RESEARCH REPORT

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PROPOSED DEGREE: MASTER OF SCIENCE IN SCIENCE EDUCATION

PROGRAMME / DEPARTMENT: SCIENCE EDUCATION

RESEARCH TITLE: EVALUATION OF THE IMPACT OF A DVD CONTENT SERIES ON THE TEACHING AND LEARNING OF GRADE 11 CHEMICAL SYSTEMS CONCEPTS.

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FEBRUARY 2013

DECLARATION

I declare that this research report is my own unaided work and I submit it for a Master of Science in Science Education degree at the University of the Witwatersrand in Johannesburg. It has not been submitted before for any degree or examination in any other University, nor has it been prepared with the assistance of any other body or organization outside of the University of the Witwatersrand. On the next page, I have acknowledged all assistance received during the preparation of this research report.

Portia Mngenela

Signature: _____

ACKNOWLEDGEMENTS

I wish to thank the following people for all the support they gave me in all different ways while doing this research:

- Professor Ian Moll, my supervisor
- The Principal, Physical Science teacher, parents and the learners of the school that participated in this research.
- My master's class lecturers and fellow students
- My family

ABSTRACT

This case study supports the National Department of Education's (DoE) strategy of integrating information and communication technologies (ICTs) into the curriculum delivery in all South African schools to enhance teaching and learning.

It examined the influence of a Mindset's multimedia digital versatile disk (DVD) instruction of chemical systems core knowledge area, a section in the grade 11 Physical Science curriculum. The main emphasis was directed at examining the influence that the DVD material would have on learners' understanding of scientific processes and concepts in that particular section. Secondary to this objective, it looked at the attitudes and perceptions of learners and their teacher towards the classroom integration of the DVD material, also taking note of the challenges and benefits attributed to the integration itself.

This study was based on the distributive cognition framework which has its roots in the socio-cultural and situated learning theories. The framework suggests that the learning process of the scientific concepts by learners is situated in a social learning environment, where learning is mediated by technological tools and artifacts (Valanides & Angeli, 2008). Under this cognitive theory the learner is positioned at the centre of the learning environment that is formulated by other people (i.e. other learners, the teacher and the community), the learning material (i.e. the content) and learning resources (i.e. physical and technological tools).Learning therefore is regarded as a social process where other people and the learning resources actively interact (Hollan, Hutchkins & Kirsh, 2000). Through the DVD's visuals and explanations, the artificial mining environment was brought into the classroom enabling learners to be exposed to the scientific processes involved in the mining industry as a social real world activity which learners could associate with. That on its own could enhance the comprehension of content.

A quasi experimental design was adopted with two grade 11 Physical Science classes from the same school, one used as an experimental group and the other one as a control group. The study sample consisted of 56 learners, 24 in the control group and 32 in the experimental group. Both classes were taught the same content by the same teacher without using the DVD lessons for a period of three weeks. Thereafter, the experimental group was exposed to the multimedia-supported lessons for three more weeks (i.e. the teacher used the DVD lessons to supplement his traditional teaching methods) while during the same period the control group was taught the same content for the same duration using the traditional teaching methods only. The pre-test and post-test measures were administered on both groups using the same instruments in order to check if the difference in the teaching approach had a positive impact or not. In addition, the data was collected in the form of questionnaires and interviews for attitudes and perceptions about using the DVD material for teaching and learning. The null hypothesis tested was: "the mean result of the experimental group would be the same or lower than that of the control group". The t-test results showed that there was no statistical difference between the performances of the two groups hence upholding the null hypothesis. Descriptively, the results showed that learners regarded a multimedia-supported learning environment as an exciting one. They mentioned that it posed more benefits than challenges. The teacher also displayed positive attitude and perceptions about using the DVD material for teaching and learning as he indicated that it is a useful teaching tool.

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CHAPTER 1: INTRODUCTION

1.1. INTRODUCTION

South Africa (SA) as a developing country is under pressure to meet the standards set by the developed world. As a country that is gradually improving its democracy and economy, it is continuously fine-tuning its educational system. Hence the new curriculum was introduced, from the nated 550 there was outcomes-based education (OBE) in 1997 and then national curriculum statements (NCS) grades 10-12 in 2002. Lately, the NCS has been revised to develop the curriculum and assessment policy statements (CAPS) document (DoE, 2011) which is implemented in different phases between 2012 and 2014 as follows: 2012 – foundation phase and grade 10, 2013 – intermediate phase and grade 11 and in 2014 – senior phase and grade 12.

However the educational transformation has been accompanied by challenges ranging from poor Mathematics and Physical Science performance of SA learners in the TIMMS assessments in 1999 (Howie, 2001). In Physical Sciences, some teachers are battling to grasp the new content and to address all three learning outcomes and assessment standards outlined in the curriculum. When looking specifically at the grade 11 Physical Science curriculum, one finds that chemical systems section is the new core knowledge area that focuses on the chemistry of the lithosphere and atmosphere. It includes topics such as laboratory processes in mining, mining in SA, extraction of metals from ores, environmental impact of mining and minerals processing, energy resources, effect of the use of fossil fuels on the environment and the environmental impact of population growth. Most of this content was initially not part of the teachers' training curriculum. Teaching this core knowledge area addresses the third learning outcome of the Science curriculum that is to expose learners to the nature of Science and its relationship to technology, society and the environment, i.e. learning outcome 3 (DoE, 2003). However without the teachers' adequate pedagogic content knowledge (PCK) and learners' exposure to the practical processes of mining, it might be difficult for

learners to relate to the science content involved in this field. To overcome some of these challenges the DoE introduced interventions such as prioritizing subjects such as English, Mathematics, Physical Science and Accounting as critical subjects that need more attention. Then, it introduced the white paper on e-Education as a policy that encourages schools to use instructional technologies across the curriculum to improve the quality of teaching and learning. Responding to this policy demand, the Gauteng Department of Education (GDE) is currently rolling out Gauteng on Line (GoL) computer laboratories to its public schools. However my observation as an ICT coordinator in one of the Gauteng Districts, also supported by the research literature and the press is that, schools which have GoL labs are still struggling to optimise the usage of the labs. One of the reasons is that the system that runs the GoL computers is unreliable, i.e. computers do not work at all or they work without internet at times. Also, there is no dedicated technician that is deployed in each school to attend to the technical problems. This discourages teachers to integrate computers into their lessons as they end up having to readapt their lessons when the computers are dysfunctional. This then calls for other alternative instructional technologies that are relatively affordable, accessible and reliable such as a multimedia DVD content series to be employed to address some of these challenges. Therefore the purpose of this research was to:

- Evaluate the impact of a grade 11 Mindset's multimedia DVD Science content series as an ICT tool for teaching and learning Science concepts.
- Identify those aspects of the DVD material that were perceived as supportive or not supportive to the learners and their teacher.

The study was only concerned about the teaching and learning of the new chemical systems concepts in the grade 11 Physical Science curriculum that were brought by the NCS (DoE, 2003). Jennings, Epp and Weaver (2007) successfully used a multimedia DVD for teaching Physical Chemistry where learners showed significant learning gains and positive attitudes to further their studies in that field.

1.2. DEFINITION OF CONCEPTS

Familiar concepts were used in this study; however it is important to explain their meaning in the context of this particular study.

ICTs – According to the white paper on e-Education (DoE, 2004), ICTs are a combination of hardware, software and means of communication that brings people together and that enable the processing, management and exchange of data, information and knowledge in order to expand human capabilities. For this particular research they refer only to the instructional technologies, in the form of multimedia DVD lessons, which were used to support teaching and learning of scientific concepts.

Multimedia – A technology based communication combining text, graphics, audio or moving video images. The communication maybe in real time or it may involve storing multimedia messages, files or programmes on disc or tape for later retrieval (Butcher and Perold, 1996, p. 7). A Mindset's DVD based content that combined text, graphics, audio and moving video images was used as a multimedia in this study.

DVD – Bialobrzeska and Cohen (2005) define a DVD as a data storage medium, optical disk capable of storing high quality video as well as data such as programs, text, still images and sound, including entire movie films (also known as "digital video disk"). The Mindset's DVD lessons were used in this research to teach the experimental group.

e-Learning - flexible learning using ICT resources, tools and applications……may involve Internet, CD-ROM, software, other media and telecommunications (DoE, 2004, p. 15). In this study e-Learning referred to the integration of the DVD lessons, as a technology resource, into the teacher's instruction.

1.3. RATIONALE / CONTEXT OF THE STUDY

This study approached its subject from two particular points of view. **Firstly**, it was concerned with the changing school curriculum in SA post-apartheid, and in particular with the new imperatives and ideas that have influenced Science education in this period. **Secondly**, it was concerned with an increasing emphasis on the use of ICTs in the classroom posed by the department of education. These two areas came together in a set of questions about the ways in which ICTs could be used to improve the quality and output of Physical Science learning in schools.

South African schools are currently implementing new curriculum i.e. (NCS, 2002) in grade 11, which is composed of carefully selected Physical Science concepts. However, the concern is that this new curriculum may pose challenges to those Science teachers who are not familiar with the new content due to reasons such as: they were never exposed to it at school or tertiary institutions or they last engaged with it at tertiary institutions, or they never had a chance to teach it. This is in accordance with Shulman (1987) who contends that teachers gain their PCK through their understanding of the content, their teaching experience and their own school experience. The most concern is that the lack of PCK can make it difficult for our teachers to deliver quality education to the learners.

With regards to the changed curriculum: There has been a general outcry about the deteriorating academic performance of South African learners over the years of the post-apartheid period especially in subjects like Mathematics, Physical Science and English (Howie, (2001); DoE (1999) and Arnott et al., (1997). Also in 2007, the grade 11 learners in SA wrote their first national examination under the new curriculum, i.e. NCS, and in my school the Physical Science group performed poorly. The analysis of results done by the Natural Sciences head of department of the school indicated that the performance was generally poor, but it was worse on the new topics such as the ones that fall under the theme of chemical systems. Those topics included the following: exploiting the lithosphere, mining processes, the environmental impact of these processes and the energy

resources. All of these topics were new in the grade 11 Physical Science curriculum.

Also in 2008 there was a drastic drop in the pass averages of the first grade 12 NCS examination results. The CAPS grades 10-12 Physical Sciences document (DoE, 2011) suggests that the ongoing NCS implementation challenges led to another curriculum review in 2009 where the RNCS grades R-9 and NCS grade 10-12 were then amended into a single document called NCS grades R-12. The NCS grades R-12 provides a policy statement for learning and teaching in South African schools through its CAPS document which only came to use in January 2012 for the foundation phase and grade 10 only. The CAPS document provides clear, restructured and practically arranged content topics for each subject and grade.

In 2009 while still implementing the NCS, the grade 12 results still did not improve and one of the worst failed subjects was Physical Science. Even in the past, Physical Science was classified as a critical subject that needed serious intervention to improve its output (DoE, 2000). Since almost all Science teachers struggled with the new content, it was impossible for them to develop one another, either internally within a school or across the neighbouring schools. Also subject workshops that were organised by the district's subject facilitators were not enough to support teachers on daily basis. So, they could not develop teachers to the required competency levels. Teachers frequently relied only on the available textbooks as sources of reference especially in the under-resourced township schools where there are limited resources for teaching. It follows that teachers could appreciate additional resources such as ICTs that could not only assist them to understand the content and to examine the teaching approach which could be used to teach it, but that could also assist learners to comprehend the content that they are lacking.

With respect to the use of ICTs in Education: The DoE encourages the integration of ICTs into the curriculum delivery i.e. e-Learning (DoE, 2004). The DoE introduced a white paper on e-Education as a guideline document for the implementation of e-Learning in all South African public schools.

According to the white paper,

"*Every learner in the GET and FET band should be ICT capable by 2013*" (DoE, 2004).

This implies that every school should use ICTs i.e. technology, to enhance teaching and learning. Hence, a wide range of ICTs both hardware and software was identified for educational use. The most common and valuable ICT mentioned in the white paper is the use of computers (accompanied by an appropriate educational software) in education. The white paper claims that computers are capable of opening doors to knowledge sharing throughout the world. However the GDE's e-Learning Strategy (DoE, 2009) states that although schools in Gauteng have on average a better ICT infrastructure than some other provinces, a high number of schools still do not have adequate ICT infrastructure especially in the rural areas. Also, the Schools' Register of Needs Survey (2001) indicates that over 70% of schools in SA still lack computers. Responding to the educational mandate that is stated in the white paper, the GDE introduced the GoL computer laboratories as an infrastructure for implementing e-Learning in all Gauteng public schools. However schools are still facing problems when using the GoL computer laboratories for teaching and learning. As I visit schools to offer support to teachers on e-Learning implementation, I identified the following problems:

- Insufficient number of computers in the laboratory (for instance GoL lab provides 24 computers to be used by 40+ learners)
- Non-functionality of the GoL laboratories (problems with internet connectivity)
- Poor response period of the call centre system to attend to the reported faults and queries
- lack of readily available technical support

- Inability to install additional educational software in the GoL computers and in some cases lack of necessary ICT skills amongst teachers.

