/LEARNING RESOURCES: Interactive computer simulations using laptop; data projector and white screen.

Time allocation	Main activity	Teacher activities	Learner activities
0—10mins	introduction	Teacher introduces lesson through asking questions linked to the previous lesson.	Learners to pay attention and respond to questions.
		Teacher to simulate how magnets attract each other. During the simulation one end of a magnet was brought closer to the end of another magnet. The simulations were then repeated while switching the polarity of one magnet and bringing its end closer towards the end of the other magnet. This simulation activity was meant to guide learners into concluding that like poles repel and unlike poles attract.	The learners were to observe and record their observations. The learners also recorded their observations.
		Teacher to lead an overall class discussion related to the properties of magnetic field lines as observed from the simulations. Teacher to provide another simulation demonstrating how the field lines appear like from within the bar magnet.	Learners were then tasked to draw magnetic field lines depicting attraction and repulsion.
		Teacher provides another simulation which involves demonstrating coil carrying current and existence of magnetic field around it. Teacher uses the simulation to introduce the concept of electromagnets.	The learners to observe and record their observations.
50—60mins	conclusion	Teacher sums up the lesson during conclusion and gives out a homework in which learners are to find out more about electromagnets and their applications in everyday life.	learners to go home and find out more about electromagnets and their applications in everyday life.
Assessment: Homework based on applications of electromagnets			

APPENDIX L1c: MR W`S LESSON PLANS ON THE INTERACTIVE USE OF CS IN GRADE 10 MAGNETISM.

LESSON PLAN: 3

TOPIC: MAGNETISM

CONTENT TO BE COVERED:

- magnetic domain theory
- Application of domain theory in magnetization.
- Magnetic monopoles.
- Permanent loss of magnetic properties through thermal agitation

LESSON OBJECTIVES: After the lesson the learners should be able to:

- Define a magnetic domain
- Explain the domain theory as it pertains to the origin of magnets.
- Demonstrate how a ferromagnetic material is magnetised through application of the domain theory.
- Use the domain theory to explain why some materials are attracted to a magnet while others cannot.
- Explain using the domain theory why magnetic monopoles cannot exist.
- Use the domain theory to explain why thermal agitation & and hammering/dropping a permanent magnet can cause it to lose its magnetic properties.
- Use the domain theory to explain the existence of an intimate relationship between electricity and magnetism.
- Identify everyday applications and uses of magnets.

ASSUMED PRIOR KNOWLEDGE: Learners are able to:

- Identify that like poles repel and unlike poles attract.
- Understand that around every coil carrying current there exist a magnetic field.
- Identify an electric bell as an electromagnet.

TEACHING/LEARNING RESOURCES: Interactive computer simulations using laptop; data projector and white screen.

Time allocation	Main activity	Teacher activities	Learner activities
0—10mins	introduction	Teacher starts by reviewing his previous lesson on magnetic field lines and electromagnets through a question and answer approach. Teacher to ask probing questions about the origin of magnets and magnetism.	Learners to participate by responding to questions based on previous lesson. Learners to suggest origin of magnets.
		Teacher then introduces and explains the domain theory using CS approach. Teacher presents a simulation that would most probably resemble domains that are randomly aligned.	Learners to observe simulation presentation resembling domains that are randomly aligned.
		Teacher presents another PhET simulation to learners to assist in providing a scientific explanation of what happens when a material is being magnetized.	Learners to observe that when an external field is applied on a ferromagnetic material, the domains will align themselves resulting in a strong magnet. Learners to observe through simulation the circumstances leading to material being magnetised.

		Teacher led class discussion on why a permanent magnet can lose its magnetic properties after being dropped or hammered several times or heated strongly. The teacher to initiates a class discussion which would allow learners to apply the domain theory on the existence or non-existence of magnetic monopoles.	Learners to suggest why a permanent magnet can lose its magnetic properties after being dropped/hammered several times or heated strongly while applying domain theory. Learners to apply the domain theory in order to explain whether magnetic monopoles exist.
50—60mins	conclusion	The teacher sums up the lesson by directing learners to realize that magnetism is directly associated with charge movements and, that electricity and magnetism are one thing	Learners to listen, respond to questions and take down a few notes
Assessment: Homework given based on magnetic saturation and the everyday uses and applications of magnets.			

APPENDIX L1d: MR W`S LESSON PLANS ON THE INTERACTIVE USE OF CS IN GRADE 10 MAGNETISM.

LESSON PLAN: 4

TOPIC: MAGNETISM

CONTENT TO BE COVERED:

- gyro-magnetic compass & earth`s magnetic field.
- Use of magnets in navigation.
- Physical phenomena that are influenced by earth`s magnetic field, eg Aurora Borealis & magnetic storms.
- Defensive mechanism of the earth`s magnetic field against solar winds.

LESSON OBJECTIVES: After the lesson the learners should be able to:

- Simulate how a compass indicates the direction of a magnetic field.
- Use CS methods to compare the magnetic field of the Earth to the magnetic field of a bar magnet using words and diagrams.
- Explain the difference between the geographical North Pole and the magnetic North pole of the Earth.
- Use CS methods to demonstrate how magnet is employed in navigation.
- Give examples of phenomena that are affected by Earth's magnetic field e.g. Aurora Borealis (Northern Lights), magnetic storms.
- Discuss qualitatively through CS presentations how the earth's magnetic field provides protection from solar winds.

ASSUMED PRIOR KNOWLEDGE: Learners are able to:

- Explain magnetic behavior of ferromagnetic materials in terms of magnetic domains.
- Use the domain theory to explain how a permanent magnet can lose its magnetic properties after being dropped/hammered/heated strongly.

TEACHING/LEARNING RESOURCES: Interactive computer simulations using laptop; data projector and white screen.

Time allocation	Main activity	Teacher activities	Learner activities
0—10mins	introduction	Teacher introduces lesson through question and answer approach to recap and clarify all ideas dealt with in the previous three lessons.	Learners to pay attention; respond to questions and also ask clarity seeking questions.
		Teacher to explain through use of CS presentation the fact that planet earth is potentially a very large natural magnet. Teacher to explain and also indicate that iron is one of the most abundant metals in the earth`s crust. Teacher`s CS presentation to also highlight the importance of directions in navigation and how magnets are used in sensing directions.	Learners to observe via CS presentation how magnets can be used in predicting the earth`s north pole
		He also went further to clarify the fact that the earth`s geographical north pole does not 100% coincide with a permanent magnet`s north pole. They differ by a very small angle of around 24 degrees. A phenomenon called magnetic declination.	Learners to pay attention; respond to questions and also ask clarity seeking questions.
		The teacher went on to lead an overall class discussion aided with CS on how magnets including gyromagnetic compasses are used in navigation systems. Teacher to present a CS indicating some natural phenomena like Aurora Borealis, magnetic storms as well as solar winds that are greatly affected by earth`s magnetic field.	Learners to observe the active and defensive role played by earth`s magnetic field against the solar winds.
50—60mins	conclusion	Teacher sums up the lesson by recapping main ideas	Learners to pay

		of the lesson and also giving learners homework based on earth`s magnetic reversal and how it will affect the future of the planet.	attention; respond to questions and also ask clarity seeking questions.
Assessment: Homework on earth`s magnetic reversal			

APPENDIX L2a: MR X`S LESSON PLANS ON THE INTERACTIVE USE OF VIDEOS IN GRADE 10 MAGNETISM.

LESSON PLAN: 1

TOPIC: MAGNETISM

CONTENT TO BE COVERED: Ferromagnetic & non-ferromagnetic materials; magnetic field

LESSON OBJECTIVES: After the lesson the learners should be able to:

- State Iron (Fe); Nickel (Ni) and Cobalt (Co) as examples of ferromagnetic materials.
- Classify materials as ferromagnetic and non-ferromagnetic
- Use videos to define a magnetic field.
- Compare the magnetic field with the electric & gravitational fields using videos
- Use videos to demonstrate the magnetic behavior of ferromagnetic materials.
- Use video to Classify magnets as temporary or permanent.

ASSUMED PRIOR KNOWLEDGE: Learners have seen and/or once interacted with a permanent magnet before.

TEACHING/LEARNING RESOURCES: Interactive videos using laptop; data projector and smart board.

TIME ALLOCATION	MAIN ACTIVITY	TEACHER ACTIVITIES	LEARNER ACTIVITIES
0—10mins	introduction	Teacher starts by asking reviewing questions on magnets taught in grade 9.	Learners to pay attention and respond to questions.
		Teacher to present video based on permanent magnet as well as the various shapes and sizes of magnets to guide learners into identifying ferromagnetic materials as those that can be attracted to a bar magnet.	Learners to observe and identify ferromagnetic and non-ferromagnetic materials as they interact with a permanent magnet.
		The teacher presents a with nails being attracted to a magnet when they are located some particular critical distance from the magnet. Teacher uses video to guide learners into defining magnetic field as “a region of space around a magnet where a ferromagnetic material experiences a magnetic force”.	Learners to observe in the next video a nails being slightly pulled towards a magnet. Learners to also observe that the nails have to reach a particular point or distance from the magnet where they will experience a magnetic force.
		In the next video the teacher to present a video based on temporary magnets to enable the learners to differentiate between temporary and permanent magnets	In the next video the learners to observe and appreciate the strength of temporary magnets and how they are made.
50—60mins	Conclusion	The teacher then sums up the lesson through asking recall questions about the entire activities and observations of the lesson.	Learners to pay attention and respond to questions.
Assessment: A homework based on the comparison of magnetic field with electrostatic and gravitational field			

APPENDIX L2b: MR X`S LESSON PLANS ON THE INTERACTIVE USE OF VIDEOS IN GRADE 10 MAGNETISM.

LESSON PLAN: 2

TOPIC: MAGNETISM

CONTENT TO BE COVERED:

- Laws of magnetism
- Physical properties of magnetic field lines
- magnetic field around a coil-carrying current
- Designing a simple electromagnet.

LESSON OBJECTIVES: After the lesson the learners should be able to:

- State laws of magnetism
- Identify poles of a magnet and that of a gyromagnetic compass.
- Outline the properties of magnetic field lines.
- Draw magnetic field lines around a permanent bar magnet
- Observe from videos that like poles repel and that unlike poles attract.
- Observe from videos the existence of a magnetic field around a coil carrying current.
- Observe from video a simple electromagnet.

ASSUMED PRIOR KNOWLEDGE: Learners are able to:

- classify materials as ferromagnetic and non-ferromagnetic;
- define magnetic field as a region of space around a magnet where a ferromagnetic material experiences a magnetic force.
- Differentiate between permanent and temporary magnets.

TEACHING/LEARNING RESOURCES: Interactive videos using laptop; data projector and smart board.

TIME ALLOCATION	MAIN ACTIVITY	TEACHER ACTIVITIES	LEARNER ACTIVITIES

0—10mins	Introduction	Teacher introduces the lesson by reviewing his previous lesson on magnets through a question and answer approach.	Learners to pay attention and respond to questions.
		Teacher presents a video which guides learners into observing what happens during attraction and requests learners to record their observations.	Learners to view what happens when unlike poles of permanent magnets were brought closer together. Learners to record their observations.
		Teacher presents another video which guides learners into observing what happens during repulsion and requests learners to record their observations. Video also presents magnetic levitation	Learners to view what happens when like poles of permanent magnets were brought closer together. Learners to record their observations.
		Teacher presents the next video which demonstrates the existence of a magnetic field around a conductor carrying current	Learners to observe how nail can become magnetized by winding an insulated copper conductor around it and allowing current to flow through the copper wire.
50--60	Conclusion	Teacher uses the last video based on magnetic field around a coil-carrying current to sum up the lesson and also to introduce learners to electromagnets.	Learners to pay attention and respond to questions.
Assessment: Homework based on electromagnetism and its application e.g in electric bells			

APPENDIX L2c: MR X`S LESSON PLANS ON THE INTERACTIVE USE OF VIDEOS IN GRADE 10 MAGNETISM.

LESSON PLAN: 3

TOPIC: MAGNETISM

CONTENT TO BE COVERED:

- Magnetic domain theory
- Application of domain theory in magnetization.
- Magnetic monopoles.
- Permanent loss of magnetic properties through thermal agitation

LESSON OBJECTIVES: After the lesson the learners should be able to:

- Explain the domain theory using videos.
- Observe how a ferromagnetic material is magnetised through application of the domain theory.
- Use the domain theory to explain why some materials are attracted to a magnet while others cannot.
- Use the domain theory to explain why thermal agitation & hammering/dropping a permanent magnet can cause it to lose its magnetic properties.
- Use the domain theory to explain the existence of an intimate relationship between electricity and magnetism.
- Identify everyday applications and uses of magnets.

ASSUMED PRIOR KNOWLEDGE: Learners are able to:

- State the laws of magnetism.
- Identify that like poles repel and unlike poles attract.
- Understand that around every coil carrying current there exist a magnetic field.
- Identify an electric bell as an electromagnet.

TEACHING/LEARNING RESOURCES: Interactive videos using laptop; data projector and smart board.

TIME ALLOCATION	MAIN ACTIVITY	TEACHER ACTIVITIES	LEARNER ACTIVITIES
0—10mins	Introduction	Teacher to start off by reviewing his previous lesson on magnetic field lines and electromagnets through a question and answer approach. Teacher to go further to ask probing questions about the origin of magnets and magnetism.	Learners to pay attention and participate by responding to questions. Learners to suggest origin of magnets during class discussion.
		Teacher introduces the magnetic domain theory while making use of a video presentation with randomly arranged compasses which will later on align themselves	Learners to watch an interactive video showing a how randomly arranged magnet compasses will eventually align themselves. Learners to record their observation
		In another video the teacher uses it to show and explain to the learners that even iron needles can be used to demonstrate the domain theory. The video starts off with a lot of needles randomly distributed on table surface. The needles will then appear aligned after a magnetic field is applied from below the table.	Learners to watch another interactive video with nails used to explain domain theory. The randomly arranged nails align themselves after application of the external magnetic field. Learners to record their observations
		Teacher to present another interactive videos showing how magnetic domains align after an external magnetic field has been	Learners to watch another interactive video showing a how to align magnetic domains using external magnetic field. Learners

		applied.	to observe that the direction in which the external magnetic field is applied will eventually be the direction in which the domains will align themselves. Learners to record their observations
		Teacher to present another interactive video showing a permanent magnet being demagnetized by strong heating.	Learners to watch the video of a magnet initially attracted to a nail later on falling down after losing its magnetic properties forever. Learners to explain using domain theory that the arrangement of electrons and domain alignment is randomized by thermal agitation.
50—60mins	Conclusion	Teacher to sum up the lesson through discussion with learners guiding them to realise that magnetism is directly associated with charge movements.	Learners to pay attention and participate by responding to questions. Learners to realize and accept that electricity and magnetism are one thing during class discussion.
Assessment: Homework in which they need to find out what is meant based on residual/saturation magnetism and also the everyday uses and applications of magnets.			

APPENDIX L2d: MR X`S LESSON PLANS ON THE INTERACTIVE USE OF VIDEOS IN GRADE 10 MAGNETISM.

LESSON PLAN: 4

TOPIC: MAGNETISM

CONTENT TO BE COVERED:

- gyro-magnetic compass & earth`s magnetic field.
- Use of magnets in navigation.
- Physical phenomena that are influenced by earth`s magnetic field, eg Aurora Borealis & magnetic storms.
- Defensive mechanism of the earth`s magnetic field against solar winds.

LESSON OBJECTIVES: After the lesson the learners should be able to:

- Explain how a compass indicates the direction of a magnetic field.
- Compare the magnetic field of the Earth to the magnetic field of a bar magnet using words and diagrams.
- Explain the difference between the geographical North Pole and the magnetic North pole of the Earth using videos.
- Demonstrate how magnet is employed in navigation.
- Give examples of phenomena that are affected by Earth's magnetic field e.g. Aurora Borealis (Northern Lights), magnetic storms.
- Discuss qualitatively how the earth's magnetic field provides protection from solar winds.

ASSUMED PRIOR KNOWLEDGE: Learners are able to:

- Explain magnetic behavior of ferromagnetic materials in terms of magnetic domains.
- Understand that a ferromagnetic material can be magnetized by applying an external magnetic field.
- Use the domain theory to explain how a permanent magnet can lose its magnetic properties after being dropped/hammered/heated strongly.

TEACHING/LEARNING RESOURCES: Interactive videos using laptop; data projector and white screen.

Time allocation	Main activity	Teacher activities	Learner activities
0--10	Introduction	Teacher starts off by explaining to learners the fact that planet earth is potentially a very large natural magnet due to the large abundance of iron in the crust. Teacher to emphasise and also highlight the importance of directions in navigation and how magnets are used in sensing directions.	Learners to pay attention and participate by responding to questions. Learners to realize and accept the magnetic nature of the GPS and contributions of magnets in navigation during class discussion.
		Teacher to show a video to the entire class based on how magnets can be used in predicting the earth`s north pole and how magnets including gyromagnetic compasses are used in navigation systems.	Learners to watch a video based on how magnets can be used in predicting the earth`s north pole and how magnets including gyromagnetic compasses are used in navigation systems.
		Teacher to present the next video based on natural magnetic phenomena such as Aurora Borealis and magnetic storms.	Learners to watch the video based on natural magnetic phenomena such as Aurora Borealis and magnetic storms.
		Teacher presents the next video which he uses to explain solar winds. Teacher to use the same video to explain that the earth`s magnetic field plays a major role to defend the planet from solar winds.	Learners to watch the video in order to comprehend the active role that the earth`s magnetic field plays to defend the planet from harmful effects of solar winds.
50—60mins	Conclusion	Teacher to sum up the lesson by giving a brief discussion based on earth`s magnetic reversal and earth`s future. Teacher to ask learners to prepare for a post test based on magnetism.	Learners to pay attention and participate by responding to questions. Learners to realize and accept that earth`s magnetic field is reversing.
Assessment: Homework based on earth`s magnetic reversal and how it will affect the future of the planet			

APPENDIX L3a: MR Y`S LESSON PLANS ON THE INTERACTIVE USE OF CS + VIDEOS IN GRADE 10 MAGNETISM.

LESSON PLAN: 1

TOPIC: MAGNETISM

CONTENT TO BE COVERED: Ferromagnetic & non-ferromagnetic materials; magnetic field

LESSON OBJECTIVES: After the lesson the learners should be able to:

- State Iron (Fe); Nickel (Ni) and Cobalt (Co) as examples of ferromagnetic materials.
- Classify materials as ferromagnetic and non-ferromagnetic
- Define a magnetic field.
- Compare the magnetic field with the electric & gravitational fields
- Demonstrate magnetic behavior of ferromagnetic materials
- Classify magnets as temporary or permanent.

ASSUMED PRIOR KNOWLEDGE: Learners have seen and/or once interacted with a permanent magnet before at GET level.

TEACHING/LEARNING RESOURCES: Interactive CS + videos using laptop; data projector and smart board.

TIME ALLOCATION	MAIN ACTIVITY	TEACHER ACTIVITIES	LEARNER ACTIVITIES
0—10mins	Introduction	Teacher starts off by asking review questions based on magnetism taught in grade 9. Teacher to ask guiding questions to enable learners to explain what a magnet is in their own words.	Learners to pay attention and participate by responding to questions. Learners to suggest a suitable explanation of what a magnet is.
		Teacher to provide a video presentation in which the learners are able to observe different classified materials according to whether they can be attracted or not attracted by a magnet.	Learners to watch a video which would enable to classify materials as either ferromagnetic and non-ferromagnetic.
		Teacher to present a CS to enable learners to realize and appreciate magnetic field strength existing around magnet and observe the value of magnetic force and magnetic field strength vary inversely with distance from the magnet.	Learners to then watch CS to enable them to realise magnetic field strength existing around magnet. Learners to also observe that the value of magnetic force and magnetic field strength vary inversely with distance from the magnet.
50—60mins	Conclusion	Teacher to sum up the lesson through class discussion so as to guide learners into defining magnetic field as a region of space around a magnet where a ferromagnetic material experiences a magnetic force.	Learners to pay attention and participate by responding to questions. Learners to suggest a suitable explanation of what a magnet field is.
Assessment: Homework based on the comparison of magnetic field with electrostatic and gravitational field			

APPENDIX L3b: MR Y`S LESSON PLANS ON THE INTERACTIVE USE OF CS + VIDEOS IN GRADE 10 MAGNETISM.

LESSON PLAN: 2

TOPIC: MAGNETISM

CONTENT TO BE COVERED:

- Laws of magnetism
- Physical properties of magnetic field lines
- magnetic field around a coil-carrying current
- Designing a simple electromagnet.

LESSON OBJECTIVES: After the lesson the learners should be able to:

- State laws of magnetism
- Identify poles of a magnet and that of a gyromagnetic compass.
- Outline the properties of magnetic field lines.
- Draw magnetic field lines around a permanent bar magnet
- Demonstrate that like poles repel and that unlike poles attract.
- Demonstrate the existence of a magnetic field around a coil carrying current.
- Design a simple electromagnet.

ASSUMED PRIOR KNOWLEDGE: Learners are able to:

- classify materials as ferromagnetic and non-ferromagnetic;
- define magnetic field as a region of space around a magnet where a ferromagnetic material experiences a magnetic force.
- Differentiate between permanent and temporary magnets.

TEACHING/LEARNING RESOURCES: Interactive CS + videos using laptop; data projector and smart board.

TIME ALLOCATION	MAIN ACTIVITY	TEACHER ACTIVITIES	LEARNER ACTIVITIES
0—10mins	Introduction	Teacher to start off by reviewing his previous lesson on magnets through a question and answer approach	Learners to pay attention and participate by responding to questions.

		Teacher to present a video meant to enable learners to realise that like poles repel and unlike poles attract.	Learners to watch video in order to observe and appreciate what happens during attraction and repulsion.
		Teacher to present a CS meant to enable learners to realise that like poles repel and unlike poles attract in the presence of field lines.	Learners to watch CS clip in order to observe and appreciate what happens during attraction and repulsion. CS presentation will show learners the presence of field lines during attraction and repulsion.
		Teacher to present a CS in order to show learners a bar magnet with its internal and external magnetic fields lines exposed.	Learners to watch a CS in order to realize and appreciate that there are no sources or sinks for magnetic field.
		Teacher to provide a video presentation to the learners to enable them realize that there exists a magnetic field around every coil-carrying current.	Learners to watch a video presentation so as to realize and appreciate that there exist a magnetic field around every coil-carrying current.
		Teacher to then present a CS which gives details of current flow in relation to magnetic field. Teacher to use the CS and video to explain that the direction of the magnetic field is predicted using the right hand rule.	Learners to watch the CS presentation so as to get the details of current flow in relation to magnetic field.
50—60mins	Conclusion	Teacher to conclude by presenting another video on electromagnets. t.	Learners to watch the video and pose any clarity seeking questions
Assessment: Homework based on the importance of electromagnets			

APPENDIX L3c: MR Y`S LESSON PLANS ON THE INTERACTIVE USE OF CS + VIDEOS IN GRADE 10 MAGNETISM.

LESSON PLAN: 3

TOPIC: MAGNETISM

CONTENT TO BE COVERED:

- Magnetic domain theory
- Application of domain theory in magnetization.
- Magnetic monopoles.
- Permanent loss of magnetic properties through thermal agitation

LESSON OBJECTIVES: After the lesson the learners should be able to:

- Define a magnetic domain
- Explain the domain theory as it pertains to origin of magnets.
- Demonstrate how a ferromagnetic material is magnetised through application of the domain theory.
- Use the domain theory to explain why some materials are attracted to a magnet while others cannot.
- Explain using the domain theory why magnetic monopoles cannot exist.
- Use the domain theory to explain why thermal agitation & hammering/dropping a permanent magnet can cause it to lose its magnetic properties.
- Use the domain theory to explain the existence of an intimate relationship between electricity and magnetism.
- Identify everyday applications and uses of magnets.

ASSUMED PRIOR KNOWLEDGE: Learners are able to:

- State the laws of magnetism.
- Identify that like poles repel and unlike poles attract.
- Understand that around every coil carrying current there exist a magnetic field.
- Identify an electric bell as an electromagnet.

TEACHING/LEARNING RESOURCES: Interactive CS + videos using laptop; data projector and smart board.

TIME ALLOCATION	MAIN ACTIVITY	TEACHER ACTIVITIES	LEARNER ACTIVITIES
0—10mins	Introduction	Teacher to start off by reviewing his previous lesson on magnetic field lines and electromagnets through a	Learners to pay attention and participate by responding to questions. Learners to suggest origin of

		question and answer approach. Teacher to then to ask further questions about the origin of magnetic effect and magnetism.	magnetism.
		Teacher to explain the domain theory and magnetization process by using a video presentation. Teacher to also guide learners through use of video that a material can only be magnetized by applying a strong external magnetic field.	Learners to watch a video which shows randomised magnetic domains representing unmagnetised material and, aligned domains as they appear in a magnetised material
		Teacher presents a CS showing how magnetic domains will appear before and after magnetisation by using an external magnetic field. Teacher presents a CS showing how a magnet and its aligned domains would appear from inside the magnet.	Learners to watch the simulation which shows randomly aligned domains before magnetisation and, aligned domains after magnetization by using an external magnetic field. Learners to observe from the CS and appreciate that magnetic field lines have no sources or sinks.
		Teacher to present another interactive video showing a permanent magnet being demagnetized by strong heating.	Learners to watch the video of a magnet initially attracted to a nail later on falling down after losing its magnetic properties forever. Learners to explain using domain theory that the arrangement of electrons and domain alignment is randomized by thermal agitation.
50—60mins	Conclusion	Teacher to sum up by directing learners through discussion to realise that magnetic monopoles cannot exist and that magnetism is directly associated with charge movements. Teacher also asks learners to find out more about magnetic saturation.	Learners to pay attention and participate by responding to questions. Learners to find out more about magnetic saturation.
Assessment: Homework based on magnetic saturation			

APPENDIX L3d: MR Y`S LESSON PLANS ON THE INTERACTIVE USE OF CS + VIDEOS IN GRADE 10 MAGNETISM.

LESSON PLAN: 4

TOPIC: MAGNETISM

CONTENT TO BE COVERED:

- gyro-magnetic compass & earth`s magnetic field.
- Use of magnets in navigation.
- Physical phenomena that are influenced by earth`s magnetic field, e.g Aurora Borealis & magnetic storms.
- Defensive mechanism of the earth`s magnetic field against solar winds.

LESSON OBJECTIVES: After the lesson the learners should be able to:

- Explain how a compass indicates the direction of a magnetic field.
- Compare the magnetic field of the Earth to the magnetic field of a bar magnet using words and diagrams.
- Explain the difference between the geographical North pole and the magnetic North pole of the Earth.
- Use a permanent bar magnet to demonstrate how magnet is employed in navigation.
- Give examples of phenomena that are affected by Earth's magnetic field e.g. Aurora Borealis (Northern Lights), magnetic storms.
- Discuss qualitatively how the earth's magnetic field provides protection from solar winds.

ASSUMED PRIOR KNOWLEDGE: Learners are able to:

- Explain magnetic behavior of ferromagnetic materials in terms of magnetic domains.
- Understand that a ferromagnetic material can be magnetized by applying an external magnetic field.
- Use the domain theory to explain how a permanent magnet can lose its magnetic properties after being dropped/hammered/heated strongly.

TEACHING/LEARNING RESOURCES: Interactive CS + videos using laptop; data projector and white screen.

Time allocation	Main activity	Teacher activities	Learner activities
0—10	Introduction	Teacher to start off by asking review questions related to previous lesson. Teacher to also indicate to learners that iron is one of the most abundant metals in the earth`s crust.	Learners to pay attention and participate by responding to questions.
		Teacher to present a video to highlight the importance of directions in navigation and how magnets are used in sensing directions.	Learners to watch video so as to realise and appreciate that a free-moving gyromagnetic compass aligns itself with earth`s magnetic field.
		Teacher to demonstrate using CS methods how magnets can be used in predicting the earth`s north pole..	Learners to watch CS which leads them to understand that the arctic region is magnetic south and geographical north
		Teacher to use another video to allow learners to realise natural phenomena in the magnetosphere like Aurora borealis and solar winds. The video to be followed by another CS presentation based on how the planet earth`s magnetic field protects us from solar winds	Learners to watch video based on Aurora borealis and appreciate that the phenomenon is a result of charged particles in the solar wind trapped and experiencing downward spiral into field lines towards the poles. Learners to watch CS clip and appreciate how the magnetosphere protects the earth from the solar wind by forming an obstacle in the path of the solar wind causing it to be deflected.
50—60	Conclusion	Teacher to conclude lesson through class discussion and also highlights the issue called earth`s magnetic reversal. He also urge learners to prepare for a test.	Learners to pay attention and participate by responding to questions.
Assessment: Homework based on earth`s magnetic reversal and how it will affect the future of the planet			

APPENDIX L4a: MISS Z`S LESSON PLANS ON THE TRADITIONAL METHODS OF TEACHING GRADE 10 MAGNETISM.

LESSON PLAN: 1

TOPIC: MAGNETISM

CONTENT TO BE COVERED: Ferromagnetic & non-ferromagnetic materials; magnetic field

LESSON OBJECTIVES: After the lesson the learners should be able to:

- State Iron (Fe); Nickel (Ni) and Cobalt (Co) as examples of ferromagnetic materials.
- Classify materials as ferromagnetic and non-ferromagnetic
- Define a magnetic field.
- Compare the magnetic field with the electric & gravitational fields
- Demonstrate magnetic behavior of ferromagnetic materials
- Classify magnets as temporary or permanent.

ASSUMED PRIOR KNOWLEDGE: Learners have seen and/or once interacted with a permanent magnet before.

TEACHING/LEARNING RESOURCES: Chalks; Chalkboard & duster; Physical Sciences Study & Master grade 10 textbooks; 4 bar magnets 6 magnetic compasses; iron fillings; 2 nails; paper clips.

TIME ALLOCATION	MAIN ACTIVITY	TEACHER ACTIVITIES	LEARNER ACTIVITIES
0—10mins	Introduction	reviewing lessons on magnets taught in grade 9. She started by asking learners guiding questions which would enable them to explain what a magnet is in their own words.	Learners to pay attention and participate by responding to questions
		The teacher led class discussion to guide learners into identifying ferromagnetic materials and non-ferromagnetic materials	Learners during class discussion to identify ferromagnetic materials as those that can be attracted to a bar magnet. Those that could not be attracted to a bar magnet were called non-ferromagnetic.
		Teacher now to use a nail in a demonstration lesson by bringing it closer to but not in conduct with a bar magnet. Teacher to repeat the activity at various distances.	Learners to observe and record that when a nail reaches a particular point or distance from the magnet it will experience a magnetic force.
		Teacher to request learners to turn into their study and master physical science text in order to have a better view of the magnetic field. The activity made the teacher to guide learners into defining magnetic field in their groups.	Learners to write the definition of magnetic field in their notebooks while referring to the textbook
50—60mins	Conclusion	Teacher to sum up the lesson through asking recall questions about the entire activities of the lesson. Teacher to provide other examples of physical fields	Learners to pay attention and participate by responding to questions
Assessment: Homework based comparison of magnetic field with electrostatic and gravitational fields			

APPENDIX L4b: MISS Z`S LESSON PLANS ON THE TRADITIONAL METHODS OF TEACHING GRADE 10 MAGNETISM.

LESSON PLAN: 2

TOPIC: MAGNETISM

CONTENT TO BE COVERED:

- Laws of magnetism
- Physical properties of magnetic field lines
- magnetic field around a coil-carrying current
- Designing a simple electromagnet.