These challenges and many others discourage the integration of GoL resources into everyday teaching. From the challenges stated above it shows that as a developing country some obstacles still need to be removed before computers can be fully integrated into the curriculum delivery. For instance we need to acknowledge that schools do not have similar ICT maturity levels due to the wide digital gaps that exist across the schools nationally. It is therefore the prerogative of the school to explore a wide range of instructional technologies and choose those that will be accessible, suitable and relevant to meet their educational needs. For an example, because the school that participated in my study did not have any computers which could be used for teaching and learning, the multimedia DVD lessons were used as a form of an instructional technology.

This study was important in South Africa at the time because it focused on linking the two educational initiatives, i.e. the implementation of the new Physical Science curriculum and the integration of ICTs into the teaching and learning of Physical Science. The study examined how ICTs could be used to address challenges posed by the new Physical Science curriculum.

The study was also important in the entire Science education sphere as it intended to contribute to the literature that explores ways of improving Science instruction around the world. Hence it explored the impact that could be brought by the use of multimedia DVD lessons on the learners' understanding of scientific concepts while also assessing the attitudes and perceptions of learners and teachers about using the DVD lessons for teaching and learning. It also sought to take note of the nature of challenges and benefits that were experienced when using the DVD material as a teaching tool.

1.4. THE AIM OF THE STUDY

The aim of this study was to evaluate the impact of a grade 11 Mindset's multimedia DVD Science content series as an ICT tool for teaching Science concepts. To investigate if the DVD material could support the teacher's teaching process and learners' learning process of scientific concepts. To identify those aspects of the DVD material that was perceived as supportive or not supportive by learners and their teacher.

1.5. RESEARCH QUESTIONS

- What influence does a Mindset multimedia DVD Science content series have on learners' understanding of some grade 11 chemical systems concepts?
- What are the attitudes and perceptions of the grade 11 Physical Science learners with regards to the nature of challenges and benefits experienced when using the DVD material to learn chemical systems topic?
- What are the grade 11 Physical Science teacher's attitude and perceptions about using the DVD material for teaching?

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

The literature that is reviewed in this chapter relates to the current South African education policy that specifies the expected learning goals in the Further Education and Training (FET) band i.e. grades 10 to 12, Physical Science syllabus. From the policies of the education department we get the South African government's expectations regarding the role of instructional technologies in the curriculum delivery in general. Since the effectiveness of a multimedia DVD, as a form of an instructional technology for teaching Physical Science was evaluated in this study, this chapter also examines the literature that supports the use of ICTs in the education fraternity as a whole but also specifically in the teaching of Physical Sciences. A brief description of the nature of the DVD lessons that were used as an intervention in this study is also given. The explanation covers the aims of the DVD lessons and their intended instructional principles as set out by the designer, their multimedia nature, the DVD lessons themselves and the equipment that was used to deliver the DVD lessons. Finally a brief description of a theoretical framework that guided this study as a lens used to interpret results is also given.

2.2. EDUCATION AND TECHNOLOGY

From **the policies that guide curriculum delivery** in SA, I reviewed the contents of the white paper on e-Education, which is a guiding document for the introduction and management of e-Learning in South African schools. According to the white paper (DoE, 2004); ICT resources should be integrated into teaching in order to enhance the learning process. The white paper claims that ICTs are capable of enriching the learning environment (DoE, 2004). Enriching the learning environment within the context of OBE involves learning with ICTs (to supplement normal processes and resources) and learning through ICTs (to support new ways of teaching and learning). The white paper states that, the use of ICTs in teaching and learning encourages:

- Learner-centered learning.
- Inquiry based learning.
- Collaborative work among learners & teachers.
- Creativity and analytical skills.
- Understanding and knowledge retention (DoE, 2004, p. 19).

The white paper claims that technology-supported education is capable of allowing learners and teachers to interact in various ways with the content to enhance learning. Hence this study aimed to create opportunities for such interactions that would hopefully improve the quality of teaching and learning Science through the use of a multimedia DVD content as an instructional technology. The choice of the DVD content series above all other ICTs was informed by its availability at the school that participated in this study. The whole instructional set was donated to the school by the designers as part of their social responsibility. The school did not have a computer laboratory that could be used for teaching and learning. Another reason was that the content in the DVD was NCS compliant since this resource is a South African product.

For the purpose of this study, I define the term multimedia-supported learning in the similar way as Mayer (2003) did i.e. as a learning process where learners obtain information or instructional messages in **two** formats, i.e. as words (spoken or printed) and as pictures (illustrations, maps, charts photos, contextualized scenery, animations and video). This study was carried out under a non-interactive multi-modal environment wherein the instruction was presented (by the teacher or the DVD tutor) in a pre-determined way, not allowing learners the freedom of controlling, manipulating, searching or navigating through the DVD's contents during the learning period. However, learners were still allowed to ask questions, discuss and answer questions as they would in a traditional teaching environment.

Since my research problem emanated from the curriculum changes that SA experiences, I reviewed the Science curriculum policy document as well.

According to the NCS document, grades 10-12, pg viii overview, Science curriculum needs to ensure that learners acquire and apply knowledge and skills in ways that are meaningful to their own lives (DoE, 2003). The purpose of Science curriculum as stated in the NCS document, amongst others, is to apply scientific knowledge to worldwide issues and events i.e. economic, environmental, ethical, social and technological, (p. 54). The South African Physical Science curriculum has three learning outcomes which promote "learner-centered teaching strategies", i.e. practical scientific inquiry and problem-solving skills, constructing and applying scientific knowledge and the nature of Science and its relationships to technology, society and environment (DoE, 2003, p. 54-55). The choice of my research content (i.e. chemical systems), was informed by these learning outcomes especially the last one that acknowledges the relationship between science and technology, society and environment. It should be noted that this study was solely guided by the NCS grades 10-12 Physical Sciences principles because it was the policy that was in place by the time this study was conducted in 2009. In other words, the NCS grades R-12 and the CAPS were still being developed only to be implemented in 2012. During the study learners were supposed to solve problems, construct and apply scientific knowledge associated with this relationship in order to achieve the learning outcome. All this was supposed to be done under the facilitation of a teacher.

To scaffold learning, the teacher could guide learners using his lesson plans. The lesson plans were meant to highlight problem solving tasks or practical scientific investigations that would be done by learners in class as well as the ways that the teacher intended to assist learners to master tasks or concepts that they would otherwise be unable to grasp independently, i.e. a step by step scaffolding plan. Scaffolding is defined by Benson (1997) as a bridge used to build upon what learners already know to arrive at something they do not know. When properly administered scaffolding acts as an enabler of meaningful learning (Benson, 1997). Some of the benefits of scaffolding as mentioned in Lipcomb, Swanson and West, (n.d.) are:

- It engages the learner.
- It creates momentum – through the structure provided by scaffolding, learners spend less time searching and more time on learning and discovering, resulting in quicker learning.
- It gives greater assurance of the learner acquiring the desired skills, knowledge or ability.

The multimedia DVD content also meant to assist teachers to deal with the third learning outcome as it is not always easy to explicitly explain and teach natural and artificial processes associated with this learning outcome.

2.3. SUPPORT FOR MULTIMEDIA-BASED LEARNING

Educational researchers across the Globe in their attempt to improve Mathematics and Physical Science instruction, continuously investigate the impact of technology supported teaching on learners' understanding of Mathematical and Physical Science concepts. Over the years the focus of these studies has shifted from venturing into the benefits of small, simple and affordable technological resources into computer-based teaching with special reference to simulations and World Wide Web. However in general, multimedia-supported learning has been recommended as a means of: fostering meaningful collaborative learning, increasing learners' content knowledge, improving learners' academic performance and improving learners' and teachers' attitudes towards Science by different authors including the following:

- In SA, computer assisted learning (CAL) of Mathematics and Physical Science involving the grade 12 learners was examined by Hartley, et al., (2007). The findings of their study revealed that learners considered the application of CAL as a positive step to improve their learning while they also believed that their teacher still had to play a vital role in mediating the content in order for them to do well in their end of the year examinations. In the light of these findings, in my study, the DVD content was

incorporated into the teacher's lessons to allow learners to experience all the affordances that could be brought by the teacher's mediation of the DVD content. **Nieuwoudt et al., (2007**) investigated the influence of a video class system (VCS) on the grade 9 learners' study and learning strategies as well as achievement in Mathematics. Their study results showed no change on the achievement scores but rather improved learning and study strategies after being exposed to the VCS.

- In Botswana, **Thomas and Emereole (2002**) investigated if learners who were taught Physics using both computer-based instruction (CBI) and traditional instruction (TI) methods (i.e. the experimental group) would perform better than those taught with only the TI method (i.e. the control group). The experimental group was taught in the same way as the control group but in addition they engaged with the CBI material on their own in the afternoons. Their study findings revealed that learners who were exposed to the CBI lessons performed better that those who were not.
- In Kenya, **Wekesa et al., (2006)** assessed the effects of CBI on the learners' understanding of cell theory in Life Sciences. In their study the experimental group received their lessons from purely CBI simulation programme while the control group received theirs through regular conventional teaching without the use of CBI material. Also, in their study the experimental group performed significantly better than the control group.
- **Tao (2000)** conducted a study aiming at investigating how learners acquire knowledge and understanding when exposed to multimedia lessons. This was done by exposing learners to a computer-supported collaborative learning environment. The aim was to assist learners to develop an understanding of image formation by lenses. The data collected from this study indicated that learners gained more understanding of concepts. My study anticipated that problem solving tasks and enquiry based learning facilitated by the teacher during a

multimedia-supported lesson would promote collaboration, metacognition and understanding of the concepts of chemical systems.

- **In Dyer (2005)**, students' attitudes and content knowledge was investigated when a multimedia DVD was used to learn the concepts of Physical Chemistry. Dyer found that students' content knowledge increased after having been exposed to the DVD content, and that the majority of students had positive attitudes about the usefulness of the DVD for their learning. They showed excitement about using similar technology to learn other topics. My study is directly related to that of Dyer in terms of investigating students' attitudes and content knowledge when a multimedia DVD is used as an instructional technology tool. However in the Dyer study, students used the DVD individually outside the classroom setting for study or revision purposes, whereas in my study the DVD was used strictly for teaching purposes in class based on the teacher's way of integrating it into his normal teaching.
- **Jennings, Epp and Weaver (2007),** in their study about the use of a multimedia DVD for Physical Chemistry, found that students showed statistically significant learning gains after using the DVD and showed an increase in their recognition of the application of Physical Chemistry to solve real life problems. Students also showed an increased interest in further studies of Physical Chemistry (p. 308). However their study looked at the DVD as a replacement for a laboratory activity, whereas mine was looking at the use of a multimedia DVD to support normal teaching and learning (i.e. to support traditional teaching). Also in their study, learners had individual access to the DVD material so they could access any part of the material in any order that they chose (p. 313). They could watch videos as often as they liked, and could scan through them using the slider bar. The access to the resources was only during the laboratory period. Similarly, in my study I aimed to establish if there would be any learning gains while the access was also strictly during teaching time only. In my

study, there was no individual student access; instead there was class access through the teacher's mediation methods.

There is research literature that suggests that ICTs can also be used to empower teachers with advanced content knowledge and teaching methods. For an example in a study conducted by **Anneta and Matus (2003)**, the role of technology in mediating teacher's professional development was acknowledged. They reported that technology enhances the access of new information and teaching strategies. Through my study, I also hoped that the DVD's content and illustrations would increase the content knowledge (CK) and the PCK of the teacher. This is especially because I believed that many of our Physical Science teachers still need continuous support to master the new content as well as ways of mediating it for the learners.

2.4. THE DVD CONTENT SERIES

It comprised of different media through which instruction was delivered. The DVD package consisted of DVD lessons accompanied by the teacher's guide and learners' notes. The general aims of the Mindset's Learn programme as stated in the Mindset Consolidation Analysis of Research Book (Greenop, 2008, p. 15) are:

- To provide high quality multimedia resources using a wide range of delivery strategies to support teaching and learning in under-resourced communities.
- To be the lead agency in the provision of multimedia educational resources, contributing to systemic change in secondary schooling.
- To provide high quality comprehensive curriculum aligned multimedia content for teachers and learners from previously disadvantaged communities in the FET band subjects or learning areas.