LESSON OBJECTIVES: After the lesson the learners should be able to:

- State laws of magnetism
- Identify poles of a magnet and that of a gyromagnetic compass.
- Outline the properties of magnetic field lines.
- Draw magnetic field lines around a permanent bar magnet
- Demonstrate that like poles repel and that unlike poles attract.
- Demonstrate the existence of a magnetic field around a coil carrying current.
- Design a simple electromagnet.

ASSUMED PRIOR KNOWLEDGE: Learners are able to:

- classify materials as ferromagnetic and non-ferromagnetic;
- define magnetic field as a region of space around a magnet where a ferromagnetic material experiences a magnetic force.
- Differentiate between permanent and temporary magnets.

TEACHING/LEARNING RESOURCES: Chalks; Chalkboard & duster; Physical Sciences Study & Master grade 10 textbooks; 4 bar magnets 6 magnetic compasses; iron fillings; 2 nails; paper clips.

TIME ALLOCATION	MAIN ACTIVITY	TEACHER ACTIVITIES	LEARNER ACTIVITIES
0—10mins	Introduction	Teacher starts off by reviewing her previous lesson on magnets through a question and answer	Learners to pay attention and participate by responding to questions

		approach.	
		Teacher to assign learners into their groups and give each group a pair of permanent bar magnets, powdered iron fillings and a clean & blank piece of A4 white paper.	Learners in groups to bring the end of a magnet painted blue closer to the end of another magnet also painted blue. The learners were to observe and record their observations. Leaners to repeat the activity while bringing the blue end of magnet closer to the red end of the magnet and record their findings. Learners to repeat the activities while sprinkling iron fillings between like & unlike poles.
		Teacher to request the learners to make use of their textbooks to draw diagrams.	Learners use their textbooks to draw magnetic field lines formed when like poles or unlike poles are brought close together
		Teacher to monitor group discussions based on field lines	Learners in their groups to discuss the properties of magnetic field lines. Group discussions to be followed by overall class discussions during which each group is to provide a feedback.
		The teacher wrote notes on the chalkboard based on the characteristic properties of magnetic field lines.	Learners to copy notes from chalkboard into their notebooks based on properties of magnetic field lines.
50—60mins	Conclusion	Teacher to conclude lesson by discussion to guide learners about existence of magnetic field around a coil carrying current and electromagnets	Learners to pay attention and participate by responding to questions
Assessment: Homework based on application of electromagnets			

APPENDIX L4c: MISS Z`S LESSON PLANS ON THE TRADITIONAL METHODS OF TEACHING GRADE 10 MAGNETISM.

LESSON PLAN: 3

TOPIC: MAGNETISM

CONTENT TO BE COVERED:

- Magnetic domain theory
- Application of domain theory in magnetization.
- Magnetic monopoles.
- Permanent loss of magnetic properties through thermal agitation

LESSON OBJECTIVES: After the lesson the learners should be able to:

- Explain the domain theory using videos.
- Observe how a ferromagnetic material is magnetised through application of the domain theory.
- Use the domain theory to explain why some materials are attracted to a magnet while others cannot.
- Use the domain theory to explain why thermal agitation & hammering/dropping a permanent magnet can cause it to lose its magnetic properties.
- Use the domain theory to explain the existence of an intimate relationship between electricity and magnetism.
- Identify everyday applications and uses of magnets.

ASSUMED PRIOR KNOWLEDGE: Learners are able to:

- State the laws of magnetism.
- Identify that like poles repel and unlike poles attract.
- Understand that around every coil carrying current there exist a magnetic field.
- Identify an electric bell as an electromagnet.

TEACHING/LEARNING RESOURCES: Chalks; Chalkboard & duster; Physical Sciences Study & Master grade 10 textbooks.

TIME ALLOCATION	MAIN ACTIVITY	TEACHER ACTIVITIES	LEARNER ACTIVITIES
0—10mins	Introduction	Teacher to start off by reviewing her previous lesson on magnetic field lines and electromagnets through a question and answer approach.	Learners to pay attention and participate by responding to questions
		Teacher asks probing questions about the origin of magnets and magnetism so as to initiate group discussions followed by overall class discussions based on why some materials can be magnetized while others cannot.	Learners to discuss in groups about what makes up a make and why only ferromagnetic materials are the ones attracted to magnets
		Teacher to lead an overall class discussion based on the domain theory. Teacher to also request learners to turn to their textbooks in order to have a better view of the magnetic domains.	Learners to pay attention and participate by responding to questions. Learners to turn to their textbooks in order to have a better view of the magnetic domains.
		Teacher to then task learners in their groups to use the domain theory to explain: How ferromagnetic materials are magnetized by applying an external magnetic field; why a permanent magnet can lose its magnetic properties after being dropped/hammered several times or	Learners in their groups to use the domain theory to explain how ferromagnetic materials are magnetized by applying an external magnetic field. Learners also to suggest why a permanent magnet can lose its magnetic properties after being dropped/hammered several times or

		heated strongly; why magnetic monopoles cannot exist by applying the domain theory	heated strongly, Learners to explain why magnetic monopoles cannot exist by applying the domain theory.
50—60mins	Conclusion	Teacher to sum up the lesson by directing learners to realize that magnetism is directly associated with charge movements and, that electricity and magnetism are one thing.	Learners to pay attention and participate by responding to questions
Assessment :Homework based on magnetic saturation and also the everyday uses and applications of magnets.			

APPENDIX L4d: MISS Z`S LESSON PLANS ON THE TRADITIONAL METHODS OF TEACHING GRADE 10 MAGNETISM.

LESSON PLAN: 4

TOPIC: MAGNETISM

CONTENT TO BE COVERED:

- gyro-magnetic compass & earth`s magnetic field.
- Use of magnets in navigation.
- Physical phenomena that are influenced by earth`s magnetic field, e.g Aurora Borealis & magnetic storms.
- Defensive mechanism of the earth`s magnetic field against solar winds.

LESSON OBJECTIVES: After the lesson the learners should be able to:

- Explain how a compass indicates the direction of a magnetic field.
- Compare the magnetic field of the Earth to the magnetic field of a bar magnet using words and diagrams.
- Explain the difference between the geographical North pole and the magnetic North pole of the Earth.
- Use a permanent bar magnet to demonstrate how magnet is employed in navigation.
- Give examples of phenomena that are affected by Earth’s magnetic field e.g. Aurora Borealis (Northern Lights), magnetic storms.
- Discuss qualitatively how the earth’s magnetic field provides protection from solar winds.

ASSUMED PRIOR KNOWLEDGE: Learners are able to:

- Explain magnetic behavior of ferromagnetic materials in terms of magnetic domains.
- Understand that a ferromagnetic material can be magnetized by applying an external magnetic field.
- Use the domain theory to explain how a permanent magnet can lose its magnetic properties after being dropped/hammered/heated strongly.

TEACHING/LEARNING RESOURCES: Chalks; Chalkboard & duster; Physical Sciences Study & Master grade 10 textbooks.

Time allocation	Main activity	Teacher activities	Learner activities
0—10mins	Introduction	Teacher to start off by explaining to learners the fact that our planet earth is potentially a very large natural magnet. Teacher to indicate that iron is one of the most abundant metals in the earth`s crust and also highlight the importance of directions in navigation and how magnets are used in sensing directions.	Learners to pay attention and participate by responding to questions
		Teacher to demonstrate to the entire class how magnets can be used in predicting the earth`s north pole and south pole.	Learners to pay attention and participate by responding to questions
		Teacher to further clarify the fact that the earth`s geographical north pole does not exactly coincide with the magnetic south pole. They differ by a very small angle of around 24 degrees, a phenomenon called magnetic declination.	Learners to pay attention and participate by responding to questions
		Teacher to lead an overall class discussion on how magnets including gyromagnetic compasses are used in navigation systems. Teacher to also indicate and explain some magnetospheric natural phenomena like Aurora Borealis, magnetic storms as well as solar winds that are greatly affected by earth`s magnetic field.	Learners to pay attention and participate by responding to questions
50—60mins	Conclusion	The teacher concluded the lesson by giving learners homework based on earth`s magnetic reversal and how it will affect the future of the planet.	Learners to pay attention and participate by responding to questions
Assessment: Homework based on earth`s magnetic reversal and how it will affect the future of the planet.			

APPENDIX M

UNISA university of south africa

UNISA INSTITUTE FOR SCIENCE AND TECHNOLOGY EDUCATION (ISTE)
RESEARCH ETHICS REVIEW COMMITTEE

Date: 15 November 2017

ERC Reference # :2017_CGS/ISTE+014
Name: Lister Munodawafa Dzikiti
Student #: 43529712

Dear Mr Lister Munodawafa Dzikiti

Decision: **Ethics Approval from 15 November 2017 to 15 November 2022**

Researcher(s):	Name:	Mr. Lister Munodawafa Dzikiti
	Address:	P. O. BOX 250 ELUKWATINI 1192
	E-mail address:	listerdz@yahoo.com
	Tel:	0787510784
Supervisor (s):	Name:	Prof. Jeanne Kriek
	E-mail address:	kriekj@unisa.ac.za
	Tel:	+27 (012) 429-8406

RECEIVED
2017 -11- 16
OFFICE OF THE EXECUTIVE DEAN
College of Science, Engineering and Technology

Working title of research:

Investigating the interactive use of computer simulations and videos on magnetism in grade 10. A case study of four high schools in Mpumalanga province.

Qualification: MSc (Physics Education)

Thank you for the application for research ethics clearance by the Unisa ISTE Ethics Review Committee for the above mentioned research. Ethics approval is granted for **5 years.**

The low-risk application was reviewed by the ISTE Ethics Review Committee on 13 July 2017 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

APPENDIX N

education
MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

Building No. 5, Government Boulevard, Riverside Park, Mpumalanga Province
Private Bag X11341, Mbombela, 1200.
Tel: 013 766 5552/5115, Toll Free Line: 0800 203 116

Litiko le Temfundvo | Umnyango we Fundo | Departement van Onderwys | Ndzawulo ya Dyondzo

Mr. LM Dzikiti
Stand Number 1237
ELUKWATINI
1192

RE: APPLICATION TO CONDUCT RESEARCH: MR LM DZIKITI

Your application to conduct research study was received and is therefore acknowledged. The title of your study reads thus: "**The interactive use of computer simulations and videos on the teaching and learning of magnetism in grade 10 Physics. A case study of four high schools in Mpumalanga Province.**" I trust that the aims and the objectives of the study will benefit the whole department in particular the curriculum division. Your request is approved subject to you observing the provisions of the departmental research policy which is available in the departmental website. You are also requested to adhere to your University's research ethics as spelt out in your research ethics document.

In terms of the research policy, data or any research activity can only be conducted after school hours as per appointment with affected participants. You are also requested to share your findings with the relevant sections of the department so that we may consider implementing your findings if that will be in the best interest of the department. To this effect, your final approved research report (both soft and hard copy) should be submitted to the department so that your recommendations could be implemented. You may be required to prepare a presentation and present at the department's annual research dialogue.

For more information kindly liaise with the department's research unit @ 013 766 5476 or a.baloyi@education.mpu.gov.za.

The department wishes you well in this important project and pledges to give you the necessary support you may need.

MRS M.O.C MHLABANE
HEAD: EDUCATION

17/10/17
DATE

MPUMALANGA
THE PLACE OF THE RISING SUN

APPENDIX P: RTOP OBSERVATIONS

LESSON 1

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A:	BACKGROUND INFORMATION
EDUCATOR NAME: Mr W	
ANNOUNCED OBSERVATION: YES	
TEACHING EXPERIENCE: +20	
SCHOOL NAME: D	
NAME OF CIRCUIT: BADPLAAS	
DISTRICT / PROVINCE: GERT-SIBANDE / MPUMALANGA	
GRADE/CLASS: 10	
DATE OF OBSERVATIONS: 06-03-18	
SUBJECT: PHYSICS	
TOPIC: MAGNETISM INTRODUCTION, MAGNETIC FIELD	
NAME OF OBSERVER: DZIKITI N.M.	

SECTION B:	CONTEXTUAL BACKGROUND AND ACTIVITIES	
TIME	DESCRIPTION OF EVENTS	
(minutes)	Teacher activities	Students activities
0 – 10	SEE LESSON PLAN	
10 – 20		
20 – 30		
30 – 40		
40 – 50		
50 - 60		

SECTION C:		LESSON PLAN/DESIGN & IMPLEMENTATION					
	CRITERIA	RATING 0	1	2	3	4	Descriptive Comments
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.					X	Planning recognised prior knowledge
2	The lesson was designed to engage students as members of a learning community.				X		lesson planning was learner centred
3	In this lesson, student exploration preceded formal presentation.				X		lesson prioritised student's
4	This lesson encouraged students to seek and						

1

		0	1	2	3	4	Descriptive comments
	value alternative modes of investigation or of problem solving					X	
5	The focus and direction of the lesson was often determined by ideas originating with students.					X	questions from learners determined what they presented
SECTION D:	**CONTENT (Propositional Knowledge)**						
	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
6	The lesson involved fundamental concepts of the subject.					X	
7	The lesson promoted strongly coherent conceptual understanding.					X	Concept of magnetic matter & fields was conceptualised
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.					X	
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.				X		learners draw B-fields from presentation
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.				X		topic was well connected to electric charges
SECTION E:	**CONTENT (Procedural Knowledge)**						
	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.					X	
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.				X		
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.				X		learners responded very well to this questionnaire
14	Students were reflective about their learning.				X		
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.				X		
SECTION F	**CLASSROOM CULTURE (Communicative Interactions)**						
	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
16	Students were involved in the communication of their ideas to others using a variety of means and media.				X		learners communicate with one another in group & class discussion
17	The teacher's questions triggered divergent modes of thinking.					X	
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.				X		

19	Student questions and comments often determined the focus and direction of classroom discourse.				X		
20	There was a climate of respect for what others had to say.					X	learners appreciate one another

SECTION G: **CLASSROOM CULTURE**
(Teacher /Student Relationships

	CRITERIA	RATING					Descriptive comment
		0	1	2	3	4	
21	Active participation of students was encouraged and valued.					X	The learners participated greatly
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.				X		
23	In general the teacher was patient with students.				X		true
24	The teacher acted as a resource person, working to support and enhance student investigations.				X		teacher only provided guide
25	The metaphor "teacher as listener" was very characteristic of this classroom.				X		

FEEDBACK

This was a learner centred lesson with higher levels of learner involvement

SIGNATURE OF TEACHER: [signature] .... DATE: 06-03-18

SIGNATURE OF OBSERVER: [signature] .... DATE: 06-03-18

3

LESSON 2

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A:	BACKGROUND INFORMATION
EDUCATOR NAME:	MR W
ANNOUNCED OBSERVATION:	YES
TEACHING EXPERIENCE:	20
SCHOOL NAME:	D
NAME OF CIRCUIT:	BADPLAAS
DISTRICT / PROVINCE:	GERT SIBANDE / MPUMALANGA
GRADE/CLASS:	10
DATE OF OBSERVATIONS:	08 – 03 – 18
SUBJECT:	PHYSICS
TOPIC:	MAGNETISM; LAWS OF MAGNETISM ELECTROMAGNETS
NAME OF OBSERVER:	DZIKITI LM

SECTION B:	CONTEXTUAL BACKGROUND AND ACTIVITIES	
TIME (minutes)	DESCRIPTION OF EVENTS	
	Teacher activities	Students activities
0 – 10		
10 – 20		
20 – 30	SEE LESSON PLAN	
30 – 40		
40 – 50		
50 - 60		

SECTION C:	LESSON PLAN/DESIGN & IMPLEMENTATION						
	CRITERIA	RATING					Descriptive Comments
		0	1	2	3	4	
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.					X	This was planned while basing and including all learners irrespective of their ability
2	The lesson was designed to engage students as members of a learning community.				X		
3	In this lesson, student exploration preceded formal presentation.				X		
4	This lesson encouraged students to seek and						

1

		0	1	2	3	4	Descriptive comments
	value alternative modes of investigation or of problem solving				X		
5	The focus and direction of the lesson was often determined by ideas originating with students.					X	

SECTION D: **CONTENT (Propositional Knowledge)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
6	The lesson involved fundamental concepts of the subject.					X	Attraction & repulsion of electromagnets were treated.
7	The lesson promoted strongly coherent conceptual understanding.					X	
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.					X	Tr knew his stuff
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.					X	
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.				X		

SECTION E: **CONTENT (Procedural Knowledge)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.					X	Diagram of attraction & repulsion
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.				X		were drawn from ES presentation
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.					X	True
14	Students were reflective about their learning.				X		
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.				X		

SECTION F **CLASSROOM CULTURE (Communicative Interactions)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
16	Students were involved in the communication of their ideas to others using a variety of means and media.					X	This characterized the lesson
17	The teacher's questions triggered divergent modes of thinking.					X	Yes
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.					X	True

2

		0	1	2	3	4	
19	Student questions and comments often determined the focus and direction of classroom discourse.				X		True
20	There was a climate of respect for what others had to say.					X	learners appreciated comments & ~~responses~~ of other learners

SECTION G:
(Teacher /Student Relationships **CLASSROOM CULTURE**

	CRITERIA	RATING					Descriptive comment
		0	1	2	3	4	
21	Active participation of students was encouraged and valued.					X	true of this lesson
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.				X		learners were able to predict scenarios given
23	In general the teacher was patient with students.					X	
24	The teacher acted as a resource person, working to support and enhance student investigations.				X		
25	The metaphor "teacher as listener" was very characteristic of this classroom.			X			Tr responded to most of learner questions

FEEDBACK

This was typical of a learner Centred lesson with active involvement of learners. The teacher demonstrated high levels of patients and tolerance

SIGNATURE OF TEACHER: [signature] .... DATE: 08-03-18

SIGNATURE OF OBSERVER: [signature] .... DATE: 08-03-18

3

LESSON 3

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A: BACKGROUND INFORMATION
EDUCATOR NAME: MR W
ANNOUNCED OBSERVATION: YES
TEACHING EXPERIENCE: 20
SCHOOL NAME: D
NAME OF CIRCUIT: BADPLAAS
DISTRICT / PROVINCE: GERT SIBANDE / MPUMALANGA
GRADE/CLASS: 10
DATE OF OBSERVATIONS: 09-03-18
SUBJECT: PHYSICS
TOPIC: MAGNETISM; MAGNETIC DOMAINS DOMAIN THEORY
NAME OF OBSERVER: DZIKITI L M.

SECTION B:	CONTEXTUAL BACKGROUND AND ACTIVITIES	
TIME (minutes)	DESCRIPTION OF EVENTS	
	Teacher activities	Students activities
0 – 10		
10 – 20		
20 – 30	SEE LESSON PLAN	
30 – 40		
40 – 50		
50 - 60		

SECTION C:	LESSON PLAN/DESIGN & IMPLEMENTATION						
	CRITERIA	RATING					Descriptive Comments
		0	1	2	3	4	
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.					X	This was a learner centred lesson plan
2	The lesson was designed to engage students as members of a learning community.					X	yes
3	In this lesson, student exploration preceded formal presentation.				X		yes
4	This lesson encouraged students to seek and						

1

		0	1	2	3	4	Descriptive comments
	value alternative modes of investigation or of problem solving				X		
5	The focus and direction of the lesson was often determined by ideas originating with students.					X	true

SECTION D: CONTENT (Propositional Knowledge)

	CRITERIA	RATING 0	1	2	3	4	Descriptive comments
6	The lesson involved fundamental concepts of the subject.					X	Domain theory clearly explained
7	The lesson promoted strongly coherent conceptual understanding.					X	true
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.					X	Tr's knowledge of content very good
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.				X		Thru CS presentation
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.			X			To some extend with thermodynamics

SECTION E: CONTENT (Procedural Knowledge)

	CRITERIA	RATING 0	1	2	3	4	Descriptive comments
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.				X		CS presentation was clear
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.					X	learners were able to predict scientific ideas
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.					X	while apply domain theory
14	Students were reflective about their learning.					X	yes
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.				X		To a greater extend

SECTION F CLASSROOM CULTURE (Communicative Interactions)

	CRITERIA	RATING 0	1	2	3	4	Descriptive comments
16	Students were involved in the communication of their ideas to others using a variety of means and media.				X		high level of discos was among learners
17	The teacher's questions triggered divergent modes of thinking.					X	very true
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.					X	yes

2

		0	1	2	3	4	Descriptive comment
19	Student questions and comments often determined the focus and direction of classroom discourse.					X	very true
20	There was a climate of respect for what others had to say.					X	Yes

SECTION G: CLASSROOM CULTURE
(Teacher /Student Relationships

	CRITERIA	RATING					Descriptive comment
		0	1	2	3	4	
21	Active participation of students was encouraged and valued.					X	There was high level of
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.				X		To a greater extend
23	In general the teacher was patient with students.					X	very patient
24	The teacher acted as a resource person, working to support and enhance student investigations.				X		To a greater extend
25	The metaphor "teacher as listener" was very characteristic of this classroom.				X		To some extend

FEEDBACK

This lesson involved active learner participation. The existence of domains were clearly demonstrated thru CS presentation.

SIGNATURE OF TEACHER: [signature] DATE: 09-03-18

SIGNATURE OF OBSERVER: [signature] DATE: 09-03-18

3

LESSON 4

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A:	BACKGROUND INFORMATION
EDUCATOR NAME: MR W	
ANNOUNCED OBSERVATION: YES	
TEACHING EXPERIENCE: +20 YEARS	
SCHOOL NAME: D	
NAME OF CIRCUIT: BADPLAAS	
DISTRICT / PROVINCE: GERT SIBANDE / MPUMALANGA	
GRADE/CLASS: 10	
DATE OF OBSERVATIONS: 12-03-18	
SUBJECT: PHYSICS	
TOPIC: MAGNETISM: EARTH'S MAGNETIC FIELD, NAVIGATION, MAGNETOSPHERE	
NAME OF OBSERVER: DZIKITI L M	

SECTION B:	CONTEXTUAL BACKGROUND AND ACTIVITIES	
TIME	DESCRIPTION OF EVENTS	
(minutes)	Teacher activities	Students activities
0 – 10		
10 – 20		
20 – 30		
30 – 40		
40 – 50		
50 - 60		

SEE LESSON PLAN

SECTION C:	LESSON PLAN/DESIGN & IMPLEMENTATION						
	CRITERIA	RATING					Descriptive Comments
		0	1	2	3	4	
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.					X	Prior knowledge recognised
2	The lesson was designed to engage students as members of a learning community.				X		lesson plan was learner centred
3	In this lesson, student exploration preceded formal presentation.				X		To a greater extend
4	This lesson encouraged students to seek and						

1

		0	1	2	3	4	Descriptive comments
	value alternative modes of investigation or of problem solving				X		
5	The focus and direction of the lesson was often determined by ideas originating with students.				X		learners were pacesetters

SECTION D: CONTENT (Propositional Knowledge)

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
6	The lesson involved fundamental concepts of the subject.					X	Magnetic declination & magnetosphere
7	The lesson promoted strongly coherent conceptual understanding.				X		lesson was based on concepts of B-field
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.					X	Tr was well armed for the lesson
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.				X		Yes
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.				X		Connected to Geog & Astrophysics

SECTION E: CONTENT (Procedural Knowledge)

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.					X	Yes
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.				X		learners could easily predict field effect
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.				X		Tr triggered thought provoking questions
14	Students were reflective about their learning.					X	Yes
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.				X		Yes

SECTION F CLASSROOM CULTURE (Communicative Interactions)

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
16	Students were involved in the communication of their ideas to others using a variety of means and media.				X		learner to learner interaction was prominent
17	The teacher's questions triggered divergent modes of thinking.					X	Yes
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.				X		To a greater extend

		0	1	2	3	4	
19	Student questions and comments often determined the focus and direction of classroom discourse.				X		CS presentation motivated learners to ask questions
20	There was a climate of respect for what others had to say.				X		learners appreciated each other's explanations

SECTION G: CLASSROOM CULTURE
(Teacher /Student Relationships

	CRITERIA	RATING					Descriptive comment
		0	1	2	3	4	
21	Active participation of students was encouraged and valued.				X		Students were active & inquisitive
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.				X		yes
23	In general the teacher was patient with students.					X	yes
24	The teacher acted as a resource person, working to support and enhance student investigations.				X		lesson present was thru use of CS
25	The metaphor "teacher as listener" was very characteristic of this classroom.			X			Tr did most of the explanations

FEEDBACK

This was a learner centred lesson with highest level of learner participation and involvement

SIGNATURE OF TEACHER: [signature] DATE: 12-03-18

SIGNATURE OF OBSERVER: [signature] DATE: 12-03-18

LESSON 1

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A:	BACKGROUND INFORMATION
EDUCATOR NAME: MR X	
ANNOUNCED OBSERVATION: YES	
TEACHING EXPERIENCE: 8	
SCHOOL NAME: E	
NAME OF CIRCUIT: MASHISHILA	
DISTRICT/PROVINCE: GERT SIBANDE / MPUMALANGA	
GRADE/CLASS: 10	
DATE OF OBSERVATIONS: 06-03-18	
SUBJECT: PHYSICS	
TOPIC: MAGNETISM; INTRODUCTION; FERROMAGNETICS B-FIELD	
NAME OF OBSERVER: DZIKITI LM	

SECTION B:	CONTEXTUAL BACKGROUND AND ACTIVITIES	
TIME	DESCRIPTION OF EVENTS	
(minutes)	Teacher activities	Students activities
0 – 10		
10 – 20		
20 – 30		
30 – 40		
40 – 50		
50 - 60		

SEE LESSON PLAN

SECTION C:		LESSON PLAN/DESIGN & IMPLEMENTATION					
	CRITERIA	RATING					Descriptive Comments
		0	1	2	3	4	
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.					X	Yes
2	The lesson was designed to engage students as members of a learning community.					X	Yes
3	In this lesson, student exploration preceded formal presentation.				X		To a larger extend
4	This lesson encouraged students to seek and						

1

		0	1	2	3	4	Descriptive comments
	value alternative modes of investigation or of problem solving				X		Yes
5	The focus and direction of the lesson was often determined by ideas originating with students.				X		Yes

SECTION D: **CONTENT (Propositional Knowledge)**

	CRITERIA	RATING 0	1	2	3	4	Descriptive comments
6	The lesson involved fundamental concepts of the subject.					X	Concept of field treated well
7	The lesson promoted strongly coherent conceptual understanding.					X	Very true
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.					X	Good subject command
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.					X	Yes
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.			X			To some extend with matter

SECTION E: **CONTENT (Procedural Knowledge)**

	CRITERIA	RATING 0	1	2	3	4	Descriptive comments
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.				X		To a greater extend
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.					X	true
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.					X	During group of class discussions
14	Students were reflective about their learning.				X		Yes
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.				X		Very good and relevant questions were asked by learners

SECTION F **CLASSROOM CULTURE (Communicative Interactions)**

	CRITERIA	RATING 0	1	2	3	4	Descriptive comments
16	Students were involved in the communication of their ideas to others using a variety of means and media.					X	Most of it was among learners
17	The teacher's questions triggered divergent modes of thinking.				X		It triggered thought provoking questions
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.					X	true

2

		0	1	2	3	4	Descriptive comment
19	Student questions and comments often determined the focus and direction of classroom discourse.				X		To some extend
20	There was a climate of respect for what others had to say.					X	Yes

SECTION G: CLASSROOM CULTURE

(Teacher /Student Relationships

	CRITERIA	RATING 0	1	2	3	4	Descriptive comment
21	Active participation of students was encouraged and valued.					X	High level of participation
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.					X	Yes
23	In general the teacher was patient with students.					X	Yes
24	The teacher acted as a resource person, working to support and enhance student investigations.				X		Yes thru use of videos
25	The metaphor "teacher as listener" was very characteristic of this classroom.			X			To some extend

FEEDBACK

This lesson was loaded with a lot of excitement amongst learners. It motivated learners to ask questions and participate actively

SIGNATURE OF TEACHER: .... DATE: 06-03-18

SIGNATURE OF OBSERVER: .... DATE: 06-03-18

3

LESSON 2

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A:	BACKGROUND INFORMATION
EDUCATOR NAME:	MR X
ANNOUNCED OBSERVATION:	YES
TEACHING EXPERIENCE:	8
SCHOOL NAME:	E
NAME OF CIRCUIT:	MASHISHILA
DISTRICT / PROVINCE:	GERT SIBANDE / MPUMALANGA
GRADE/CLASS:	10
DATE OF OBSERVATIONS:	07-03-18
SUBJECT:	PHYSICS
TOPIC:	MAGNETISM: LAWS OF MAGNETISM; ELECTROMAGNETS
NAME OF OBSERVER:	DZIKITI L M

SECTION B:	CONTEXTUAL BACKGROUND AND ACTIVITIES	
TIME	DESCRIPTION OF EVENTS	
(minutes)	Teacher activities	Students activities
0 – 10		
10 – 20		
20 – 30		
30 – 40		
40 – 50		
50 - 60		

SEE LESSON PLAN

SECTION C:	LESSON PLAN/DESIGN & IMPLEMENTATION						
	CRITERIA	RATING					Descriptive Comments
		0	1	2	3	4	
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.					X	lesson plan was tailored to meet learners needs
2	The lesson was designed to engage students as members of a learning community.				X		very inclusive
3	In this lesson, student exploration preceded formal presentation.				X		Yes
4	This lesson encouraged students to seek and						

1

		0	1	2	3	4	Descriptive comments
	value alternative modes of investigation or of problem solving				X		Yes
5	The focus and direction of the lesson was often determined by ideas originating with students.					X	Yes

SECTION D: **CONTENT (Propositional Knowledge)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
6	The lesson involved fundamental concepts of the subject.					X	laws of magnets
7	The lesson promoted strongly coherent conceptual understanding.					X	levitation of electromagnets
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.					X	were clearly exposed by
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.				X		video
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.				X		yes To some extent with engineering

SECTION E: **CONTENT (Procedural Knowledge)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.					X	Yes
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.					X	true
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.					X	While videos were being paused
14	Students were reflective about their learning.				X		yes
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.				X		Very true

SECTION F **CLASSROOM CULTURE (Communicative Interactions)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
16	Students were involved in the communication of their ideas to others using a variety of means and media.					X	Most of it among learners
17	The teacher's questions triggered divergent modes of thinking.				X		Very good thought provoking questions
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.					X	Most was learner to learner discussion

19	Student questions and comments often determined the focus and direction of classroom discourse.				X		To a greater extend
20	There was a climate of respect for what others had to say.					X	Yes

SECTION G: **CLASSROOM CULTURE**

(Teacher /Student Relationships

	CRITERIA	RATING					Descriptive comment
		0	1	2	3	4	
21	Active participation of students was encouraged and valued.					X	teacher allowed learners to freely express themselves
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.				X		Yes
23	In general the teacher was patient with students.				X		very patient
24	The teacher acted as a resource person, working to support and enhance student investigations.				X		Yes
25	The metaphor "teacher as listener" was very characteristic of this classroom.				X		Yes

FEEDBACK

This was a learner centred approach The learners fully enjoyed the lesson thru the interactive use of videos, and had a lot of questions thru-out

SIGNATURE OF TEACHER: [signature] DATE: 07-03-18

SIGNATURE OF OBSERVER: [signature] DATE: 07-03-18

3

LESSON 3

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A:	BACKGROUND INFORMATION
EDUCATOR NAME: MR X	
ANNOUNCED OBSERVATION: YES	
TEACHING EXPERIENCE: 5 – 10 YEARS (8 YEARS)	
SCHOOL NAME: E	
NAME OF CIRCUIT: MASHISHILA	
DISTRICT / PROVINCE: GERT - SIBANDE / MPUMALANGA	
GRADE/CLASS: 10	
DATE OF OBSERVATIONS: 08 – 03 – 18	
SUBJECT: PHYSICS	
TOPIC: MAGNETISM; MAGNETIC DOMAINS & APPLICATION OF DOMAIN THEORY	
NAME OF OBSERVER: DZIKITI LM	

SECTION B:	CONTEXTUAL BACKGROUND AND ACTIVITIES	
TIME	DESCRIPTION OF EVENTS	
(minutes)	Teacher activities	Students activities
0 – 10		
10 – 20		
20 – 30	SEE LESSON PLAN	
30 – 40		
40 – 50		
50 - 60		

SECTION C:	LESSON PLAN/DESIGN & IMPLEMENTATION						
	CRITERIA	RATING					Descriptive Comments
		0	1	2	3	4	
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.					X	Prior knowledge recognised
2	The lesson was designed to engage students as members of a learning community.					X	lesson planning very inclusive
3	In this lesson, student exploration preceded formal presentation.				X		Yes
4	This lesson encouraged students to seek and						

1

		0	1	2	3	4	Descriptive comments
	value alternative modes of investigation or of problem solving				X		to a great extend
5	The focus and direction of the lesson was often determined by ideas originating with students.				X		true

SECTION D: **CONTENT (Propositional Knowledge)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
6	The lesson involved fundamental concepts of the subject.					X	Domain theory was treated with exteness
7	The lesson promoted strongly coherent conceptual understanding.					X	
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.					X	good subject command
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.				X		true
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.				X		true

SECTION E: **CONTENT (Procedural Knowledge)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.					X	exposition of domains make it easy for
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.				X		learners to concretise concepts and
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.					X	to respond to questions
14	Students were reflective about their learning.				X		yes
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.				X		To a great extend

SECTION F **CLASSROOM CULTURE (Communicative Interactions)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
16	Students were involved in the communication of their ideas to others using a variety of means and media.				X		More of it was among themselves
17	The teacher's questions triggered divergent modes of thinking.				X		To a greater extend
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.					X	Very true.