Specifically, the instructional principles that the Mindset's multimedia lithosphere DVD content seeks to scaffold (as stated in the Mindset's learn teacher's guide grade 11 lithosphere DVD) are:

- Taking learners beyond the classroom by visiting different mining sites and engaging with mining professionals while witnessing real mining processes, demonstrations and reactions taking place. This was meant to enhance learners' positive attitudes and interest to learn Science. It was also meant to enhance learners' understanding of scientific concepts and processes within the relevant context created by the DVD.
- Allowing learners to optimally engage with the content throughout the lesson. That could be done by asking learners to answer questions that were posed in the DVD through group discussions and post-lesson assessment activities.
- Challenging learners to develop various skills through different assessment methods that demand learners to analyse data and apply scientific knowledge to real life situations.

The DVD contained 6 NCS compliant lithosphere lessons (consisting of multimedia materials such as colourful graphics, video clips, science models and demonstration, mining scenery, experts' interviews, examples taken from everyday life). Each lesson lasted for twenty minutes on average and was accompanied by the learning outcomes and assessment standards which were highlighted at the beginning. The DVD could also be used in any standard DVD player or in a computer that has a DVD player feature. This could allow learners to revisit the concepts discussed in class to reinforce learning.

The equipment used to present the DVD lessons comprised of a server that was connected to the receiver (decoder) and then connected to a television for mass teaching. The equipment had a pause feature to allow time for the teacher's explanations, instructions to learners, learners' discussions as well as time to ask or answer questions. When the equipment was donated to the school, teachers had undergone two days of training on how to use it before using the DVD material.

Thereafter the DVD designers were supposed to visit the school twice a week to provide technical and pedagogical support to the teachers.

2.5. THEORETICAL FRAMEWORK

This study was based on the Distributed Cognition Framework that is rooted in both situated and socio-cultural learning theories. The framework suggests that learning of scientific concepts by learners is situated in a social learning environment, where learning is mediated by technological tools and artifacts (Valanides & Angeli, 2008). According to the socio-cultural learning theories, all human actions are based on cultural and social contexts (Armstrong et al., 2005). For instance, when a teacher works with learners in a classroom, it is understood that they all bring diverse history of experience that is related to the work done during the lesson. It follows that their teaching and learning thereof will be influenced by the local, national and global factors. Equally important is the fact that through the use of tools such as a pen, paper, textbooks, DVDs, computers e.t.c. and semiotic systems such as language, graphs and diagrams, learning is mediated whereby learners are supported and coached to comprehend new information and complete tasks that would otherwise be difficult when working alone (Armstrong et al., 2005; McMahon, 1997; Hall & Robinson, 2007). This is referred as the scaffolding process whereby learners' level of understanding is extended from a level of what they know towards a level of what they need to know. On the other hand the situated learning approach argues that learning should bridge the gap between the formal classroom theoretical work and the application of the knowledge in the real life environment (McMahon, 1997; Herrington & Oliver, 1995). This means that learning occurs best when embedded upon relevant cultural contexts. For instance educational technology such as multimedia DVD lessons can create situated learning environments where learners are exposed to Science concepts and processes in ways that display how they are used in real life. In other words through the DVD material learners can experience the real Science activity. Situated cognitive theorists refer to this as the enculturation of learners into authentic practices done by scientists in the field.

Under the distributed cognitive theory, the learner is positioned at the centre of the learning environment that is constituted by other people (i.e. other learners, teacher and the community), learning material (i.e. the content) and learning resources (i.e. physical and technological tools). Therefore meaningful learning is not an individual process, it occurs when there is an active interaction between the above elements (Hollan, Hutchkins & Kirsh, 2000). That makes learning to be a social process where other people and learning resources interact as a cognitive system. Hollan, et al., (2000, p.176) goes further to explain the distribution of cognitive process in three ways i.e.

- Cognitive process may be distributed across the members of societal group.
- May involve coordination between internal and external structure.
- May be distributed through time in such a way that the products of earlier events can transform the nature of other events.

My study acknowledged that, in the classroom learners together with their teacher would work together to understand the mining process as a scientific process. During the Science lesson there would be active participation of all members. This participation would come in different forms such as the ways in which the teacher and learners would interact with the multimedia DVD material while solving problems, conducting investigations or working on scientific projects. All those interactions would then contribute to how the cognition or learning occurs among the individual learners. This implies that learners' thinking processes would be influenced or even be shaped by what was said by the teacher and by other learners as individual learners participated on enquiry based tasks. Through their interaction with the DVD material, learners could see and learn about scientific processes involved in the mining industry as a social real world activity which they could associate with since some of their friends and relatives are involved in the mining industry. Their cognition could then be distributed across people, content and tools since it would be shaped by the information gathered from all those sources.

The DVD material that was used in my study demonstrated the scientific processes that take place during the mining process. These processes included the extraction of gold from its ore i.e. cynadisation, mining of iron and phosphates, demonstrating the chemical reactions that are involved in each of the processes. The demonstrations were explained by the mining experts within an artificial mining scenery or environment (from the DVD's video clip). Through the DVD's narrative and graphics representations, artificial mining environment was created in the classroom to promote learning. Also, the teacher could guide learners through the learning process by specifically arranging the content in a certain sequence, He or she could decide how the lesson would be introduced, what kind of questions would be asked for class or group discussions and when would they be asked, when and how would the DVD content be used to explain concepts or scientific processes, what kind of learner difficulties could be anticipated, what learner activity would take place, etc. According to Laurillard, (1993), academic knowledge relies on the symbolic representations as well as the media used to teach. My opinion is that through these learning materials, learners would be able to perceive and conceptualise the unfamiliar mining world.

Finally this study considered culture as an important factor that could shape the learning process. For instance it was noted that just by using the teacher's knowledge of the subject matter of mining together with textbooks, charts and other manual teaching aids, learners might experience a heavy cognitive load when trying to imagine the real mining world, hence conceptualization might be constrained. Hence the integration of the DVD with its combined effects of visualisation and verbal information (written and spoken) was done to enhance learners' understanding (Chan & van Aalst, 2008). I believed that the DVD material would provide the context of the mining activity through its mining scenery, the history and the culture of how mining originated, how it was done in the past and how it is done now. That in turn would provide learners with enough background information about mining. That could enable them to learn, solve problems, analyse mining as a human activity and suggest new mining initiatives

(Chan & van Aalst, 2008). In other words the DVD material in its entirety was responsible for providing the direct world experience while the teacher's teaching strategies and methods were responsible for addressing the indirect world experiences by explaining the nature of Science and its relationships to the technology, society and environment. For instance through visual representations of the DVD material that displayed the positive and negative aspects of mining, learners were exposed to the impact of mining as a human activity, enabling them to evaluate the impact of humans to the environment in order to satisfy the third science learning outcome. Therefore the teacher's role in this research was to mediate the learning process by using the available multimedia DVD lessons as an instructional tool.

CHAPTER 3: RESEARCH DESIGN

A quasi experimental research design was employed in this study.

3.1. DEFINING A QUASI EXPERIMENTAL DESIGN

Opie (2004, p. 91) defines a quasi experimental design as a research design that does not allow randomisation of control and experiment groups in order to minimize the effects of the differences on the variables that are looked at by the researcher. In other words this design does not follow all the stages of a true experimental design. Below follows an explanation of how a quasi experimental design was set up in this study in relation to the stages stated by Opie (2004, p. 91 – 92).

Stage 1: An analysis of the theory related to the research:

Here the researcher should select the dependent and independent variables which will be considered in the research (Opie, 2004).

Dependent and independent variables

This study aimed at evaluating the influence of a multimedia DVD, as a teaching tool, on learners' understanding of some chemical systems concepts by answering the following research questions:

1. What influence does a Mindset's multimedia DVD Science content series have on learners' understanding of some of the grade 11 chemical systems concepts?
2. What are the attitudes and perceptions of the grade 11 Physical Science learners with regards to the nature of challenges and benefits experienced when using the DVD material to learn chemical systems theme?
3. What are the grade 11 Physical Science teacher's attitudes and perceptions about using the DVD material for teaching?

For this study, the teaching method used which is the use of a Physical Science multimedia DVD was an independent variable because it was tested as to whether it would affect other variables or not. The main dependent variable then was the learners' achievement scores in the pre- and post-tests. Values and attitudes of the experimental group after the intervention was administered as well as those of the teacher were regarded as the secondary dependent variables. This then covers all three research questions as highlighted above.

Stage 2: Formulation of hypothesis and setting an appropriate level at which to test it:

A hypothesis should be set based on the predicted relationship between the dependent and independent variables. An example would be what effect will an independent variable have on the dependent variable? Therefore the so called "null hypothesis" such as that "the independent variable will have no effect on the dependent variable" is being tested. Also at this stage a level of significance should be set. Level of significance refers to the number of times a result might have occurred by chance i.e. not as a result of an independent variable. In most researches a "p" value of 0.05 is usually used which means that only 5 times out of 100 is a result likely to have occurred by chance. This implies that if the obtained "p" value is less than 0.05 then the null hypothesis is false i.e. the independent variable actually has an effect on the independent variables (Opie, 2004).

Hypothesis and level of significance "p"

The null hypothesis of this study was that "the mean result of the experimental group would be the same or lower than that of the control group". The actual prediction of this hypothesis was that the experimental group's mean result would be higher or equal to that of the control group. A two-tailed t-test was used as a statistical test and was set at a "p" level of 0.05 which is 95% confidence level. The choice of a statistical test for this study was informed by the fact that t-tests can show whether the difference between the mean of the two samples were

statistically significant or not and also the fact that for this test it is not a pre-requisite for the two groups to have the equal number of respondents as it was the case in my study (Opie, 2004).

Stage 3: Taking account of the research population and drawing a sample from it:

This defines the type of people that the researcher is interested to work with (Opie, 2004).

Research Population and Participants

This study was conducted with two classes from one secondary school in the Gauteng Province of South Africa. The school was located in a lower socio-economic environment and therefore was under-resourced. The school was fortunate to be selected for a Mindset's pilot project. Under the project the school received a Mindset's multimedia DVD content series and equipment for teaching Mathematics and Physical Science. That particular school was selected to participate in this research because it was the only Mindset's pilot project school in the Johannesburg East district which is my work locality. The target group was the grade 11 Physical Science learners. The study was conducted during the second and third terms of 2009. Participating learners from the two classes were of mixed gender and ethnical groups from the same neighbourhood. They matched in certain aspects including age, gender and socio-economic background. The study was conducted with 56 learners in total, 24 learners from one class (control group) and 32 learners from the other class (experimental group). These classes were taught by the same teacher. The study was planned to be conducted during the Physical Science periods according to the teacher's lesson plans.

Stage 4: Piloting your experimental procedures:

This stage emphasises the importance of testing the research instrument to a different sample in order to reduce ambiguity and improve the validity of the research tools (Opie, 2004).

In this study, pre-tests were piloted with the learners of the same grade from the neighbouring school and then edited to correct vague questions.

Stage 5: Assigning subjects to an experimental or control group:

In a true experiment the researcher draws a research sample from the entire research population and through the process of randomisation assigns respondents to either experimental or control group. This is done to ascertain that capabilities and skills of respondents in the two groups are the same before the intervention is administered (Opie, 2004).

For the selection purposes, all grade 11 Physical Science teachers from the participating school were invited to an information session where the purpose of the research was explained and interested teachers were asked to participate. One teacher who was teaching two grade 11 Physical science classes volunteered to participate.

From the information session, the teacher assigned one of his classes as the experimental group and the other one as the control group. Random selection of subjects was not done in order to avoid disturbing the classroom settings, so both classes were taken as they were which meant that every learner in the class was a subject. Although randomisation was not done, through the administration of the pre-test in both groups, the researcher was able to establish the academic ability of each group prior to the use of the DVD-supported lessons.

Stage 6: Carrying out the treatment on the experimental group:

Here the experimental group should be exposed to the intervention while the control group is not. There is no ideal prescribed length for experimental work, it is important though that the researcher should discuss any limitations of the experimental work she or he performed (Opie, 2004).

Teaching method before and during the implementation of the intervention

Both classes were taught separately in their classes by the same teacher. The whole section was taught during regular Science periods over a period of three weeks (24 periods) in each class. The teacher used his lesson plans accompanied by the appropriate teaching aids i.e. textbooks to teach both classes. The questions and learning tasks that were given to both classes were similar. Learners used class notes and textbooks as learning resources to supplement the learning process. After the whole section was taught in both classes, a pre-test was administered on both classes. The pre-test was compiled by the researcher and questions were taken from the 2007 national examinations (DoE, 2007) and from the grade 11 textbook (Brookes, Alant, Gibbon & Patrick, 2005). Learners were informed that the test was not for assessment purposes and that they should answer as much as they could and if they were not certain about an answer they should write "*I do not know*" instead of leaving a blank space. Test scripts were marked by the teacher and the researcher and results were tallied. Scripts were kept by the teacher and were never returned back to the learners.

Implementation of the intervention

After the pre-test, both groups were taught again for three weeks, the control group undergoing the same lessons as before during their regular Physical Science periods and only the experimental group was taught using a Mindset's multimedia DVD material. However, the multimedia-supported lessons for the experimental group could not be carried out during the regular Physical Science periods as it was initially planned. This was because the Mindset's equipment for presenting the DVD lessons was not installed in the experimental group's classroom. It was installed in a class used by the Social Science learners as it was the only class that was big enough for their class number. The research design was altered to cater for that unplanned situation. Therefore the experimental group's lessons were conducted after school for an hour every day for three weeks.

The DVD material was integrated into the teacher's lesson plans, ensuring that concepts were explained clearly by the use of the DVD's multi-representation. The DVD also had an ability to demonstrate processes which are usually carried out in specialized facilities (e.g. mining) which were not always accessible to learners. Learners' tasks were given from the DVD and from other resources (textbooks) as chosen by the teacher. The participating teacher was at liberty to decide on how to integrate the DVD into his lessons i.e. he viewed the DVD while preparing for his lessons and decided on the aspects of it that would best demonstrate or explain any of the concepts and processes that needed to be taught. He was also at liberty to use the pause button to stop the DVD for a while at anytime to explain concepts and to include other information or even to facilitate group or class discussions or give time for learners to ask questions or complete class activities.

The post-test that was similar to the pre-test was written by both classes soon after the content was taught. Marking of test scripts was done by the teacher and the researcher. Results of the post-test for each class were tallied (Refer to Table 4).

Stage 7: Comparing the performance of the two groups and testing for a causal relationship:

The researcher at this stage should compare the mean results of the two groups and use inferential statistics to decide if the difference between the mean results occurred by chance or is caused by the intervention (Opie, 2004).

Comparing the experimental and control groups and testing for a causal relationship:

Firstly, a t-test was used as a parametric statistical technique to compare the mean scores of the two groups between pre-test and post-test and also within each group from pre-test to post-test. This was done in order to check whether the performance of the two groups was significantly different or not. Both descriptive and inferential statistics were used. Secondly, the shift in the understanding of

scientific concepts was measured by the changes in the individual learner's open responses between pre-test and post-test. Individual learner's responses for the pre-test as well as post-test were scored using the scoring scheme (Refer to Table 1) to get pairs of scores for each learner per question. The scoring scheme had five scoring categories i.e. from a level of no understanding i.e. score of 1 on the scoring scheme, to a level of understanding i.e. score of 5 on the scoring scheme. The pairs of scores were worked out for only those learners who wrote both tests. Scores of all learners that wrote only one test were eliminated from the data because pairs were needed. Then the class average scores for each test per question were worked out as pairs for the 11 test items. Finally a Wilcoxon matched pairs signed rank test was performed using the class average pairs of scores obtained from the scoring scheme to determine if the changes in the responses were statistically significant or not.

3.2. A CRITIQUE OF THE RESEARCH DESIGN

The strong aspect of the research design employed in this study was that both groups were taught the same scientific content using the same teaching method (i.e. traditional way of teaching) and teaching aids by the same teacher and thereafter wrote the same pre-test. As a result the researcher was able to establish the academic ability of each group prior to the experimental intervention, so that any changes in the academic ability of the experimental group after the application of the intervention would be attributed to the intervention itself. This was necessary to ensure reliability since randomisation was not done when the groups were selected.

However there were also two problematic aspects of the design:

Firstly, there was a likelihood of a spill-over effect from the experimental group to the control group. This means that the experimental group could "in principle" share their experiences about the multimedia-supported lessons with the control group. That could happen because learners from both groups were accommodated

in the same school, had similar break times and shared the same space such as playgrounds.

The assumption was that learners from the experimental group could get excited about the technology used in their multimedia supported lessons since the research literature indicates that learners of today are generally more excited by and are interested in technology (Howe & Strauss, 2000; 2003) because they were born into a rich technology culture. It is said that they grow up being immersed in technology as ICTs form an integral part of their lives. Some authors call these learners "digital natives" or "digital generation" (Shelly, Gunter & Gunter, 2010). So out of their excitement it would feel natural for learners to discuss the technology that was used in their multimedia-supported lessons. However, the challenge is that although learners are usually excited about the technology, that excitement does not always translate into positive attitudes to learn Science (or any academic subject) or into better understanding of scientific content. For instance Kennedy, Krause, Judd, Churchward and Gray (2006) highlight that much as students possess some core technological skills; they still cannot use the technology-based tools to optimise their learning experiences and outcomes. This suggests that in technology-supported teaching environments; it is still the responsibility of a teacher to lure learners to the content while their attention is captured by the technology. Yaman, (2009) and Shelly et al., (2010) support this notion by stating that teachers need to motivate learners by tapping into their digital world and using their natural inclination inquisitiveness about all that is digital. Therefore based on this literature, for this study it was assumed that even if the experimental group shares their experiences, they would most probable share the information about the technology itself rather than the specific science content learned. So, since this study focused specifically on assessing the changes in the learners' performance scores due to the learning gains in the Science content as a result of their exposure to the multimedia-supported lessons, this factor was considered to have little or no impact on the study findings.

Secondly, there was likelihood that the impact of the DVD-supported lessons on the experimental learners' performance might have been compromised by conducting lessons after school when learners might have been too tired to take full advantage of the DVD's affordances.

3.3. DATA COLLECTION INSTRUMENTS

The following data collection instruments were used:

- Teacher's lesson plans.
- Pre- and post-tests (structured questions).
- Semi-structured interviews with focus group of learners and the teacher, for deeper probing.
- Questionnaires (attitudes and perceptions) for learners and their teacher.

3.3.1. Analysis of teacher's lesson plans was done to establish the aims and the expected learning outcomes of each lesson and in the case of the experimental group, how the teacher planned to integrate the DVD content into his lessons. This meant to assist in improving the validity of results at the end, so that if there were any conclusions or claims that were to be made about the learning gains associated with the use of the intervention, they would be made based on what was happening during the lessons (i.e. learners' and teacher's activities, the use of the intervention etc.). Observation schedule was not used because of the fear to interfere with the naturalness of the setting of the lessons (Descombe, 2007). The idea was to give the teacher an opportunity to conduct the lessons in his own way and not being influenced by the presence of the researcher. Video recordings were also avoided for the same reasons.

3.3.2. The pre and post- knowledge tests were used to answer the first research question about the impact of a multimedia DVD material on learners' understanding of scientific concepts. The term "knowledge test" in this study meant that the test was designed in a similar format as the questions in a typical Physical Science textbook or in the national and school examinations (Bloom et

al., 1971). It measured if learners could cope with problems of different levels of intellectual demands. The purpose of the test was to measure or assess learners' knowledge as determined by the learners' performance on the pre-test and post-test on the concepts taught over a period of six weeks. Therefore for this study, improved test scores would prove that the intervention had a positive impact on learners' understanding and vice versa. A sixty minute test consisting of 11 structured questions was used. The test was developed to measure learners' understanding of concepts that fall under the following chemical systems themes:

- Mining and mining processing (Gold, iron and phosphates) in the SA context.
- Environmental impact of these activities.

When selecting the questions, the notion brought by MacGuire and Johnstone (1987, p. 566) was used as a guidance. The authors suggested that the indicators that a learner has fully grasped the concept are:

- The ability of a learner to define the concept in words.
- The ability of a learner to recognise the instances of that particular concept.
- The ability of a learner to distinguish between instances and non-instances of the concept.
- And the ability of a learner to solve problems which involve the concept.

Therefore test items were specifically designed to demand the learners to use various intellectual levels as suggested by Bloom's taxonomy, i.e. knowledge, comprehension, application and evaluation (Maree & Fraser, 2004).
Other research tools like interviews, questionnaires and observations could have been used to collect the required data. For example, Fraenkel and Wallen (1990) support the usage of interviews in the educational research to determine learners' cognitive level of development and understanding of basic scientific concepts. However in my study interviews and questionnaires were only used at a later

stage as a follow-up on learners' responses to elicit their deeper attitudes and perceptions about the multimedia-supported lessons.

3.3.3. Questionnaires were used after the intervention lessons for the experimental group only to collect data needed for answering the third research question about the perceptions and attitudes of learners and teacher about the usefulness of the Mindset's DVD content series. Questionnaires are the most widely used procedure for obtaining information because they allow questions to be tailored for specific purposes, they are relatively economical and anonymity can be assured (Opie, 2004). For the purposes of this study, a questionnaire adapted from studies such as Hartley, (2007); Thomas & Emeorole, (2002); Niewoudt et al., (2007) and Maor & Fraser, (2005), was completed only by the experimental group of learners and their teacher to elicit their perceptions and attitudes about the use of the DVD material for teaching and learning concepts of chemical systems.

3.3.4. Semi- structured interviews were used for an in-depth probing of learners' test and questionnaire responses and were conducted only for a selected number of learners. Only 8 of the 32 experimental group learners were interviewed. The use of this instrument was informed by its capability to allow for a depth of feelings to be ascertained by providing opportunities to explain and expand the interviewee's responses, unlike the structured ones which are rigid in nature (Opie, 2004). Because there is some structure in the semi- structured interviews, it was possible to structure them in such a way that they elicit the learners' perceptions and attitudes about multimedia-supported learning. The categories for the semi–structured interviews were formulated on the basis of the dominant categories that transpired from the questionnaire phase of the research. Therefore the interview schedule was only compiled once the analysis of the knowledge test and questionnaire results was complete. The teacher's interview schedule was also prepared to elicit his attitude about using the multimedia-supported teaching.

3.4. ANALYSIS METHODS

Since the pre-test and post-test data was regarded as parametric data, an Excel t-test was administered as a statistical tool for comparing the performances of the two groups. Also, the test data was analysed per question qualitatively in order to verify if there were any changes, whether positive or negative in the learners' responses per question from pre-test to post-test. Then a Wilcoxon matched pairs test was administered to check if the change in the responses was significant in each group. The test was performed for each group separately, using class average response score pairs per item for 11 test items worked out from the data of only those learners that wrote both tests.

Since the data from questionnaires was an ordinal data that only provided the levels of ranking and had unequal intervals between the values (Jamieson, 2004), it was only analysed qualitatively through descriptive methods. The total frequency at which each response occurred was computed to get an average percentage for each response. The teacher's lesson plans and interview data were analysed descriptively also.

3.5. VALIDITY AND RELIABILITY

When doing an educational research, issues of validity and reliability need to be considered. For an example, Wellington (2000, p. 201) defines validity as the degree to which a method, test or research tool actually measures what it is supposed to measure. So, in this study, face validity of pre- and post-tests was ensured by the teacher of the two participating classes since the researcher compiled the test items. Internal validity about the reliability of the research data-capturing tools so that a claim could be made as stated by Scaife (2004) was ensured by my supervisor.

Leedy and Ormrod (2005, p. 93) define reliability of a measuring instrument as the extent to which it yields consistent results when the characteristic being measured has not changed. Keeping the same educator in both classes enabled

both groups to receive standardized lessons prior to the pre-tests and standardized pre-tests thereafter. This to an extent improved the reliability of the research method and measuring tool as it ensured consistency of teaching from one group to the other. To improve inter-rater reliability, learners' scripts were marked by both the researcher and the teacher.

Since this study used both quantitative and qualitative research methods, issues of validity and reliability have been separated to address the two methods as follows:

3.5.1 Validity for quantitative method

Pre-test and post-test questions were adopted from the Physical Science textbook (Brookes, et al., (2005) and examination question papers (Grade 11 Physical Science national senior certificate, DoE, (November 2007, p. 15-17) and were therefore considered validated and piloted. Also, tests were piloted with the learners of the same grade from a neighbouring school and then edited to correct vague questions to ensure face validity.

3.5.2. Validity for qualitative methods

The triangulation of data was done as follows.