2

		0	1	2	3	4	
19	Student questions and comments often determined the focus and direction of classroom discourse.					X	true
20	There was a climate of respect for what others had to say.					X	yes

SECTION G:
(Teacher /Student Relationships **CLASSROOM CULTURE**

	CRITERIA	RATING					Descriptive comment
		0	1	2	3	4	
21	Active participation of students was encouraged and valued.					X	It encouraged learner particip
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.				X		To a greater extend
23	In general the teacher was patient with students.				X		yes
24	The teacher acted as a resource person, working to support and enhance student investigations.				X		yes
25	The metaphor "teacher as listener" was very characteristic of this classroom.			X			To some extend

FEEDBACK

Presentation of domain theory thru videos made it easier for learners to explain the randomisation of domain which occurs due to thermal agitation of permanent magnets. This was a learner centred lesson full of active participation

SIGNATURE OF TEACHER: .... DATE: ..08-03-18..

SIGNATURE OF OBSERVER: ....DATE: ..08-03-18..

3

LESSON 4

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A:	BACKGROUND INFORMATION
EDUCATOR NAME: MR X	
ANNOUNCED OBSERVATION: YES	
TEACHING EXPERIENCE: 8	
SCHOOL NAME: E	
NAME OF CIRCUIT: MASHISHILA	
DISTRICT / PROVINCE: GERT SIBANDE / MPUMALANGA	
GRADE/CLASS: 10	
DATE OF OBSERVATIONS: 12-03-18	
SUBJECT: PHYSICS	
TOPIC: MAGNETISM EARTH'S GEOMAGNETIC FIELD MAGNETOSPHERE	
NAME OF OBSERVER: DZIKITI LM	

SECTION B:	CONTEXTUAL BACKGROUND AND ACTIVITIES	
TIME (minutes)	DESCRIPTION OF EVENTS	
	Teacher activities	Students activities
0 – 10		
10 – 20		
20 – 30		
30 – 40	SEE LESSON PLAN	
40 – 50		
50 - 60		

SECTION C:		LESSON PLAN/DESIGN & IMPLEMENTATION					
	CRITERIA	RATING					Descriptive Comments
		0	1	2	3	4	
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.					X	Catered for and was
2	The lesson was designed to engage students as members of a learning community.					X	inclusive
3	In this lesson, student exploration preceded formal presentation.				X		To a great extent
4	This lesson encouraged students to seek and						

1

	value alternative modes of investigation or of problem solving				X		Yes.
5	The focus and direction of the lesson was often determined by ideas originating with students.					X	true

SECTION D: CONTENT (Propositional Knowledge)

	CRITERIA	RATING 0	1	2	3	4	Descriptive comments
6	The lesson involved fundamental concepts of the subject.					X	Videos made it easier for learners to appreciate physics of magnetosphere and solar winds
7	The lesson promoted strongly coherent conceptual understanding.				X		
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.					X	
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.				X		
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.				X		Yes with Geo & Astrophysics

SECTION E: CONTENT (Procedural Knowledge)

	CRITERIA	RATING 0	1	2	3	4	Descriptive comments
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.				X		Video presentation
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.				X		Predict effects of magnetic reversal
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.				X		To a greater extend
14	Students were reflective about their learning.				X		yes
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.				X		yes

SECTION F CLASSROOM CULTURE (Communicative Interactions)

	CRITERIA	RATING 0	1	2	3	4	Descriptive comments
16	Students were involved in the communication of their ideas to others using a variety of means and media.				X		Most of it amongst learners
17	The teacher's questions triggered divergent modes of thinking.					X	Yes
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.				X		To a larger extend

2

		0	1	2	3	4	
19	Student questions and comments often determined the focus and direction of classroom discourse.				X		Yes
20	There was a climate of respect for what others had to say.				X		true

SECTION G:
(Teacher /Student Relationships **CLASSROOM CULTURE**

	CRITERIA	RATING					Descriptive comment
		0	1	2	3	4	
21	Active participation of students was encouraged and valued.				X		Tr encouraged learners
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.				X		yes
23	In general the teacher was patient with students.				X		
24	The teacher acted as a resource person, working to support and enhance student investigations.				X		very resourceful thru use of video
25	The metaphor "teacher as listener" was very characteristic of this classroom.				X		To a greater extend

FEEDBACK

This was a learner centred lesson which involved active learner participation. Teacher played a major role of inciting though provoking questioning.

SIGNATURE OF TEACHER: .... DATE: 12-03-18

SIGNATURE OF OBSERVER: .... DATE: 12-03-18

3

LESSON 1

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A:	BACKGROUND INFORMATION
EDUCATOR NAME: MR Y	
ANNOUNCED OBSERVATION: YES	
TEACHING EXPERIENCE: 25	
SCHOOL NAME: F	
NAME OF CIRCUIT: MASHISHILA	
DISTRICT / PROVINCE: GERT SIBANDE / MPUMALANGA	
GRADE/CLASS: 10	
DATE OF OBSERVATIONS: 07 – 03 – 18	
SUBJECT: PHYSICS	
TOPIC: MAGNETISM; INTRODUCTION, FERROMAGNETICS, MAGNETIC FIELD	
NAME OF OBSERVER: DZIKITI LM	

SECTION B:	CONTEXTUAL BACKGROUND AND ACTIVITIES	
TIME	DESCRIPTION OF EVENTS	
(minutes)	Teacher activities	Students activities
0 – 10		
10 – 20		PLANS
20 – 30		
30 – 40	SEE LESSON	
40 – 50		
50 - 60		

SECTION C:	LESSON PLAN/DESIGN & IMPLEMENTATION						
	CRITERIA	RATING					Descriptive Comments
		0	1	2	3	4	
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.					X	Very inclusive and catered
2	The lesson was designed to engage students as members of a learning community.					X	for all learners
3	In this lesson, student exploration preceded formal presentation.				X		To a greater extend
4	This lesson encouraged students to seek and						

1

		0	1	2	3	4	Descriptive comments
	value alternative modes of investigation or of problem solving				X		Yes
5	The focus and direction of the lesson was often determined by ideas originating with students.					X	Yes

SECTION D: CONTENT (Propositional Knowledge)

	CRITERIA	RATING 0	1	2	3	4	Descriptive comments
6	The lesson involved fundamental concepts of the subject.					X	concepts of field, of relationship clearified
7	The lesson promoted strongly coherent conceptual understanding.					X	
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.					X	Knowledge Content of tr good
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.				X		To a greater extend
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.				X		To a large extend with electri

SECTION E: CONTENT (Procedural Knowledge)

	CRITERIA	RATING 0	1	2	3	4	Descriptive comments
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.				X		To a large extend
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.				X		The inverse relationship between distance and magnetic force field
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.				X		
14	Students were reflective about their learning.				X		Yes
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.				X		To a great extend

SECTION F CLASSROOM CULTURE (Communicative Interactions)

	CRITERIA	RATING 0	1	2	3	4	Descriptive comments
16	Students were involved in the communication of their ideas to others using a variety of means and media.					X	Mostly among learners
17	The teacher's questions triggered divergent modes of thinking.					X	good thought provoking quest
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.					X	Very true

		0	1	2	3	4	
19	Student questions and comments often determined the focus and direction of classroom discourse.				X		true
20	There was a climate of respect for what others had to say.					X	Very tru

SECTION G: **CLASSROOM CULTURE**
(Teacher /Student Relationships

	CRITERIA	RATING					Descriptive comment
		0	1	2	3	4	
21	Active participation of students was encouraged and valued.					X	learners freely participated
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.				X		To a greater extend
23	In general the teacher was patient with students.				X		yes
24	The teacher acted as a resource person, working to support and enhance student investigations.				X		Very resourcefull thru use of both
25	The metaphor "teacher as listener" was very characteristic of this classroom.					X	cs & videos

FEEDBACK

This lesson involved use of both CS & videos during presentation. It was associated with highly motivated and active learner participation

SIGNATURE OF TEACHER: .... DATE: 07-03-18

SIGNATURE OF OBSERVER: .... DATE: 07-03-18

3

LESSON 2

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A:	BACKGROUND INFORMATION
EDUCATOR NAME: MR Y	
ANNOUNCED OBSERVATION: YES	
TEACHING EXPERIENCE: + 10 YEARS (25)	
SCHOOL NAME: F	
NAME OF CIRCUIT: MASHISHILA	
DISTRICT / PROVINCE: GERT-SIBANDE / MPUMALANGA	
GRADE/CLASS: 10	
DATE OF OBSERVATIONS: 08-03-18	
SUBJECT: PHYSICS	
TOPIC: MAGNETISM; LAWS OF MAGNETISM & FIELD LINES; ELECTROMAGNETS	
NAME OF OBSERVER: DZIKITI LM	

SECTION B:	CONTEXTUAL BACKGROUND AND ACTIVITIES	
TIME (minutes)	DESCRIPTION OF EVENTS	
	Teacher activities	Students activities
0 – 10		
10 – 20		
20 – 30		
30 – 40		
40 – 50		
50 - 60		

SEE LESSON PLAN

SECTION C:	LESSON PLAN/DESIGN & IMPLEMENTATION						
	CRITERIA	RATING					Descriptive Comments
		0	1	2	3	4	
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.					X	lesson recognised learners prior knowledge & was inclusive
2	The lesson was designed to engage students as members of a learning community.					X	
3	In this lesson, student exploration preceded formal presentation.					X	
4	This lesson encouraged students to seek and						

1

		0	1	2	3	4	Descriptive comments
	value alternative modes of investigation or of problem solving				X		To a large extent
5	The focus and direction of the lesson was often determined by ideas originating with students.					X	Very true

SECTION D: CONTENT (Propositional Knowledge)

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
6	The lesson involved fundamental concepts of the subject.					X	laws of magnetism
7	The lesson promoted strongly coherent conceptual understanding.					X	& intimate
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.					X	relationship between
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.				X		electricity & magnetism clearly shown
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.				X		To some extent

SECTION E: CONTENT (Procedural Knowledge)

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.					X	thru use of cs & videos
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.				X		prediction of direction of field
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.					X	lines, + Magnetic [illegible]
14	Students were reflective about their learning.					X	yes
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.					X	Yes

SECTION F CLASSROOM CULTURE (Communicative Interactions)

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
16	Students were involved in the communication of their ideas to others using a variety of means and media.					X	Very true
17	The teacher's questions triggered divergent modes of thinking.				X		To a larger extent
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.					X	Yes

		0	1	2	3	4	
19	Student questions and comments often determined the focus and direction of classroom discourse.					X	Yes
20	There was a climate of respect for what others had to say.				X		To a large extend

SECTION G: (Teacher /Student Relationships **CLASSROOM CULTURE**

	CRITERIA	RATING					Descriptive comment
		0	1	2	3	4	
21	Active participation of students was encouraged and valued.					X	Tr recognised learner participation
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.				X		To a great extend
23	In general the teacher was patient with students.				X		Yes
24	The teacher acted as a resource person, working to support and enhance student investigations.					X	thru use of cs & videos
25	The metaphor "teacher as listener" was very characteristic of this classroom.					X	Very good listening skills

FEEDBACK

This lesson involved using cs & video interactively to demonstrate laws of magnetism, electromagnets & magnetic levitation. It was associated with active involvement & participation of learners

SIGNATURE OF TEACHER: ...[signature]... DATE: 08-03-18

SIGNATURE OF OBSERVER: ...[signature]... DATE: 08-03-18

3

LESSON 3

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A:	BACKGROUND INFORMATION
EDUCATOR NAME: MR Y	
ANNOUNCED OBSERVATION: YES	
TEACHING EXPERIENCE: 25	
SCHOOL NAME: F	
NAME OF CIRCUIT: MASHISHILA	
DISTRICT / PROVINCE: GERT-SIBANDE / MPUMALANGA	
GRADE/CLASS: 10	
DATE OF OBSERVATIONS: 09-03-18	
SUBJECT: PHYSICS	
TOPIC: MAGNETISM; DOMAIN THEORY & ITS APPLICATION	
NAME OF OBSERVER: DZIKITI L M	

SECTION B:	CONTEXTUAL BACKGROUND AND ACTIVITIES	
TIME	DESCRIPTION OF EVENTS	
(minutes)	Teacher activities	Students activities
0 – 10		PLAN
10 – 20	LESSON	
20 – 30		
30 – 40	SEE	
40 – 50		
50 - 60		

SECTION C:		LESSON PLAN/DESIGN & IMPLEMENTATION					
	CRITERIA	RATING					Descriptive Comments
		0	1	2	3	4	
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.					X	highly inclusive & catered for prior knowledge of learners
2	The lesson was designed to engage students as members of a learning community.					X	
3	In this lesson, student exploration preceded formal presentation.					X	
4	This lesson encouraged students to seek and						

1

	CRITERIA	0	1	2	3	4	Descriptive comments
	value alternative modes of investigation or of problem solving					X	Yes
5	The focus and direction of the lesson was often determined by ideas originating with students.				X		To a great extend

SECTION D: CONTENT (Propositional Knowledge)

	CRITERIA	RATING 0	1	2	3	4	Descriptive comments
6	The lesson involved fundamental concepts of the subject.					X	concept of domain theory & physics of magnets was properly covered thru use of cs & videos
7	The lesson promoted strongly coherent conceptual understanding.					X	
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.					X	
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.					X	
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.					X	Connected to matter & thermal physics

SECTION E: CONTENT (Procedural Knowledge)

	CRITERIA	RATING 0	1	2	3	4	Descriptive comments
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.					X	thru use of cs & videos learners could visualise & appreciate existence of domain & there after apply it in physics
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.					X	
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.					X	
14	Students were reflective about their learning.					X	
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.				X		Applying domain theory

SECTION F CLASSROOM CULTURE (Communicative Interactions)

	CRITERIA	RATING 0	1	2	3	4	Descriptive comments
16	Students were involved in the communication of their ideas to others using a variety of means and media.				X		mainly among themselves during group discussion
17	The teacher's questions triggered divergent modes of thinking.				X		good questions provoked learners minds
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.					X	

2

19	Student questions and comments often determined the focus and direction of classroom discourse.				X		Yes
20	There was a climate of respect for what others had to say.					X	a lot of respect for indivi opinions

SECTION G: **CLASSROOM CULTURE**
(Teacher /Student Relationships

	CRITERIA	RATING					Descriptive comment
		0	1	2	3	4	
21	Active participation of students was encouraged and valued.				X		Tr encouraged and respected
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.				X		each learner 's opinions
23	In general the teacher was patient with students.				X		To a large extent
24	The teacher acted as a resource person, working to support and enhance student investigations.				X		thru use of cs & videos
25	The metaphor "teacher as listener" was very characteristic of this classroom.				X		To a large degree

FEEDBACK

This was a lesson associated with active learner participation. The combination of cs & videos made it possible to involve all learners & hence generate a lesson centred on them.