Teacher's lesson plans

During the interview stage, the researcher verified whether the teacher followed his lessons the same way it was planned on his lesson plans or he made some modification. The verification was done in order to ensure reliability of the data presented in this study so that if at all a claim was made, it was made based on what was happening during the lesson since the observation of the lesson was not done. The teacher confirmed that he followed his lessons as planned (see line 54 - 58) he further followed up by stating that the multimedia material fitted well into his teaching.

"Did you integrate the DVD material as indicated in your lesson plan?" (Interviewer - line 52 - 53)

"Yes. It was possible to integrate as indicated on the lesson plan, I was using the DVD straight forward, pause to explain and answer learners' questions as I told them to raise their hands if they did not understand." (Teacher - line 54 – 58).

Furthermore, during the learners' interviews ALL learners confirmed that the teacher adequately used the DVD material during their multimedia-supported lessons (see learner 1- line 50, learner 2- line 47, learner 3- line 46, etc.)

Controlling the testing process

To prevent the leakage of test question papers learners from both classes wrote their pre-test and post-test on the same day, during their regular Physical Science double periods. Contact between the two groups was restricted by ensuring that no learner was allowed to leave the class during the test, test question papers were collected back with scripts from the first class after writing and the second class wrote immediately after the first group's period.

3.6. ETHICAL ISSUES

Ethical issues of doing an educational research were considered by honouring the four aspects of doing a research where human subjects are used as subjects, as given by Leedy and Ormrod (2005), which are: protection from harm, informed consent, right to privacy and honesty with professional colleagues, as follows:

Protection from harm.

Official ethics permission was requested from the University's Ethics Committee through ethics application in order to ensure that the research participants were not exposed to undue harm and that their rights were protected. The ethics clearance was granted with Protocol number: 2008ECE227. It was also explained to the control group why the DVD was not used in their lessons during the research and that once the research was finished they would also be exposed to the multimedia-supported lessons since the DVD package belonged to the school.

Learners were informed that tests answers, questionnaires and their responses to the interviews were not going to be used for assessment purposes.

Informed Consent

Access to the participating school, teachers and learners was negotiated by sending request letter to the principal of the participating school. After approval was granted, a meeting was held with the grade 11 Physical Science teachers to inform them about the research and to invite them to participate. The teacher of the two participating classes volunteered to participate. Learners from the two classes were briefed about the research process and consent forms were given to the participating teacher, learners and were also sent to the learners' parents (in the case of minors). This was done to allow participants to formally accept to participate or decline from participating.

Right to privacy

All participants were informed that all the information gathered from this study would be used for the purposes of this study only and would be kept safe until destroyed after a period of three to five years. Anonymity of the names of respondents when reporting was also ensured.

Honesty with professional colleagues

Claims and conclusions that were made in this study report were informed and drawn from the data that was collected and ideas from the existing research literature used in this study report were acknowledged within the document and also on the reference list.

CHAPTER 4: DATA PRESENTATION AND ANALYSIS

4.1. INTRODUCTION

In this chapter the data that was collected using the instruments mentioned in the previous chapter is presented and analysed. This study set out to evaluate the impact of a multimedia DVD content series on the teaching and learning of the chemical systems concepts found in the grade 11 syllabus. Therefore the analysis of the collected data was meant to assist in answering the following research questions:

- What influence does a multimedia DVD Science content series have on learners' understanding of some chemical systems concepts?
- What are the attitudes and perceptions of learners with regards to the nature of challenges and benefits experienced when using the DVD material to learn chemical systems topics?
- What are the teacher's attitudes and perceptions about using the DVD material for teaching?

To answer the first research question, the data collected from the pre-test and post-test was presented and analysed (Refer to appendix A & B for a copy of test and memorandum). Learners' test scores in percentages for both tests were presented in a table (Refer to Table 2).

Firstly, the sets of test scores were analysed quantitatively using a t-test so that the performances of the two groups could be compared. The t-test was meant to test the null hypothesis that "the mean result of the experimental group would be the same or lower than that of the control group". In other words, if the results lead to the acceptance of the null hypothesis that would imply that the DVD usage did not have any positive influence on the learners' understanding of content. On the other hand if the results led to the rejection of the null hypothesis that would imply that the DVD material had a positive influence on the learners' understanding of concepts.

Secondly, the test data was analysed per question qualitatively in order to verify if there were any changes, whether positive or negative in the learners' responses per question from pre-test to post-test using the following scoring scheme:

Table 1

Scoring scheme for learners' responses in 11 test items.

Numeric Score	Degree of Understanding	Criteria for Score
0	No Response	Blank, "I don't know"
1	No Understanding	Irrelevant or unclear response
2	Specific Misconception	Responses that include illogical or incorrect information
3	Partial Understanding with Specific Misconception	Responses that show understanding of concept, but also make statements which demonstrate a misunderstanding
4	Partial Understanding	Responses that include at least one component of the validated response, but not all the components
5	Sound Understanding	Responses that include all components of the validated response.

Note: adapted from Jennings, Epp and Weaver (2007)

A Wilcoxon matched pairs signed rank test was administered using the average response scores of each class per test question from pre-test to post-test to check if the difference in the responses was significant in each group.

4.2. PRESENTATION OF PRE-TEST AND POST-TEST DATA

Test scores (in percentages) of twenty four (24) control group learners and thirty two (32) experimental group learners are displayed on Table 2. The results include the percentage marks obtained by learners, class mean scores and standard deviations for each test.

Table 2

Marks per learner for pre-test and post-test

MARKS OF PRE-TEST CONTROL GROUP in % (N=24) **(X1)1**	**MARKS OF POST- TEST CONTROL GROUP in % (N=17)** **(X1)2**	**MARKS OF PRE - TEST EXPERIMENTAL GROUP in % (N=32)** **(X2)1**	**MARKS OF POST-TEST EXPERIMENTAL GROUP in % (N=32)** **(X2)2**
27	57	43	50
36	11	25	41
32	36	23	23
19	14	25	59
43	38	39	63
13	30	21	36
30	45	20	39
43	50	23	38
41	48	32	34
29	45	41	36
27	48	18	43
11	11	29	38
18	25	39	43
8	29	32	38
27	16	36	52
38	39	23	38
54	67	41	42
50		18	30
34		27	29
34		30	32
39		23	25
32		32	75
45		32	46
21		29	38
		27	13
		16	7
		14	13
		38	30
		36	16
		23	41
		16	46
		32	50
Mean: 31.29167	**35.82353**	**28.21875**	**37.625**
Sta Dev: 12.06677	**16.58401**	**8.150735**	**14.46408**

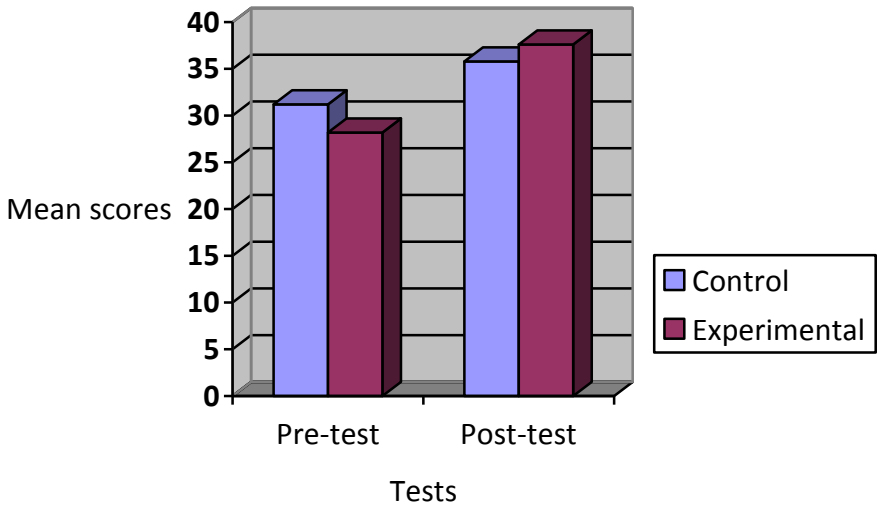


Figure 1. Mean score graph of the two groups

4.3. ANALYSIS OF TEST DATA USING LEARNERS' MEAN SCORES

The data in Table 2 displays what Opie (2004) classifies as parametric data specifically an interval data. When looking at the data one can see that scores improved within the same groups from the pre-test to post-test and also across the two groups. In order to test for causal relationships i.e. check if the mean difference was significantly different or not, a t-test was employed as a statistical test. Since the null hypothesis that "the mean result of the experimental group would be the same or less than that of the control group" was tested, a two-tailed t-test, set at "p" level of 0.05 which is 95% confidence level was applied. The t-test results were expected to prove whether:

- The mean scores of the post-tests **for the two groups** were equal or not in order to determine if the performance of the group that was exposed to the intervention (i.e. experimental group) was lower or equal to that of control group hence revealing the impact of the intervention while upholding or rejecting the null hypothesis.

- The mean scores of **each group** for the pre-test and post-test were different or not in order to determine if there were gains in performance within the individual groups, and if so how much.
- There was a significant difference between the mean scores of **the control and experimental groups'** pre-test results to determine their ability levels before the experimental group was exposed to the intervention so that if there was a difference only after the intervention, it could be attributed to the use of the intervention.

PRIMARY FINDING

The two-tailed t-test performed on the post-test mean scores of the two groups revealed that statistically there was no significant performance difference between the two groups. This finding upholds the initially set null hypothesis that "the mean result of the experimental group would be the same or lower than that of the control group" which then implies that the multimedia DVD Science material had no positive impact on learners' understanding of chemical systems concepts. The t-test gave a "p" value of 0.695 which is greater than the set 0.05 indicating that there was no significant performance difference between the two groups. This is regarded as a primary finding because it enables the researcher to either reject or uphold the set hypothesis hence answering the first research question. Therefore in answering the first research question which says:

"What influence does a Mindset's Science DVD content series have on the understanding of grade 11 chemical systems concepts?" The results indicated that it did not have any influence on the learners' understanding of the taught concepts. However descriptively, results displayed that both groups' performance improved during the post-test. This was revealed by the elevated mean scores for both groups. For instance the post-tests mean score of the control group changed from 31.29167 to 35.823 and for the experimental group from 28.21875 to 37.625. This showed that both groups performed better in the post-test and that the experimental group outperformed the control group by 1.801. The standard

deviations for both groups were relatively high on both tests. However, the experimental group's standard deviation was always less than that of the control group. This can be interpreted as suggesting that the scores of individual learners within the experimental group were a bit closer to the group's average mean score as compared to those of the control group. It was also noted that the standard deviations of the post-tests for both groups were relatively higher than those of the pre-tests. This could suggest that the gap between the performances of learners within their respective groups widened after the post teaching which could imply that conceptual shift happened at that stage. That conceptual change then resulted in some learners getting very high scores while some got very low ones.

SECONDARY FINDINGS

Following are the three secondary findings deduced from the above results:

Initially during the pre-test i.e. before the experimental group was exposed to the DVD lessons, there was no significant difference between the performances of the two groups. The results revealed that the mean score of the control group was better than that of the experimental group i.e. 31.29% versus 28.21%. This gave a mean difference of 3.07% in favour of the control group. However, the two-tailed t-test results gave a "p" value of 0.260 which implied that this difference was not statistically significant since $p > 0.05$. From these results it can be claimed that the performance levels of the two groups used in this study before the intervention were as equivalent as possible even though randomisation was not done. This then implies that the effect of the group's potential differences on the dependent variables was limited.

Within the same group i.e. the control group, there was no significant difference between pre-test and post-test performance. The results displayed a mean difference of 4.53 between pre-test and post-test, which suggested that this group performed better in the post-test than in the pre-test. However the two-tailed t-test results confirmed that this mean difference was not significant at a "p" value of 0.09 which is greater than the set 0.05.

Within the same group i.e. the experimental group, there was a significant difference between the pre-test and post-test performance. This was confirmed by the T value of 3.2052 at the actual confidence of 99.79% at a "p" value of 0.005. From this finding, it can be deduced that the multimedia DVD Science material seemed to have had some positive impact towards learners' understanding of chemical systems concepts. This is indicated by the fact that the experimental group, which was exposed to the DVD content, managed to improve their performance from pre-test to post-test by a mean difference of 9.4 i.e. from 28.22 to 37.63 mean score. Also these learners managed to outperform the control group in the post-test even though the control group had outperformed them initially during the pre-test. However this is regarded as a secondary finding because the improvement is just within the experimental group, it is not significant when comparing the performances of the two groups and hence it could not be used to reject or uphold the hypothesis.

4.4. CLASS AVERAGE TEST RESPONSE SCORES PER QUESTION ACCORDING TO THE SCORING SCHEME

The average scores of the two groups per question (in 11 questions) which were worked out from the scoring scheme are displayed in Table 3.

Table 3:

Class average scores per question for both groups

Control group			Experiment group	
Pretest	**Posttest**	**Question**	**Pretest**	**Posttest**
4.11	4.71	1	4.25	4.81
1.58	4.11	2	1.75	4.4
1.17	2.3	3	0.56	2.68
1.17	2.6	4	1.75	2.81
2.41	2.9	5	1.8	3.4
1.76	3.17	6	0.84	3.59
1.94	3.52	7	0.81	3.75
0.76	1.76	8	0.75	2
2.52	3.2	9	1.93	3.25
1.35	4.05	10	1.59	4.37
4.05	4.58	11	2.53	4.68
TOTAL AV: 2.074545	3.354545		1.687273	3.612727

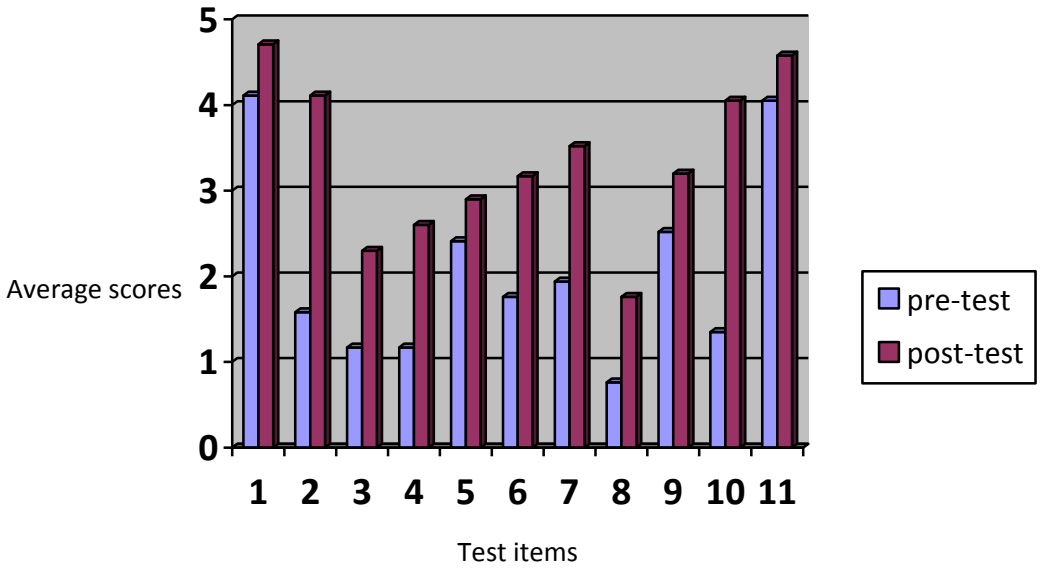
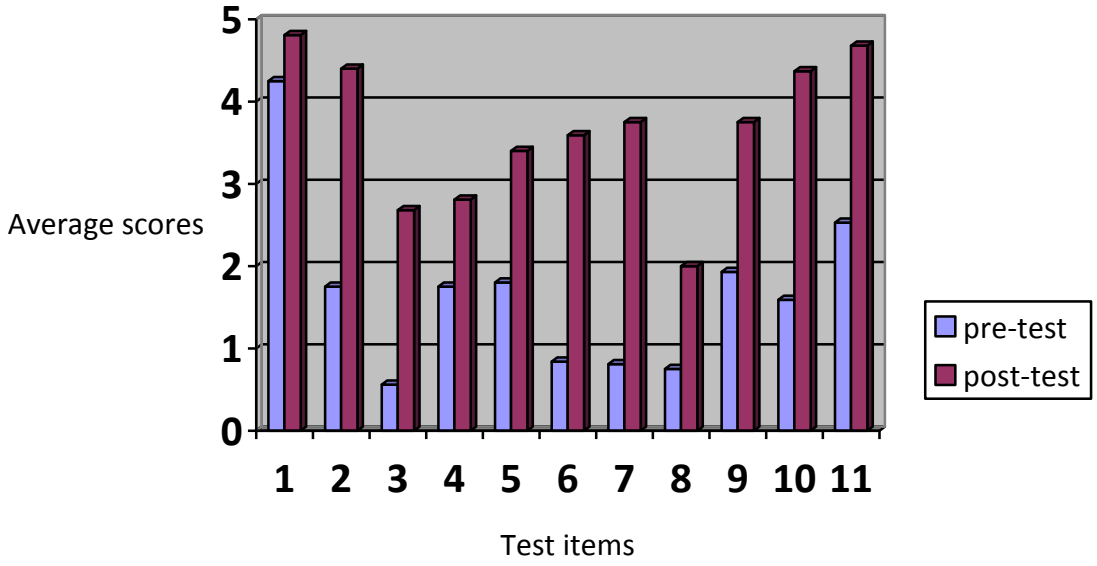


Figure 2: Average scores per item for the control group



Fig*ure* 3: Average scores per item for the expermental group

4.5. ANALYSIS OF TEST SCORES USING AVERAGE SCORING CATEGORIES PER QUESTION FOR BOTH GROUPS

The second type of analysis was based on learners' average scores per question between the pre-test and post-test as discussed in section 4.1. This analysis was done in order to measure if there was an improvement in the manner in which learners answered questions. If so, that would imply that there was an improved understanding of scientific concepts amongst the learners. **Descriptively, the results indicated that generally there was an important scientific improvement in the responses for all questions in both groups of learners**. For instance, a shift from a level of "no understanding" towards "understanding" appeared in questions 2, 10 and 11 while a shift from "no understanding" to "partially understanding" could be noticed in questions 5, 6 and 7. Question 2 was about explaining the extraction of metals from their compounds, a clear explanation was given by the DVD content and also by the teacher which resulted in both groups improving their performance in that question. Questions 9 and 10 were about the phosphate mining that was also thoroughly explained during the teaching time since different types of mining were the focus. Question 11 was

about the percentage calculation of elements; it required learners to follow mathematical steps. Experimental group initially did not master the steps during the pre-test but after they viewed the calculation examples from the DVD they improved during the post-test. Questions 5, 6 and 7 were all based on gold mining, starting from gold extraction, definition and balanced chemical equations for this process and factors that affect the cost of gold mining in South Africa. All aspects of gold mining were explicitly explained by the DVD material, so the experimental group could still remember the details partially. All learners did well in question one, stating the advantages and disadvantages of mining, since it merely demanded rote learning. The data also showed that much as both groups had some change in the conceptual understanding in almost similar pattern per question, the experimental group's improvement proved to be higher than that of the control group in all questions. The total averages for each group per test in Table 3 support this claim.

Since there was an observable gain in scores from pre-test to post-test for both groups, a Wilcoxon matched pairs signed rank test was performed using the scoring categories from the scoring scheme per question and per class to determine if this gain was statistically significant (Refer to Table 3). The test was performed for each group separately using 11 pre-test and post-test class average scores as pairs. The p-value was set at 0.05 for testing a null hypothesis that "there is no significant difference between the pairs of scores for each group of learners". The results are as follows for both groups:

W = -66

N = 11

$N_{s/r}$ = 11

P (1-tail) = 0.0018 P (2-tail) = 0.0036

The results obtained from the test showed that all "p" values are below 0.05 which implies that the gains in scores were significantly different for all items in both groups of learners showing an improvement in response quality for both groups.

4.6. SEMI STRUCTURED INTERVIEWS

For learners, only 8 learners from the experimental group were interviewed. This number of subjects constituted for almost 25 percent of the experimental group. The selection of learners was based on their performance in the pre-test and post-test. For instance, of the eight selected learners, three had improved test scores from pre-test to post-test. The other three had decreased scores and the last two had the same scores in both pre-test and post-test. The learners' interview schedule consisted of thirteen questions (Refer to appendix D attached for learners' interview schedule). Questions 1-5 were about the learners' exposure to the ICTs, to establish whether they had used them before or not. Questions 6-13 were all about the challenges and benefits of using multimedia-supported learning. The interview questions were aimed at getting the data to answer the first research question about the influence of a multimedia DVD lesson on learners' understanding of concepts and the second research question about learners' attitudes about multimedia-supported learning. For the first research question, learners were asked how their performance was influenced by the use of multimedia-supported learning.

For the teacher, a total number of sixteen questions were prepared for the interview. They were divided into three categories. The first four questions were aimed at establishing the teacher's ICT professional development level, eight questions were about the teacher's teaching methods and the last four were about the teacher's perceptions and attitudes about ICTs as instructional tools (Refer to appendix E attached for the Teacher's interview schedule).

4.6.1. Analysis of learners' interview data

In answering the first research question: ***"What influence does Mindset's Multimedia DVD Science content series have on learners' understanding of some chemical systems concepts?"*** The interview data showed that multimedia learning had a positive influence on the learners' understanding (Refer to appendix D attached for learners' interview transcription). It was drawn out of the

learners' responses mentioning that they liked the DVD's pictures, scenery and visuals of how scientific processes happen. Learners indicated that those features assisted them to improve their understanding. In particular, they mentioned that the manner in which the process of gold extraction was demonstrated and explained by the DVD, with its graphics, made them to understand all the steps involved such that when they wrote their test they could still recall vivid images and explanations of that process. However it was contradictory to note that this positive attitude about the DVD-supported lessons did not lead to the improvement of test scores amongst the learners as there was no significant improvement of the test scores for the post-test. During the interview learners that had decreased or unchanged scores from pre-test to post-test confessed that they were not prepared for the post-test because of reasons such as: they knew that they would write about the same concepts as in the pre-test, they knew that test scores will not affect their assessment record or they did not have time to study (learner 1 – line 72 & 75, learner 2 – line 59, learner 6 – line 74 and learner 7 – line 75). On the other hand, those who had improved test scores explained that the improvement was due to the DVD's visuals which assisted them to recall some of the processes and concepts when they were writing the test (learner 3 – line 62, learner 4 – line 72, learner 5 – line 80 and learner 8 – line 68).

In answering the second research question: ***"What are the attitudes and perceptions of the grade 11 Physical Science learners with regards to the nature of challenges and benefits experienced when using the DVD material to learn chemical systems topic?",*** during interviews, learners mentioned more benefits of multimedia-supported learning than challenges (Refer to appendix D for learners' interview transcription).

On the benefits, two learners stated that watching how people worked with rocks in the mining scenery of the DVD lesson triggered passion and interest in them to become geologists (Learner 4, lines 27-29 and Learner 7, lines 27-29). Most learners valued the fact that the DVD brought scenery into the classroom so that

they could see what they were learning about. However although most learners seemed to enjoy multimedia learning, all of them mentioned that they still needed their teacher to teach with or without the multimedia assistance. They stated this when they were asked to choose between the two methods (i.e. multimedia and traditional ways of teaching), 2/8 learners still chose traditional way of teaching while 6/8 learners preferred multimedia learning but suggested different ways of using it. For instance of the six learners, three of them wanted the multimedia lesson to be integrated into the teacher's lesson plan, so that he could use it to supplement his explanations. Their reason was that the DVD material could supplement what the teacher taught by demonstrating the processes with graphic concrete examples to enforce understanding. The visual graphics and the playback features of the DVD were mentioned as learning enablers that offered learners an opportunity to understand the content and that ensured recalling during exams. The other three preferred to use the DVD lessons as a group of learners for study purposes after the topic shall have been taught in class. They believed that the DVD material could supplement what the teacher taught by demonstrating the processes with graphic concrete examples to enforce understanding. Those who preferred traditional way of teaching appreciated the ability to interact with their teacher in that environment which was not always possible in a sole multimedia-supported learning environment.

When looking at the challenges faced by learners in a multimedia-supported lesson, the challenge that was mentioned by most learners was that of not being able to focus due to a more relaxed un-interactive setting that led to learners feeling drowsy during the lesson (3/8 learners). It was evident that the feeling of drowsiness was enhanced by the fact that the DVD lessons were carried out after school when learners were already tired. During the teacher's interview, he mentioned this as one of his challenges (line 74). Some learners also mentioned that the sound of the DVD was low even though it was set at a maximum volume. Other challenges mentioned by a number of learners included the fast pace of the DVD lesson which made it difficult to understand the explanations, difficult

language (English) used in the DVD also hindered the understanding since learners had to wait for the explanation time in order to ask for their teacher to explain. The likelihood is by then; learners would have lost interest to ask their questions.