SIGNATURE OF TEACHER: .... [signature] .... DATE: ..09-03-18..

SIGNATURE OF OBSERVER: .... [signature] ....DATE: ..09-03-18..

3

LESSON 4

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A:	BACKGROUND INFORMATION
EDUCATOR NAME:	MR Y
ANNOUNCED OBSERVATION:	YES
TEACHING EXPERIENCE:	25
SCHOOL NAME:	F
NAME OF CIRCUIT:	MASHISHILA
DISTRICT / PROVINCE:	GERT-SIBANDE / MPUMALANGA
GRADE/CLASS:	10
DATE OF OBSERVATIONS:	12-03-18
SUBJECT:	PHYSICS
TOPIC:	MAGNETISM; NAVIGATION & GEOMAGNETIC FIELD, MAGNETOSPHERE
NAME OF OBSERVER:	DZIKITI L M

SECTION B:	CONTEXTUAL BACKGROUND AND ACTIVITIES	
TIME (minutes)	DESCRIPTION OF EVENTS	
	Teacher activities	Students activities
0 – 10		
10 – 20		
20 – 30		PLAN
30 – 40	LESSON	
40 – 50	SEE	
50 - 60		

SECTION C:	LESSON PLAN/DESIGN & IMPLEMENTATION						
	CRITERIA	RATING					Descriptive Comments
		0	1	2	3	4	
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.				X		To a large extend
2	The lesson was designed to engage students as members of a learning community.					X	true
3	In this lesson, student exploration preceded formal presentation.				X		To a greater extend
4	This lesson encouraged students to seek and						

1

		0	1	2	3	4	Descriptive comments
	value alternative modes of investigation or of problem solving					X	Yes
5	The focus and direction of the lesson was often determined by ideas originating with students.				X		Yes

SECTION D: CONTENT (Propositional Knowledge)

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
6	The lesson involved fundamental concepts of the subject.					X	Magnetic declination
7	The lesson promoted strongly coherent conceptual understanding.					X	Aurora borealis & solar
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.					X	winds were ~~presented~~
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.					X	well
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.					X	with Geo & Astrophysics

SECTION E: CONTENT (Procedural Knowledge)

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.					X	CS & videos presented
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.			X			→ of magnetic reversal of earth
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.				X		To a greater extend during class discussion
14	Students were reflective about their learning.				X		Yes
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.				X		Yes

SECTION F CLASSROOM CULTURE (Communicative Interactions)

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
16	Students were involved in the communication of their ideas to others using a variety of means and media.				X		Mostly learner to another
17	The teacher's questions triggered divergent modes of thinking.				X		though provoking questions
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.					X	Very true

2

		0	1	2	3	4	
19	Student questions and comments often determined the focus and direction of classroom discourse.					X	True
20	There was a climate of respect for what others had to say.				X		To a larger extend

SECTION G: **CLASSROOM CULTURE**

(Teacher /Student Relationships

	CRITERIA	RATING					Descriptive comment
		0	1	2	3	4	
21	Active participation of students was encouraged and valued.				X		To a greater extend
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.				X		true
23	In general the teacher was patient with students.				X		true
24	The teacher acted as a resource person, working to support and enhance student investigations.				X		using cs of videos
25	The metaphor "teacher as listener" was very characteristic of this classroom.					X	very good listener

FEEDBACK

This was a learner centred lesson with high levels of active participation.

SIGNATURE OF TEACHER: ......[signature]...... DATE: 12-03-18

SIGNATURE OF OBSERVER: ......[signature]...... DATE: 13-03-18

3

LESSON 1

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A:	BACKGROUND INFORMATION
EDUCATOR NAME: Miss Z	
ANNOUNCED OBSERVATION: YES	
TEACHING EXPERIENCE: 5 YEARS	
SCHOOL NAME: G	
NAME OF CIRCUIT: MASHISHILA	
DISTRICT / PROVINCE: GERT-SIBANDE / MPUMALANGA	
GRADE/CLASS: 10	
DATE OF OBSERVATIONS: 05-March-2018	
SUBJECT: PHYSICS	
TOPIC: MAGNETISM: EARTH'S GEOMAGNETIC FIELD, NAVIGATION, MAGNETOSPHERE	
NAME OF OBSERVER: DZIKITI LM	

SECTION B:	CONTEXTUAL BACKGROUND AND ACTIVITIES	
TIME (minutes)	DESCRIPTION OF EVENTS	
	Teacher activities	Students activities
0 – 10		
10 – 20		
20 – 30		
30 – 40	SEE LESSON PLAN	
40 – 50		
50 - 60		

SECTION C:	LESSON PLAN/DESIGN & IMPLEMENTATION						
	CRITERIA	RATING					Descriptive Comments
		0	1	2	3	4	
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.				X		lesson catered for prior knowledge of learners
2	The lesson was designed to engage students as members of a learning community.				X		Yes it was inclusive
3	In this lesson, student exploration preceded formal presentation.		X				Note expressed
4	This lesson encouraged students to seek and						

1

		0	1	2	3	4	
	value alternative modes of investigation or of problem solving		X				poorly presented,
5	The focus and direction of the lesson was often determined by ideas originating with students.	X					it was teacher centred

SECTION D: **CONTENT (Propositional Knowledge)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
6	The lesson involved fundamental concepts of the subject.				X		It it involved magnetic field ~~relationships~~
7	The lesson promoted strongly coherent conceptual understanding.			X			it was teacher centred
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.					X	Yes
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.		X				learners relied on textbook & teacher's explanations
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.		X				Non significant

SECTION E: **CONTENT (Procedural Knowledge)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.			X			students copied textbook diagrams
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.		X				No
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.			X			Learners relied heavily on textbook & tr's for explanations
14	Students were reflective about their learning.		X				
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.				X		To some extend

SECTION F **CLASSROOM CULTURE (Communicative Interactions)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
16	Students were involved in the communication of their ideas to others using a variety of means and media.		X				Class discussions were led by tr
17	The teacher's questions triggered divergent modes of thinking.			X			very few questions were asked
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.		X				Discussions were tr dominated.

2

19	Student questions and comments often determined the focus and direction of classroom discourse.		X				No that much
20	There was a climate of respect for what others had to say.			X			To some extend

SECTION G:
(Teacher /Student Relationships **CLASSROOM CULTURE**

	CRITERIA	RATING					Descriptive comment
		0	1	2	3	4	
21	Active participation of students was encouraged and valued.			X			Even though tr encouraged it but very few responded
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.		X				students couldn't generate conjectures
23	In general the teacher was patient with students.			X			To a lesser extend
24	The teacher acted as a resource person, working to support and enhance student investigations.		X				The only resource used was chalk & textbook
25	The metaphor "teacher as listener" was very characteristic of this classroom.	X					Teacher did most of the talking

FEEDBACK

This lesson was dominated by teacher talk. No ICT resources were used except books & chalkboard. There was poor level of participation. It was teacher centred.

SIGNATURE OF TEACHER: ...[signature]... DATE: 05-03-18

SIGNATURE OF OBSERVER: ...[signature]... DATE: 05-03-18

3

LESSON 2

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A: BACKGROUND INFORMATION
EDUCATOR NAME: Miss Z
ANNOUNCED OBSERVATION: YES
TEACHING EXPERIENCE: 5
SCHOOL NAME: G
NAME OF CIRCUIT: MASHISHILA
DISTRICT / PROVINCE: GERT-SIBANDE / MPUMALANGA
GRADE/CLASS: 10
DATE OF OBSERVATIONS: 06/03/18
SUBJECT: PHYSICS
TOPIC: MAGNETISM; LAWS OF MAGNETISM, FIELD LINES & ELECTRO MAGNETS
NAME OF OBSERVER: DZIKITI LM

SECTION B:	CONTEXTUAL BACKGROUND AND ACTIVITIES	
TIME (minutes)	DESCRIPTION OF EVENTS	
	Teacher activities	Students activities
0 – 10		
10 – 20		
20 – 30		
30 – 40		
40 – 50		
50 - 60		

SEE LESSON PLAN

SECTION C:	LESSON PLAN/DESIGN & IMPLEMENTATION						
	CRITERIA	RATING					Descriptive Comments
		0	1	2	3	4	
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.					X	lesson catered for learner's prior knowledge
2	The lesson was designed to engage students as members of a learning community.				X		Yes
3	In this lesson, student exploration preceded formal presentation.		X				To a lesser extent
4	This lesson encouraged students to seek and						

1

		0	1	2	3	4	
	value alternative modes of investigation or of problem solving		X				
5	The focus and direction of the lesson was often determined by ideas originating with students.	X					It was tr directed

SECTION D: **CONTENT (Propositional Knowledge)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
6	The lesson involved fundamental concepts of the subject.				X		True
7	The lesson promoted strongly coherent conceptual understanding.			X			To a lesser extend
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.					X	Yes
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.		X				learners copied diagrams mainly from txtbook
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.			X			

SECTION E: **CONTENT (Procedural Knowledge)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.			X			To a lesser extend
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.	X					The learning enviroment gave no room for
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.		X				predictions since explanations
14	Students were reflective about their learning.		X				originated from tr No
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.				X		To some extend

SECTION F **CLASSROOM CULTURE (Communicative Interactions)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
16	Students were involved in the communication of their ideas to others using a variety of means and media.		X				lesson was Centred on tr
17	The teacher's questions triggered divergent modes of thinking.			X			To a lesser extend
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.		X				little evidence to substantiate the statement

2

19	Student questions and comments often determined the focus and direction of classroom discourse.		X				Tr dictated what was to be done next
20	There was a climate of respect for what others had to say.				X		To some greater extend

SECTION G:
(Teacher /Student Relationships **CLASSROOM CULTURE**

	CRITERIA	RATING					Descriptive comment
		0	1	2	3	4	
21	Active participation of students was encouraged and valued.			X			To a lesser extend
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.		X				To a lesser degree
23	In general the teacher was patient with students.			X			Not very patient
24	The teacher acted as a resource person, working to support and enhance student investigations.		X				only chalkboard & textbooks used
25	The metaphor "teacher as listener" was very characteristic of this classroom.	X					Tr did most of the talking

FEEDBACK

Even though there were some group activities followed by class discussions but dominated all class discussions, It was a teacher centred environment

SIGNATURE OF TEACHER: [signature] .... DATE: 06-03-18

SIGNATURE OF OBSERVER: [signature] .... DATE: 06-03-18

3

LESSON 3

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A:	BACKGROUND INFORMATION
EDUCATOR NAME: MISS Z	
ANNOUNCED OBSERVATION: YES	
TEACHING EXPERIENCE: 5	
SCHOOL NAME: G	
NAME OF CIRCUIT: MASHISHILA	
DISTRICT / PROVINCE: GERT-SIBANDE / MPUMALANGA	
GRADE/CLASS: 10	
DATE OF OBSERVATIONS: 07/03/2018	
SUBJECT: PHYSICS	
TOPIC: MAGNETISM; DOMAIN THEORY & APPLICATIONS	
NAME OF OBSERVER: DZIKITI LM	

SECTION B:	CONTEXTUAL BACKGROUND AND ACTIVITIES	
TIME (minutes)	DESCRIPTION OF EVENTS	
	Teacher activities	Students activities
0 – 10		
10 – 20		
20 – 30		
30 – 40		
40 – 50		
50 - 60		

SEE LESSON PLAN

SECTION C:	LESSON PLAN/DESIGN & IMPLEMENTATION						
	CRITERIA	RATING					Descriptive Comments
		0	1	2	3	4	
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.			X			To some extend
2	The lesson was designed to engage students as members of a learning community.			X			
3	In this lesson, student exploration preceded formal presentation.			X			Presentation was inconsistent
4	This lesson encouraged students to seek and						

1

		0	1	2	3	4	
	value alternative modes of investigation or of problem solving		X				To a lesser extend
5	The focus and direction of the lesson was often determined by ideas originating with students.	X					Tr directed the lesson

SECTION D: **CONTENT (Propositional Knowledge)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
6	The lesson involved fundamental concepts of the subject.				X		Yes, Domain theory & Applicatn
7	The lesson promoted strongly coherent conceptual understanding.			X			learners relied on tr & textbook
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.					X	True
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.			X			diagrams were extracted from textbook & C/bd
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.		X				No much

SECTION E: **CONTENT (Procedural Knowledge)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.			X			Diags were from teacher & texbook.
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.		X				Many learners were not able to apply the domain theory
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.			X			
14	Students were reflective about their learning.		X				To a lesser extend
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.	X					No much / No

SECTION F **CLASSROOM CULTURE (Communicative Interactions)**

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
16	Students were involved in the communication of their ideas to others using a variety of means and media.		X				Tr did most of the talking
17	The teacher's questions triggered divergent modes of thinking.			X			To some extend
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.		X				Tr did most of the explanations

2

		0	1	2	3	4	
19	Student questions and comments often determined the focus and direction of classroom discourse.		X				Tr dictated the pace
20	There was a climate of respect for what others had to say.				X		True

SECTION G: **CLASSROOM CULTURE**
(Teacher /Student Relationships

	CRITERIA	RATING					Descriptive comment
		0	1	2	3	4	
21	Active participation of students was encouraged and valued.			X			To a lesser extend
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.		X				To a lesser extend
23	In general the teacher was patient with students.			X			To a lesser extend
24	The teacher acted as a resource person, working to support and enhance student investigations.		X				NO
25	The metaphor "teacher as listener" was very characteristic of this classroom.		X				No

FEEDBACK

This was a teacher centred lesson with little situations of learner involvement

SIGNATURE OF TEACHER: ....[signature].... DATE: ..07-03-18.....

SIGNATURE OF OBSERVER: ....[signature].... DATE: ..07-03-18....