4.6.2. Analysis of teacher's interview data

Interview data showed that the teacher was keen to use ICTs for teaching when he mentioned that in addition to other teaching aids such as textbooks, posters, laboratory equipment, he also used the DVD lessons in his class even before this research took place (Refer to appendix F for the teacher's interview transcript). The fact that he was never taught how to use ICTs for teaching during his pre-service training except for the overhead projector and that he had only undergone two days of training on how to operate the Mindset's multimedia DVD equipment did not discourage him. He rated himself as having 75% level of confidence in using the material. He mentioned that he would appreciate further training of how to use the equipment in order to learn how to trouble shoot. For example he found that the system took more time to send information from the server to the receiver and he did not know how to manipulate it. The teacher reported that he needed to know how to fast forward, rewind and add new content or update the one that was pre-loaded to match it with the current educational changes.

Regarding his teaching method, he stated that ICTs fit well into his teaching style. He stated that ICTs promote learning because they show the reality of Science, making it easy for the learners to understand the content within the artificial concrete context created by the DVD. When asked about the benefits of integrating ICTs into his lessons, he responded as follows:

"Learners enjoyed seeing things happening. Explaining concepts became easy for me when using the DVD's graphics and demonstrations. The DVD made it easy for me to handle LO3 as it is usually difficult to make learners understand and imagine chemical systems processes. My lesson planning process was made easy

and the learners' discipline was improved as they had to be attentive in order to hear the DVD" (line 63).

It was noted that the teacher acknowledged that the multimedia DVD material assisted him as a teacher as well as his learners. For instance, he confirmed that it assisted him with enough PCK to teach the third Science learning outcome and classroom management such as improving learners' discipline (lines 64 - 66). On the other hand learners were given a chance to see things happening (line 63) therefore linking the teacher's explanation with the DVD's practical examples to enhance understanding.

However teaching in a multimedia-supported environment also posed some challenges for the teacher as well. For instance he mentioned that the electricity cut offs disturbed his lessons and upon the return of current, the system took long to restart and resume from where it was before the cut off (lines 74 - 77). The sound of the system was low even when it was set at a maximum level, it still could not be audible enough in a big class. The teacher also could not use the multimedia material as adequately as he would have liked to. This was because the multimedia equipment was not installed in his class. The teacher managed to solve other challenges through trial and error. For example he noticed that learners felt sleepy during the first day, so on the second day he used the pause button to interact with them through question and answer sessions in order to create an interactive environment (line 80 – 83).

The teacher still upheld positive attitude and perceptions about using ICTs for teaching as he did in his questionnaire. However, he cautioned that, in order to promote learners' understanding through multimedia lesson, teachers should view the DVD lesson alone before hand to check the amount and quality of content that is covered and plan how they can supplement it with the textbook content. The duration of the DVD lesson should also be checked in order to estimate time available for other activities (Teacher – lines 92 – 96). He appreciated the South African government's calling for the integration of ICTs into the curriculum delivery. He argues that in order to realise this goal, the government should

provide resources such as computers and internet to schools. Furthermore, cheaper technologies such as Mindset's multimedia teaching material could also be used to start the process in under-resourced schools. The teacher was also aware that irrespective of his strong support for multimedia-supported learning; there was still an insignificant improvement in the performance of the experimental group as compared to that of the control group. To explain this conflicting finding, he forwarded the following possible causes:

- Passiveness of learners at first, acting like they were watching a movie, not taking notes or asking questions.
- Time constraints associated with having lessons after school when learners were too tired to learn.
- Inadequate preparation by the learners for the post-test since they knew that they were going to write about the same content as in the pre-test.

Therefore deducing from the above findings, my answer for the third research question is that the grade 11 Physical Science teacher had positive attitude and perceptions about using the DVD material for teaching and learning.

4.7. QUESTIONNAIRE DATA

The experimental group completed the questionnaires after writing the post-test. The aim of the questionnaires was to allow learners to voice out how they felt about learning in a multimedia-supported environment and to evaluate the effectiveness of the DVD lessons as a learning tool. The teacher was also requested to complete his own questionnaire to evaluate the DVD lessons as a teaching tool.

Likert scale was used to organise the questionnaire data. In this study the number of questionnaire items was increased (i.e. 20 and 19 items for teacher and learners respectively) to cover a wider scope of attitudes and perceptions about the multimedia supported teaching and learning.

4.7.1. Presentation of learners' questionnaire data

Nineteen (19) Likert scale items of attitude and perceptions on the learners' questionnaires were rated as: agree, undecided and disagree (Refer to appendix G for learners' questionnaire). This scale rating was adapted from Thomas and Emereole (2002). However in their study they used five ratings including strongly agree and strongly disagree. For this study, only three ratings were used in order to increase the validity of the questionnaire as a measuring instrument by eliminating the two categories that learners might find difficult to interpret. Only 30 of the experimental group learners completed their questionnaires. Cases where learners did not respond were also counted and recorded under "blank" option. The total frequency at which each response occurred was computed to get an average frequency percentage of each response category (Refer to appendix H attached). Figure 4 shows learners' average frequency percentages per response.

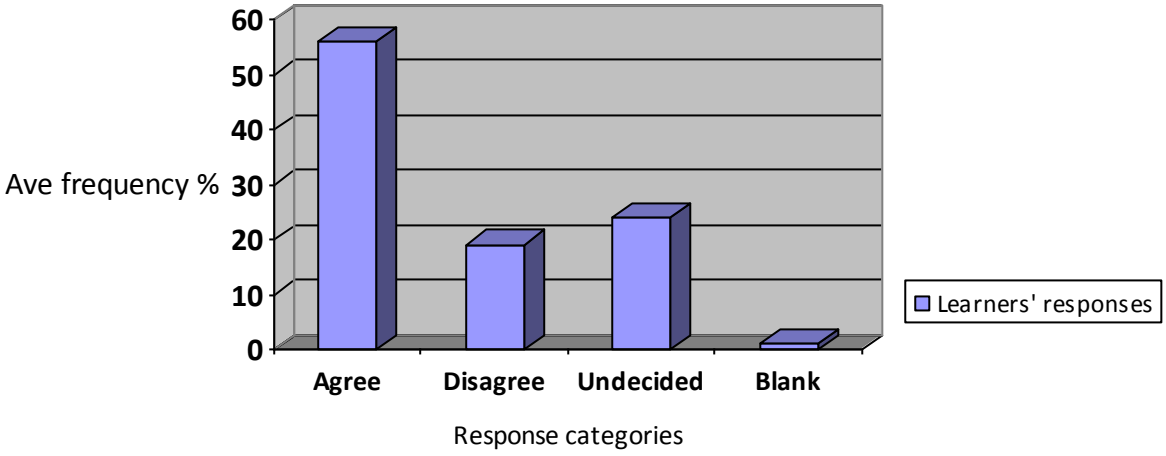


Figure 4: Summary of learners' questionnaire responses

4.7.2. Analysis of learners' questionnaire data

The nineteen questionnaire items mentioned above were further divided into three categories in order to elicit learners' attitudes and perceptions about specific capabilities of the DVD material. Categories were based on the evaluation of:

- The ability of the DVD material to teach.
- The ability of the DVD material to promote content understanding.
- The ability of the DVD material to provide learner support.

Table 4

The evaluation of DVD lessons as a teaching tool

Questions	**Agree**	**Undecided**	**Disagree**	**Blank**
1. The use of the DVD for learning purposes was an exciting experience.	15 **50 %**	9 30%	6 20%	-
5. The DVD information in all units of the chapter was clear and unambiguous.	18 **60%**	4 13%	7 24%	1 3%
6. The amount and quality of content material in the DVD were just about right compared with what would be normally covered in a traditional classroom.	14 **47%**	9 30%	6 20%	1 3%
9. The pace of the DVD lesson was appropriate for clear explanation of concepts.	10 **34%**	6 20%	13 43%	1 3%
12. I would like to commend the use multimedia DVD methods in the teaching and learning of science and other subjects as well.	18 **60%**	4 13%	8 27%	-
13.I would like the traditional method of teaching to be supplemented by the multimedia DVD method	7 **23%**	11 37%	11 37%	1 3%
15. I find that working with the multimedia program shows how complex real-life is.	25 **83%**	3 10%	2 7%	-
16. I find that working with the multimedia program presents data in meaningful ways.	14 **46%**	9 30%	5 17%	2 7%
18. I find that working with the multimedia program presents realistic tasks.	21 **70%`**	7 23%	2 7%	-
Total average frequency %	**53 %**	**23%**	**22%**	**2%**

When looking at the total average percentages, one noted that half of the learners agreed that a multimedia DVD lesson was a valuable tool for teaching new concepts. Half of the learners also regarded the use of the DVD material for

learning purposes as an exciting experience. This type of finding seemed to be suggesting that the multimedia-supported teaching had a positive impact on learners, especially because only 20% of learners did not agree that it was an exciting experience. For instance, 60% of learners indicated that the DVD information was clear and unambiguous in all units of the chapters covered in class. The same number of learners went to an extent of recommending that the multimedia teaching method should be used in the teaching of Science and other subjects. What came out clearly though in this category is a strong perception of learners (83%) that the multimedia DVD has an ability to relate Science into real world and showing how complex real life is. Similarly, 70 % of learners indicated that working with a multimedia programme presents realistic tasks. However it was also noted that a considerable number of learners was concerned that the pace of the DVD was not appropriate for clear explanation of concepts (43%) and that they did not support that the traditional teaching method be supplemented by the multimedia teaching method (37%). Also in this category there was an average percentage of 23% for “undecided” responses and 2% of blank spaces in cases where learners did not answer some of the questions.

Table 5

The DVD lesson's ability to promote content understanding

Questions	**Agree**	**Undecided**	**Disagree**	**Blank**
2. In understanding the concepts of the chapter, the multimedia-supported way of presenting material is better than the traditional classroom presentation.	10 **33%**	9 30%	11 37%	
4. My level of motivation in this learning area has increased with the use of a multimedia material.	12 **40%**	6 20%	12 40	-
7. The use of the DVD materials has increased my degree of interest in Physical Sciences.	19 **63%**	6 20%	3 10%	2 7%
14. The DVD's Diagrams/charts/animations/visual aids were useful to enable better understanding of concepts.	18 **60%**	9 30%	3 10%	-
17. The DVD's questions allowed me to think deeply about my own understanding.	20 **66%**	5 17%	5 17%	-
19. I found the print supplements (notes) to be useful to reinforce content understanding.	14 **47%**	7 23%	9 30%	-
Total average frequency %	**52 %**	**23%**	24%	1%

The data revealed that just over a half of learners appreciated (52%) the multimedia learning method. According to the learners, the aspects of the DVD which contributed to effective learning were its diagrams, charts, animations, demonstrations, visual aids and questions. The level of interest for learning Physical Science as a subject amongst most learners (63%) also increased by the use of the DVD material in class. Contrary to the positive findings, there was a great level of disagreement amongst learners when they were asked if the multimedia teaching method enhances better understanding better that the traditional one. Only 33% of learners agreed with the statement, 37% disagreed while 30% was undecided. When looking carefully at the learners' responses it was realised that learners preferred the two teaching methods integrated to each other i.e. multimedia and traditional teaching, rather than just multimedia.

Table 6

The DVD lesson's ability to support learning

Questions	Agree	Undecided	Disagree	Blank
3. The multimedia-supported approach provides a greater collaboration between me as the learner and my teacher.	20 **66%**	7 24%	3 10%	-
10. The use of multimedia during the Physical Science class made me to be more creative.	17 **57%**	9 30%	4 13%	-
8. In a multimedia-supported lesson I get to think deeply about how to become a better learner.	23 **77%**	4 13%	3 10%	-
11. I learned more material through the use of the DVD method than I would have when using traditional methods.	14 **46%**	11 37%	5 17%	-
Total average frequency %	**62 %**	26%	12%	-

The total average percentage of positive responses (agree) in this category was 62% implying that the DVD lessons managed to support the learning process. Learners specifically liked its ability to motivate learners to be better learners (77%) and allowing collaboration between the teacher and learners (66%). However they also stated that they learned almost the same amount of material that they could have learned in a traditional lesson.

4.7.3. Presentation of teacher's questionnaire data

Twenty (20) questionnaire items were prepared for the teacher's questionnaire (Refer to appendix I for teacher's questionnaire). The items covered a wide variety of aspects aiming to elicit teacher's views and perceptions about teaching with multimedia DVD lessons. Questionnaire items were meant to elicit whether or not the teacher considered it as a tool that supported his teaching activities such as lesson preparation, achieving learning outcomes, understanding new content, acquiring new teaching strategies, supporting the assessment process etc. Also if he acknowledged that it supported his learners' learning process by improving their attitudes towards learning, improving their participation during the lesson and improving their achievement scores in Physical Science. Figure 5 presents a summary of his responses.