3

LESSON 4

CLASSROOM OBSERVATION INSTRUMENT: (RTOP)

SECTION A:	BACKGROUND INFORMATION
EDUCATOR NAME: Miss Z	
ANNOUNCED OBSERVATION: YES.	
TEACHING EXPERIENCE: 5	
SCHOOL NAME: G	
NAME OF CIRCUIT: MASHISHILA	
DISTRICT/PROVINCE: GERT-SIBANDE/ MPUMALANGA	
GRADE/CLASS: 10	
DATE OF OBSERVATIONS: 09-03-18	
SUBJECT: PHYSICS	
TOPIC: MAGNETISM; INTRODUCTION; MAGNETIC FIELD & MATERIALS	
NAME OF OBSERVER: DZIKITI L M	

SECTION B:	CONTEXTUAL BACKGROUND AND ACTIVITIES	
TIME (minutes)	DESCRIPTION OF EVENTS	
	Teacher activities	Students activities
0 – 10		
10 – 20		
20 – 30		
30 – 40		
40 – 50		
50 - 60		

SEE LESSON PLAN

SECTION C:	LESSON PLAN/DESIGN & IMPLEMENTATION						
	CRITERIA	RATING					Descriptive Comments
		0	1	2	3	4	
1	Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.			X			Activities were teacher centred
2	The lesson was designed to engage students as members of a learning community.			X			No inclusivity
3	In this lesson, student exploration preceded formal presentation.		X				Not much
4	This lesson encouraged students to seek and						

1

		0	1	2	3	4	
	value alternative modes of investigation or of problem solving		X				To a lesser extend
5	The focus and direction of the lesson was often determined by ideas originating with students.	X					Tr dictated the pace

SECTION D: CONTENT (Propositional Knowledge)

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
6	The lesson involved fundamental concepts of the subject.			X			All concepts were explained as they are given in the textbook
7	The lesson promoted strongly coherent conceptual understanding.			X			
8	The teacher had a solid grasp of the subject matter content inherent in the lesson.					X	yes
9	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged where it was important to do so.		X				Not much
10	Connections with other content disciplines and/ or real world phenomena were explored and valued.		X				No

SECTION E: CONTENT (Procedural Knowledge)

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
11	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.		X				To a lesser extend
12	Students made predictions, estimations and/or hypotheses and devised means for testing them.		X				To a lesser extend
13	Students were actively engaged in thought provoking activity that often involved the critical assessment of procedures.	X					No
14	Students were reflective about their learning.		X				No much
15	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.	X					No

SECTION F CLASSROOM CULTURE (Communicative Interactions)

	CRITERIA	RATING					Descriptive comments
		0	1	2	3	4	
16	Students were involved in the communication of their ideas to others using a variety of means and media.		X				Responded only to some of tr's question
17	The teacher's questions triggered divergent modes of thinking.			X			even though tr asked but learners were not able to respond correctly
18	There was a high proportion of student talk and a significant amount of it occurred between and among students.		X				To a lesser extend

2

		0	1	2	3	4	Descriptive comment
19	Student questions and comments often determined the focus and direction of classroom discourse.		X				No
20	There was a climate of respect for what others had to say.				X		To some extend

SECTION G: (Teacher /Student Relationships **CLASSROOM CULTURE**

	CRITERIA	RATING					Descriptive comment
		0	1	2	3	4	
21	Active participation of students was encouraged and valued.			X			Tr directed the lesson
22	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.		X				No
23	In general the teacher was patient with students.			X			No
24	The teacher acted as a resource person, working to support and enhance student investigations.		X				No
25	The metaphor "teacher as listener" was very characteristic of this classroom.	X					Not at all

FEEDBACK

Most of the explanations were provided by the teacher. learners were passive recipients of knowledge

SIGNATURE OF TEACHER: ...[signature]... DATE: ..09-03-18.....

SIGNATURE OF OBSERVER: [signature]...DATE: ....09-03-18.....

3

APPENDIX Q: QUESTIONNAIRE RESPONSES

A QUESTIONNAIRE FOR PHYSICS TEACHERS ON INTERACTIVE USE OF ICT IN TEACHING AND LEARNING PHYSICS

Instructions: Please tick or fill in where necessary.

For the purpose of this questionnaire Information and Communication Technology (ICT) is defined as a range of technologies for gathering, storing, retrieving, processing, analyzing and transmitting information like computers, projectors and internet.

SECTION A: Background/Personal Information:

1. Name of teacher: MR. W.
2. Gender:

MALE	X	FEMALE	

3. Age group

20 – 25 YEARS	
25 – 30 YEARS	
30 – 35 YEARS	
35 – 40 YEARS	
+ 40 YEARS	X

4. QUALIFICATIONS

ACADEMIC	PROFESSIONAL	OTHER
M Ed.	STD	
Hons		
ACE		

4. Teaching experience:

0 – 5 YEARS	
5 – 10 YEARS	
+10 YEARS	X

SUBJECT(S) TAUGHT	GRADE(S)
MATHEMATICS	9
PHYSICAL SCIENCE	10-12
NAT SCIENCE	9

5. Name of school: D Sec. School
6. Type of School:

	RURAL	URBAN
MST SCHOOL	X	
NON-MST SCHOOL		

7. Circuit: Badplaas
8. District/Province: Gert Sibande. Mpumalanga

1

Instructions: For sections B,and C choose and use the codes given, by writing the code (e.g. 0, 1, 2, 3, 4 or 5) of your choice against the questions. The interpretation of codes is as follows:

Rating	0	1	2	3	4	5
Meaning	Not Sure	Strongly disagree	Disagree	Partially Agree	Agree	Strongly agree
Code	NS	SD	D	PA	A	SA

SECTION B: TEACHERS VIEWS ON INTERACTIVE USE CS AND VIDEOS WHEN TEACHING MAGNETISM

	STATEMENT	Rating					
		NS	SD	D	D	PA	SA
		0	1	2	3	4	5
1	I do use ICT (computer simulations and videos) to teach even before this research.						✓
2	ICT usage captures learners' attention and increases their level of concentration in class						✓
3	ICT usage makes teaching Physics easier						✓
4	ICT usage should be integrated with traditional normal instructional methods in Physics (e.g in magnetism).						✓
5	Teachers should be work-shopped on how to use computer simulations videos for teaching physical sciences concepts (e.g magnetic domains & fields).						✓
6	Use of a combination of both computer simulations & videos in physics makes it easier to visualize the reality of imaginary concepts (e.g. magnetic domains & magnetic field lines).						✓
7	Our school has a WIFI and DSTV network and internet access which can potentially be used in physics classes for computer simulations and video learning via youtube & DVDs.		✓				
8	ICT usage helps in class control and management.						✓
9	Physics is easy, fun, interesting and exciting when taught using both computer simulations & videos.						✓
10	I think computer simulations, videos & DVDs are good learning tools when dealing with physics concepts (e.g magnetic domains).						✓
11	ICT usage makes teaching Physics easier and interesting.						✓
12	ICT usage saves a lot of time used in drawing and labeling diagrams on chalk board.						✓
13	ICT usage makes diagrams and graphical work clearer than drawing them on the chalk board.						✓
14	Use of Computer simulations and videos in learning promotes high order thinking skills & enables students to realize their full potential in physics.						✓
15	Learners should be allowed to use their own smartphones or tablets via their school's WIFI network (through closely monitored school 's gmail account) so as to download, watch and share physics simulations and videos.						✓
16	Most of our schools have ICT infrastructure and tools but lacks the know-how of integrating it into the curriculum as a teaching weapon.						✓

SECTION C: Factors that may influence the successful integration of ICT in teaching Physics.

1. Whats your perception on the use ICT in teaching high school Physics?

   It can contribute in increasing learner understanding of science thus improving performance

2. How do you use Computers for teaching your school are enough for all learners in my class?

   I use my laptop and projector to show learners some lessons or presentations

3. Do you think learners can learn Physics with ICT on their own? Explain briefly.

   Yes. They will communicate with science themselves and contact other learners using ICT for assistance

4. Explain how the timetable of the school could be adjusted to accommodate the use of ICT in teaching Physics. The normal known timetable. only that during science periods ICT should be used.

5. What do you suggest to be done so as improve learner performance through interactive use of DSTV learning Channel, DVD video discs and youtube videos?

   Let learners view presentation for say 10 minutes, stop and discuss & summarise, the watch 10 min and so on

6. "Physics teachers should be ICT literate." Whats your opinion?

   Everyone should be ICT literate this is an ICT era.

7. From the study do you think Learners got distracted by ICT when teaching Physics?

   Yes when the teacher is not competent in using ICT. No when teacher uses it to teach

8. Explain the challenges that you encounter when accessing internet via WIFI in your school specifically for the direct benefit of the physics learners.

   I am using internet out of my own pocket.

9. How often do you make use of the DSTV network as well as computer laboratory with internet access during your physics lesson execution?

   NEVER used DSTV but mostly use computer with internet access

10. What is your opinion on the statement that says "Learners cannot learn Physics with ICT on their own"?

    It is incorrect. Learner can do anything provided they are motivated.

11. What do suggest should be done by SA government so that all physics teacher can confidently make use of ICT tools in teaching/learning?

    Equip science teachers to at least Honours level in science

3

12. The PhET Learners can get access to free online software can be accessed for free online.

i) How often do you use it/ comfortable are you using it for teaching physics?

I used it in years where I teach grade 12.

ii) Do you think its compatible with the South African CAPS syllabus?

Yes.

13. How often should workshops on interactive use of CS and videos in physics be held to enable SA to be at par with digital 21st century expectations?

Three time a year on quarterly bases (e.g. March, June & September)

14. Do you think that interactive use of ICT resources can complement shortage of laboratory equipment in your school? Explain briefly

Yes. because learner can see and observe from the video even if the apparatus are not available in school.

4

A QUESTIONNAIRE FOR PHYSICS TEACHERS ON INTERACTIVE USE OF ICT IN TEACHING AND LEARNING PHYSICS

Instructions: Please tick or fill in where necessary.

For the purpose of this questionnaire Information and Communication Technology (ICT) is defined as a range of technologies for gathering, storing, retrieving, processing, analyzing and transmitting information like computers, projectors and internet.

SECTION A: Background/Personal Information:

1. Name of teacher: MR X

2. Gender:

MALE	X	FEMALE	

3. Age group

20 – 25 YEARS	
25 – 30 YEARS	
30 – 35 YEARS	
35 – 40 YEARS	X
+ 40 YEARS	

4. QUALIFICATIONS

ACADEMIC	PROFESSIONAL	OTHER
MATRIC	BSc Ed	

4. Teaching experience:

0 – 5 YEARS	
5 – 10 YEARS	X
+10 YEARS	

SUBJECT(S) TAUGHT	GRADE(S)
PHY. SCIENCE	10 - 12

5. Name of school: E
6. Type of School:

	RURAL	URBAN
MST SCHOOL	X	
NON-MST SCHOOL		

7. Circuit: MASHISHILA
8. District/Province: MPUMALANGA

1

Instructions: For sections B,and C choose and use the codes given, by writing the code (e.g. 0, 1, 2, 3, 4 or 5) of your choice against the questions. The interpretation of codes is as follows:

Rating	0	1	2	3	4	5
Meaning	Not Sure	Strongly disagree	Disagree	Partially Agree	Agree	Strongly agree
Code	NS	SD	D	PA	A	SA

SECTION B: TEACHERS VIEWS ON INTERACTIVE USE CS AND VIDEOS WHEN TEACHING MAGNETISM

	STATEMENT	Rating					
		NS	SD	D	D	PA	SA
		0	1	2	3	4	5
1	I do use ICT (computer simulations and videos) to teach even before this research.						✓
2	ICT usage captures learners' attention and increases their level of concentration in class					✓	
3	ICT usage makes teaching Physics easier						
4	ICT usage should be integrated with traditional normal instructional methods in Physics (e.g in magnetism).					✓	
5	Teachers should be work-shopped on how to use computer simulations videos for teaching physical sciences concepts (e.g magnetic domains & fields).					✓	
6	Use of a combination of both computer simulations & videos in physics makes it easier to visualize the reality of imaginary concepts (e.g. magnetic domains & magnetic field lines).					✓	
7	Our school has a WIFI and DSTV network and internet access which can potentially be used in physics classes for computer simulations and video learning via youtube & DVDs.			✓			
8	ICT usage helps in class control and management.				✓		
9	Physics is easy, fun, interesting and exciting when taught using both computer simulations & videos.					✓	
10	I think computer simulations, videos & DVDs are good learning tools when dealing with physics concepts (e.g magnetic domains).					✓	
11	ICT usage makes teaching Physics easier and interesting.					✓	
12	ICT usage saves a lot of time used in drawing and labeling diagrams on chalk board.						✓
13	ICT usage makes diagrams and graphical work clearer than drawing them on the chalk board.						✓
14	Use of Computer simulations and videos in learning promotes high order thinking skills & enables students to realize their full potential in physics.				✓		
15	Learners should be allowed to use their own smartphones or tablets via their school's WIFI network (through closely monitored school 's gmail account) so as to download, watch and share physics simulations and videos.					✓	
16	Most of our schools have ICT infrastructure and tools but lacks the know-how of integrating it into the curriculum as a teaching weapon.						✓

2

SECTION C: Factors that may influence the successful integration of ICT in teaching Physics.

1. Whats your perception on the use ICT in teaching high school Physics?
It promotes critical thinking and stimulates learners
2. How do you use Computers for teaching your school are enough for all learners in my class?
Computer are not enough for all the learners as they are few.
3. Do you think learners can learn Physics with ICT on their own? Explain briefly.
Yes but they need to be computer literate
4. Explain how the timetable of the school could be adjusted to accommodate the use of ICT in teaching
Physics. It should accommodate all the learning grades in the school.
5. What do you suggest to be done so as improve learner performance through interactive use of DSTV learning Channel, DVD video discs and youtube videos?
All learners should be given the chance to ~~learn~~ use watch these channels in all learning areas.
6. "Physics teachers should be ICT literate." Whats your opinion?
Yes so that they save time to draw diagrams which are complicated in the chalkboard.
7. From the study do you think Learners got distracted by ICT when teaching Physics?
No they enjoy use of ICT and increase their level of concentration.
8. Explain the challenges that you encounter when accessing internet via WIFI in your school specifically for the direct benefit of the physics learners.
Some time network becomes a challenge
9. How often do you make use of the DSTV network as well as computer laboratory with internet access during your physics lesson execution?
They are not oftenly used due to lack of computers.
10. What is your opinion on the statement that says "Learners cannot learn Physics with ICT on their own"?
No learners can still ~~work~~ learn on their own using some other resources.
11. What do suggest should be done by SA government so that all physics teacher can confidently make use of ICT tools in teaching/learning?
All educators need to be workshopped since curriculum is always changing.

3

12. The PhET Learners can get access to free online software can be accessed for free online.

i) How often do you use it/ comfortable are you using it for teaching physics?

Not often

ii) Do you think its compatible with the South African CAPS syllabus?

Yes. it is compatible

13. How often should workshops on interactive use of CS and videos in physics be held to enable SA to be at par with digital 21st century expectations?

More often as teachers are always changing schools and ~~as~~ curriculum is changing.

14. Do you think that interactive use of ICT resources can complement shortage of laboratory equipment in your school? Explain briefly

Yes because some schools do not have the chemicals and apparatus as well as laboratory facilities.

4

A QUESTIONNAIRE FOR PHYSICS TEACHERS ON INTERACTIVE USE OF ICT IN TEACHING AND LEARNING PHYSICS

Instructions: Please tick or fill in where necessary.

For the purpose of this questionnaire Information and Communication Technology (ICT) is defined as a range of technologies for gathering, storing, retrieving, processing, analyzing and transmitting information like computers, projectors and internet.

SECTION A: Background/Personal Information:

1. Name of teacher: MR Y
2. Gender:

MALE	✓	FEMALE	

3. Age group

20 – 25 YEARS	
25 – 30 YEARS	
30 – 35 YEARS	
35 – 40 YEARS	
+ 40 YEARS	✓

4. QUALIFICATIONS

ACADEMIC	PROFESSIONAL	OTHER
BSc (Hon)	University Education Diploma (UED)	

4. Teaching experience:

0 – 5 YEARS	
5 – 10 YEARS	
+10 YEARS	✓

SUBJECT(S) TAUGHT	GRADE(S)
Physical Sciences	10

5. Name of school: Secondary F
6. Type of School:

	RURAL	URBAN
MST SCHOOL	✓	
NON-MST SCHOOL		

7. Circuit: Mashishila
8. District/Province: Gert Sibande, Mpumalanga

1

Instructions: For sections B,and C choose and use the codes given, by writing the code (e.g. 0, 1, 2, 3, 4 or 5) of your choice against the questions. The interpretation of codes is as follows:

Rating	0	1	2	3	4	5
Meaning	Not Sure	Strongly disagree	Disagree	Partially Agree	Agree	Strongly agree
Code	NS	SD	D	PA	A	SA

SECTION B: TEACHERS VIEWS ON INTERACTIVE USE CS AND VIDEOS WHEN TEACHING MAGNETISM

	STATEMENT	Rating					
		NS	SD	D	D	PA	SA
		0	1	2	3	4	5
1	I do use ICT (computer simulations and videos) to teach even before this research.					✓	
2	ICT usage captures learners' attention and increases their level of concentration in class						✓
3	ICT usage makes teaching Physics easier					✓	
4	ICT usage should be integrated with traditional normal instructional methods in Physics (e.g in magnetism).					✓	
5	Teachers should be work-shopped on how to use computer simulations videos for teaching physical sciences concepts (e.g magnetic domains & fields).						✓
6	Use of a combination of both computer simulations & videos in physics makes it easier to visualize the reality of imaginary concepts (e.g. magnetic domains & magnetic field lines).						✓
7	Our school has a WIFI and DSTV network and internet access which can potentially be used in physics classes for computer simulations and video learning via youtube & DVDs.				✓		
8	ICT usage helps in class control and management.					✓	
9	Physics is easy, fun, interesting and exciting when taught using both computer simulations & videos.						✓
10	I think computer simulations, videos & DVDs are good learning tools when dealing with physics concepts (e.g magnetic domains).						✓
11	ICT usage makes teaching Physics easier and interesting.						✓
12	ICT usage saves a lot of time used in drawing and labeling diagrams on chalk board.						✓
13	ICT usage makes diagrams and graphical work clearer than drawing them on the chalk board.						✓
14	Use of Computer simulations and videos in learning promotes high order thinking skills & enables students to realize their full potential in physics.					✓	
15	Learners should be allowed to use their own smartphones or tablets via their school`s WIFI network (through closely monitored school `s gmail account) so as to download, watch and share physics simulations and videos.						✓
16	Most of our schools have ICT infrastructure and tools but lacks the know-how of integrating it into the curriculum as a teaching weapon.				✓		

2

SECTION C: Factors that may influence the successful integration of ICT in teaching Physics.

1. Whats your perception on the use ICT in teaching high school Physics?
Use of ICT may promote motivation, interest as well as grasping of scientific concepts.

2. How do you use Computers for teaching your school are enough for all learners in my class?
Computers are not nearly enough. I use a laptop connected to an interactive smartboard.

3. Do you think learners can learn Physics with ICT on their own? Explain briefly.
It may be necessary at times to put more emphasis on certain aspects, and that requires a facilitator.

4. Explain how the timetable of the school could be adjusted to accommodate the use of ICT in teaching Physics. The duration of a teaching period (session) can be increased.

5. What do you suggest to be done so as improve learner performance through interactive use of DSTV learning Channel, DVD video discs and youtube videos?
Teachers may give home activities and assignments which require them to use Learning Channel, DVD's and youtube.

6. "Physics teachers should be ICT literate." Whats your opinion?
I agree with the statement. Many schools lack or do not have enough equipment; use of ICT may help with videos and simulations.

7. From the study do you think Learners got distracted by ICT when teaching Physics?
At first, some learners are over awed by the technology and miss the concepts being taught.

8. Explain the challenges that you encounter when accessing internet via WIFI in your school specifically for the direct benefit of the physics learners.
There is no technical support; often the wi-fi signal is inaccessible for long periods.

9. How often do you make use of the DSTV network as well as computer laboratory with internet access during your physics lesson execution?
I use it for certain topics, not the entire syllabus due to timetabling problems and technical Challenges.

10. What is your opinion on the statement that says "Learners cannot learn Physics with ICT on their own"?
I believe they can; however, a facilitator is needed at times to guide and explain.

11. What do suggest should be done by SA government so that all physics teacher can confidently make use of ICT tools in teaching/learning?
All Physics teachers must have access to a laptop and projector. The government may subsidize these for teachers. The government must facilitate training for teachers and provide technical support.

3

12. The PhET Learners can get access to free online software can be accessed for free online.

i) How often do you use it/ comfortable are you using it for teaching physics?

I use it sometimes, but I have not updated it for a while due to lack of Wi-fi connectivity.

ii) Do you think its compatible with the South African CAPS syllabus?

I am not sure about the latest version of PhET; the old version requires that a teacher must highlight CAPS requirements and emphasize certain aspects.

13. How often should workshops on interactive use of CS and videos in physics be held to enable SA to be at par with digital 21st century expectations?

I believe at least once every quarter

14. Do you think that interactive use of ICT resources can complement shortage of laboratory equipment in your school? Explain briefly

Yes; it can even save time needed to set up experiments, while also saving the school money to buy expensive equipment.

A QUESTIONNAIRE FOR PHYSICS TEACHERS ON INTERACTIVE USE OF ICT IN TEACHING AND LEARNING PHYSICS

Instructions: Please tick or fill in where necessary.

For the purpose of this questionnaire Information and Communication Technology (ICT) is defined as a range of technologies for gathering, storing, retrieving, processing, analyzing and transmitting information like computers, projectors and internet.

SECTION A: Background/Personal Information:

1. Name of teacher: Unknown · EDUCATOR
2. Gender:

MALE	X	FEMALE	

3. Age group

20 – 25 YEARS	
25 – 30 YEARS	
30 – 35 YEARS	
35 – 40 YEARS	
+ 40 YEARS	X

4. QUALIFICATIONS

ACADEMIC	PROFESSIONAL	OTHER
O' LEVEL	B. ED	

4. Teaching experience:

0 – 5 YEARS	X
5 – 10 YEARS	
+10 YEARS	

SUBJECT(S) TAUGHT	GRADE(S)
MATHEMATICS	10 – 12
PHYSICAL SCIENCE	10 – 12

5. Name of school: F SEC SCHOOL
6. Type of School:

	RURAL	URBAN
MST SCHOOL	X	
NON-MST SCHOOL		

7. Circuit: MASHISHILA
8. District/Province: GERT SIBANDE MPUMALANGA

1

Instructions: For sections B,and C choose and use the codes given, by writing the code (e.g. 0, 1, 2, 3, 4 or 5) of your choice against the questions. The interpretation of codes is as follows:

Rating	0	1	2	3	4	5
Meaning	Not Sure	Strongly disagree	Disagree	Partially Agree	Agree	Strongly agree
Code	NS	SD	D	PA	A	SA

SECTION B: TEACHERS VIEWS ON INTERACTIVE USE CS AND VIDEOS WHEN TEACHING MAGNETISM

	STATEMENT	Rating					
		NS	SD	D	D	PA	SA
		0	1	2	3	4	5
1	I do use ICT (computer simulations and videos) to teach even before this research.						X
2	ICT usage captures learners' attention and increases their level of concentration in class						X
3	ICT usage makes teaching Physics easier						X
4	ICT usage should be integrated with traditional normal instructional methods in Physics (e.g in magnetism).						X
5	Teachers should be work-shopped on how to use computer simulations videos for teaching physical sciences concepts (e.g magnetic domains & fields).						X
6	Use of a combination of both computer simulations & videos in physics makes it easier to visualize the reality of imaginary concepts (e.g. magnetic domains & magnetic field lines).						X
7	Our school has a WIFI and DSTV network and internet access which can potentially be used in physics classes for computer simulations and video learning via youtube & DVDs.						X
8	ICT usage helps in class control and management.						X
9	Physics is easy, fun, interesting and exciting when taught using both computer simulations & videos.						X
10	I think computer simulations, videos & DVDs are good learning tools when dealing with physics concepts (e.g magnetic domains).						X
11	ICT usage makes teaching Physics easier and interesting.						X
12	ICT usage saves a lot of time used in drawing and labeling diagrams on chalk board.						X
13	ICT usage makes diagrams and graphical work clearer than drawing them on the chalk board.						X
14	Use of Computer simulations and videos in learning promotes high order thinking skills & enables students to realize their full potential in physics.						X
15	Learners should be allowed to use their own smartphones or tablets via their school`s WIFI network (through closely monitored school `s gmail account) so as to download, watch and share physics simulations and videos.						X
16	Most of our schools have ICT infrastructure and tools but lacks the know-how of integrating it into the curriculum as a teaching weapon.			X			

SECTION C: Factors that may influence the successful integration of ICT in teaching Physics.

1. Whats your perception on the use ICT in teaching high school Physics?
   Physics becomes fun exciting and easy when taught using simulations and videos
2. How do you use Computers for teaching your school are enough for all learners in my class?
   More Computers need to be availed to learners in my class.
3. Do you think learners can learn Physics with ICT on their own? Explain briefly.
   Some learners can while some cannot because of both disciplinary and comprehension issues
4. Explain how the timetable of the school could be adjusted to accommodate the use of ICT in teaching Physics. The use of ICT can be accomodated during extra classes so as not to disturb mainstream teaching
5. What do you suggest to be done so as improve learner performance through interactive use of DSTV learning Channel, DVD video discs and youtube videos?
   Timetables in schools must be synced with live broadcasting for learners to interact actively with channel
6. "Physics teachers should be ICT literate." Whats your opinion?
   Most concepts in physics are abstract so an ICT literate teacher will go a long way in explaining concepts.
7. From the study do you think Learners got distracted by ICT when teaching Physics?
   Learners sometimes get distracted and need to be monitored closely when using ICT
8. Explain the challenges that you encounter when accessing internet via WIFI in your school specifically for the direct benefit of the physics learners.
   Sometimes accessing WIFI is affected by weather conditions and availability of Data bundles
9. How often do you make use of the DSTV network as well as computer laboratory with internet access during your physics lesson execution?
   With proper orientation learners can access the computer laboratory as much as they want which is a lot
10. What is your opinion on the statement that says "Learners cannot learn Physics with ICT on their own"?
    learners can learn Physics with ICT on their own with proper orientation.
11. What do suggest should be done by SA government so that all physics teacher can confidently make use of ICT tools in teaching/learning?
    Workshops must be carried out periodically to improve teachers ICT capacity

3

12. The PhET Learners can get access to free online software can be accessed for free online.

i) How often do you use it/ comfortable are you using it for teaching physics?

Most of the time am using ICT for teaching physics.

ii) Do you think its compatible with the South African CAPS syllabus?

The CAPS syllabus still need to do more to intergrate ICT in teaching

13. How often should workshops on interactive use of CS and videos in physics be held to enable SA to be at par with digital 21st century expectations?

Two times per term.

14. Do you think that interactive use of ICT resources can complement shortage of laboratory equipment in your school? Explain briefly

Yes as computer simulations can be used to substitute experiments if equipments are not available.

A QUESTIONNAIRE FOR PHYSICS TEACHERS ON INTERACTIVE USE OF ICT IN TEACHING AND LEARNING PHYSICS

Instructions: Please tick or fill in where necessary.

For the purpose of this questionnaire Information and Communication Technology (ICT) is defined as a range of technologies for gathering, storing, retrieving, processing, analyzing and transmitting information like computers, projectors and internet.

SECTION A: Background/Personal Information:

9. Name of teacher: __**Miss Z**
10. Gender:

MALE		FEMALE	X

11. Age group

20 – 25 YEARS	
25 – 30 YEARS	X
30 – 35 YEARS	
35 – 40 YEARS	
+ 40 YEARS	

4. QUALIFICATIONS

ACADEMIC	PROFESSIONAL	OTHER
Bsc degree	PGCE	

12. Teaching experience:

0 – 5 YEARS	X
6 – 10 YEARS	
+10 YEARS	

SUBJECT(S) TAUGHT	GRADE(S)
Physics	10
Physics	11
Physics	12

13. Name of school: __**G Secondary**
14. Type of School:

	RURAL	URBAN
MST SCHOOL	X	
NON-MST SCHOOL		

15. Circuit: ___**Mashishila**
16. District/Province: __**Mpumalanga**

Instructions: For section B, choose and use the codes given, by writing the code (e.g. 0, 1, 2, 3, 4 or 5) of your choice against the questions. The interpretation of codes is as follows:

Rating	0	1	2	3	4	5
Meaning	Not Sure	Strongly disagree	Disagree	Partially Agree	Agree	Strongly agree
Code	NS	SD	D	PA	A	SA

SECTION B: TEACHERS VIEWS ON INTERACTIVE USE CS AND VIDEOS WHEN TEACHING MAGNETISM							
	STATEMENT	Rating					
		NS	SD	D	D	PA	SA
		0	1	2	3	4	5
1	I do use ICT (computer simulations and videos) to teach even before this research.			X			

2	ICT usage captures learners' attention and increases their level of concentration in class					X	
3	ICT usage makes teaching Physics easier					X	
4	ICT usage should be integrated with traditional normal instructional methods in Physics (e.g in magnetism).					X	
5	Teachers should be work-shopped on how to use computer simulations videos for teaching physical sciences concepts (e.g magnetic domains & fields).						X
6	Use of a combination of both computer simulations & videos in physics makes it easier to visualize the reality of imaginary concepts (e.g. magnetic domains & magnetic field lines).						X
7	Our school has a WIFI and DSTV network and internet access which can potentially be used in physics classes for computer simulations and video learning via youtube & DVDs.						X
8	ICT usage helps in class control and management.					X	
9	Physics is easy, fun, interesting and exciting when taught using both computer simulations & videos.					X	
10	I think computer simulations, videos & DVDs are good learning tools when dealing with physics concepts (e.g magnetic domains).					X	
11	ICT usage makes teaching Physics easier and interesting.						X
12	ICT usage saves a lot of time used in drawing and labeling diagrams on chalk board.						X
13	ICT usage makes diagrams and graphical work clearer than drawing them on the chalk board.						X
14	Use of Computer simulations and videos in learning promotes high order thinking skills & enables students to realize their full potential in physics.					X	
15	Learners should be allowed to use their own smartphones or tablets via their school`s WIFI network (through closely monitored school `s gmail account) so as to download, watch and share physics simulations and videos.					X	
16	Most of our schools have ICT infrastructure and tools but lacks the know-how of integrating it into the curriculum as a teaching weapon.				X		

SECTION C: FACTORS THAT MAY INFLUENCE THE SUCCESSFUL INTEGRATION OF ICT IN TEACHING PHYSICS.

15. Whats your perception on the use ICT in teaching high school Physics? __ ___***it must be used in school as it can assist in teaching and learning and make physics to be more exiting to learners***
16. How do you use Computers for teaching your school are enough for all learners in my class?

_***computers are not enough for the whole class so I use a projector so that all learners cab be able to see***

17. Do you think learners can learn Physics with ICT on their own? Explain briefly.

___***yes. Today's generation is very fast and more interested in technology so learning could not be a problem***

18. Explain how the timetable of the school could be adjusted to accommodate the use of ICT in teaching Physics.
    ______***Some physics periods should be allocated more time***
19. What do you suggest to be done so as improve learner performance through interactive use of DSTV learning Channel, DVD video discs and youtube videos?
    ______***school subjects should be taught after school***

20. “Physics teachers should be ICT literate.” Whats your opinion?
    ___***I agree with the statement. They need to know how to use ICT before they can teach***
21. From the study do you think Learners got distracted by ICT when teaching Physics?
    __**no**
22. Explain the challenges that you encounter when accessing internet via WIFI in your school specifically for the direct benefit of the physics learners. ___***not yet done***

23. How often do you make use of the DSTV network as well as laboratory with internet access during your physics lesson execution?

    ___ _***not yet started***
24. What is your opinion on the statement that says “Learners cannot learn Physics with ICT on their own”?
    ____
    __***learners can learn on their own***
25. What do suggest should be done by SA government so that all physics teacher can confidently make use of ICT tools in teaching/learning? ***organize work shops for educators. Make the qualification for teaching to have an ICTcourse compulsory***

12 The PhET Learners can get access to free online software can be accessed for free online.

v) How often do you use it/ comfortable are you using it for teaching physics?
____***sometimes but not for teaching***

vi) Do you think its compatible with the South African CAPS syllabus?
____
__________***yes***_

13 How often should workshops on interactive use of CS and videos in physics be held to enable SA to be at par with digital 21st century expectations? _____***once per term***_____

14 Do you think that interactive use of ICT resources can complement shortage of laboratory equipment in your school? Explain briefly
____
_______***yes. In fact it will save time and chemicals and less dangerous.***