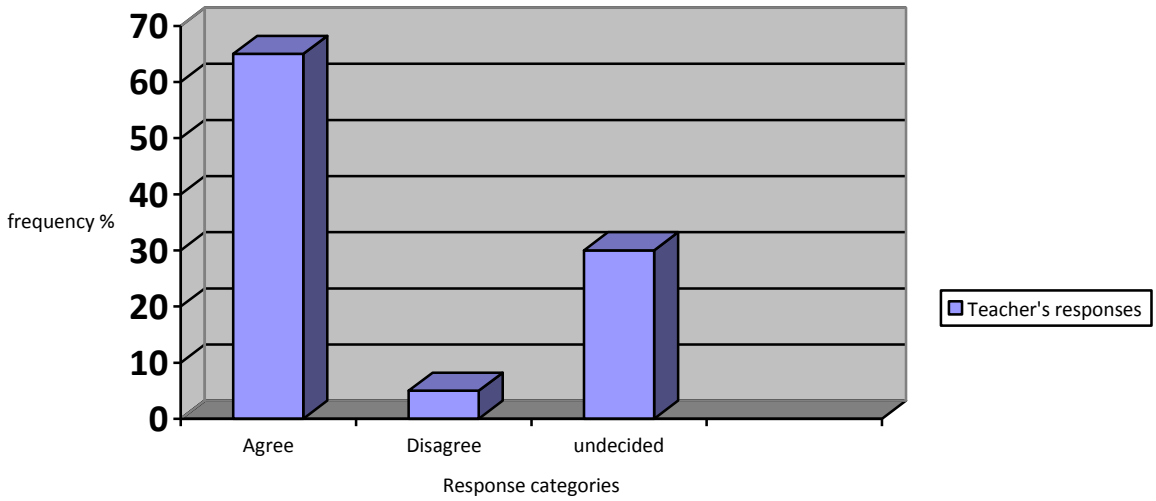


Figure 5: Summary of teacher's questionnaire responses

The data showed that the teacher regarded the multimedia DVD lesson as a useful teaching tool that supported him as a teacher as well as his learners (Refer to appendix J attached for the teacher's questionnaire responses). This was evident from his positive responses. For instance he gave positive responses (i.e. "agree") in most questions (13/20). There is only one question (question 11) where he gave a "disagree" response but even in that case it was still interpreted as a positive response because he disagreed with a negative statement. In total, that resulted into 14 positive responses. On the other six questions he did not disagree but he was undecided.

4.7.4. Analysis of teacher's questionnaire data

From the teacher's questionnaire responses, the teacher agreed that the DVD lessons benefited him and his learners. To substantiate this claim, the teacher's responses were grouped into two main categories i.e. those that had to do with checking if the DVD lesson was regarded as a useful teaching tool and those that checked if it was regarded as a good learner-support tool (Refer to Table 7):

Table 7

The DVD lesson as a teaching tool

ITEM NO	DVD LESSON AS A USEFUL TEACHING TOOL	Agree	Undecided	Disagree
1	The DVD material is a valuable facilitation tool that I can use to support my classroom teaching.	X		
2	The teacher video guide is a valuable lesson preparation tool	X		
3	The multimedia DVD material enhanced my content knowledge of the new curriculum topics	X		
4	I find that the DVD material exposed me to new teaching methodologies	X		
6	I used the content only for the introduction and revision purposes.		X	
7	The DVD's pause button feature allowed me to use the DVD content anytime during the lesson, depending on the desired outcome.		X	
8	I would recommend the DVD material to other teachers.	X		
10	I feel that the outcomes for the lessons showed how the DVD content linked with the curriculum requirements		X	
15	The DVD's questions were useful to assess learners' understanding of concepts.	X		
16.	The DVD's question answers were a useful assessment tool.		X	
17	I found the DVD content to be useful, well structured and appealing.		X	

When evaluating whether the multimedia material supported the teacher during the teaching process, the teacher gave positive responses (agree) in six of the eleven questions. The data showed that the teacher regarded the DVD material as a valuable and useful teaching tool that could be used to: facilitate the lesson, prepare the lesson, assess learners' understanding of concepts, enhance teachers' content understanding of new curriculum topics, and expose teachers to new

teaching methodologies. He also indicated that he would recommend the DVD material to other teachers. He was undecided in the other five questions. The teacher was undecided when asked if he used the DVD content for only introduction and revision purposes or that he used the DVD pause button to control the lesson, the material was useful or that the DVD material was well structured and appealing and that the DVD's question answers were a useful assessment tool.

Table 8

The DVD lesson as a learning support tool

ITEM NO	DVD LESSON AS A VALUABLE TOOL TO SUPPORT LEARNERS	Agree	Undecided	Disagree
5	I find the content to be appropriate for the targeted level of learners.	X		
9	I find that the DVD's graphics/charts/animations/visual aids were useful to enforce understanding of concepts.	X		
11	I find that the language used in the DVD was difficult for second language learners			X
12	I find that the videos were interesting and engaging for my learners.	X		
13	Demonstrations, experiments and site visits included in the lessons supported the learning of my learners.	X		
14	The use technology to explain curriculum aspects instilled positive inquisitiveness amongst my learners.		X	
18	Multimedia supported learning improved my learners' attitude to learn.	X		
19	Multimedia-supported teaching improved participation of my learners in class.	X		
20	Multimedia-supported teaching improved academic achievement in physical sciences.	X		

When evaluating whether a multimedia environment supports the learning process or not, the teacher gave positive responses in eight of the nine questions. In this

case, even the "disagree" is regarded as a positive response since it opposes a negative statement (Refer to Table 8). The aspects of the DVD teaching material that the teacher regarded as useful for the understanding of concepts, engaging learners, supporting learning, improving learners' attitude to learn, improving participation of learners in class and improving academic achievement are the following: quality of content, graphics, language and demonstrations. So it could be claimed that he regarded the multimedia environment as supportive to learning. However he was undecided on one question i.e. on whether the integration of technology into curriculum instilled positive inquisitiveness amongst learners.

4.8. PRESENTATION OF TEACHER'S LESSON PLANS

A sample of three lesson plans is presented and analysed in this study (Refer to Appendix L for lesson plan copies). The lessons were taught only to the experimental group. The following presentation is made assuming that the teacher conducted his lessons according to the way he had planned on the lesson plans as he confirmed when he was interviewed (Teacher – line – 54 – 58).

LESSON 1: Mineral Resources of the Lithosphere

The first lesson plan indicated that the teacher intended to solely use the DVD lesson not supplemented by his explanation. According to the lesson plan, during his one hour period he played the first DVD lesson about the formation of mineral resources of the lithosphere uninterrupted from the start to the end. The lesson lasted for 19 minutes. He then played the second DVD lesson about mining and extraction of gold. The duration of the lesson was 19 minutes. He followed the DVD lesson as was, and only paused when said so in the DVD. Pausing for the first time allowed learners to answer the following question posed on the video:

Why should the milling process take place before leaching?

The expected explanation should state that during the milling process the gold bearing ore is crushed to a powder to increase the surface area allowing the extraction to be more efficient during the leaching process.

The second pause was for allowing them to answer the following question:

Write a balanced chemical equation for the cyanidation or leaching reaction.

Expected answer: $4Au_{(s)} + 8KCN_{(aq)} + 2H_2O_{(l)} + O_{2(g)} \rightarrow 4KAu(CN)_2 + 4KOH_{(aq)}$

In the DVD lesson a lecture was given by the DVD's tutor covering the properties of gold followed by a geologist's interview about how gold deposits and then lastly a step by step explanation of mining, extraction and purification of gold, using chemical equations to show chemical reactions that take place. The lessons contained visual graphics, mining scenery and demonstrations of scientific processes through animations.

The teacher then used the last 20 minutes of his period to allow learners to answer the following questions individually in their exercise books.

Task:

1. Draw up a spider diagram or mind map to show the positive and negative aspects of the recovery and use of minerals on society and the environment.
2. Here is the balanced chemical equation for the reaction of zinc and potassium gold cyanide:

   Zn (s) + 2KAu (CN) (aq) → 2Au (s) + Zn (CN) 2 (aq) + 2KCN (aq)

   (a) Identify the oxidation and reduction half reactions taking place.

   (b) Identify any redox reactions taking place during the extraction and purification of gold.

   (c) Research the zinc process and write a report about why this process was phased out by most gold mining companies and replaced by the

charcoal filtration process.

LESSON 2: Gold Mining

The lesson plan showed that the teacher would spend the first 20 minutes of the lesson checking on learners' responses for the task given on the previous lessons. Class discussion, questioning, answering and correction of learners' conceptions would be done during that time. Then the teacher would inform learners that they were very passive during the first lesson and give them tips such as to always take notes of important ideas from the DVD and to write down their questions so that during the question and answer session they can ask their teacher. Learners would be told that the teacher will "pause" the DVD lesson whenever he felt necessary and ask questions so learners needed to stay alert.

He would then teach them the steps involved in the mining, extraction and purification of gold using textbook explanations and examples. He would explain by drawing flow chart diagrams on the chalkboard. Definitions of important terms involved in the process would also be given. Explanation of redox reactions that take place in every step would be given by taking learners through the rules of assigning oxidation numbers to atoms and molecules or compounds and how to balance redox reactions. Then he would fast forward the gold mining DVD lesson to a step by step explanation of gold extraction and purification to reinforce his teaching pausing from time to time to explain further. The follow up assessment task for learners was from the textbook and learners would be asked to finish it at home.

Task:

1. Briefly explain how gold-ore is mined.
2. Draw a flow chart to show how gold is extracted from the ore and purified.
3. Use a balanced chemical equation to represent the chemical reaction that takes place when gold is extracted from its rock.
4. Define the following terms relating to the extraction of gold:

(a) milling
(b) Leaching
(c) Gangue
(d) Adsorption
(e) Elution
(f) Electro-winning

LESSON 3: Iron and Phosphate Mining

In this lesson the teacher planned to use the DVD lesson to introduce the lesson. He would play the first part of the DVD lesson that involves the mining and extraction of iron. Thereafter he would pause to show learners all chemical equations that represent chemical reactions that are involved such as:

Carbon + Oxygen → Carbon Dioxide

$C_{(s)} + O2_{(g)} \rightarrow CO2_{(g)}$

Carbon + Carbon Dioxide → Carbon Monoxide

$CO2_{(g)} + C_{(s)} \rightarrow 2CO_{(g)}$

Iron (III) Oxide + Carbon Monoxide → Iron + Carbon Dioxide

$FeO_{3\ (s)} + 3CO\ (g) \rightarrow 2Fe_{(s)} + 3CO_{2\ (g)}$

Oxidation and reduction half reactions would be identified and the net redox reactions be explained.

He would then play the second part of the DVD lesson that covers the mining of phosphate, pausing only when prompted by the video to allow learners to solve the given problems. The teacher would show learners how to calculate the percentage of atoms from compounds e.g. percentage of phosphorous from ammonium phosphate fertilizer. At the end of the lesson he planned to entertain the learners' questions during a class discussion. Learners would be asked to complete a skeletal flow chart given by the teacher on the chalkboard representing the steps that should be followed in a phosphate mining. As part of homework learners would be asked to include chemical equations in all the relevant steps of the flow chart.

4.8.1. Analysis of the teacher's lesson plans

A sample of three lesson plans was analysed i.e. the first three lessons. Distributed cognition framework was used to analyse the data. Lesson plans showed that at the beginning the teacher used the DVD lesson as a sole teaching method and expected learners to obtain the required learning gains from the DVD material alone (Refer to lesson plan 1). Learners became passive during the first DVD lesson since all they did besides answering just two questions within a lesson duration of forty minutes, was to watch and listen to the DVD without taking notes or asking questions. During interviews the teacher confirmed that passiveness became an obstacle towards meaningful learning. Lesson plans showed that after the teacher identified that learning barrier, he adopted a more integrated approach of using the DVD lessons in the subsequent lessons (Lesson 2 & 3 above). For example he would start the lesson by playing the DVD lesson and pause to explain certain concepts and processes and then continue with the DVD lesson again, then pausing for a class discussion (either emanating from the teacher's or learners' questions) then playing the rest of the DVD lesson followed by a class activity with questions extracted from the DVD material and/or other teaching resources (Refer to the appendix L attached for a lesson plan sample). In lesson two he only played a specific part of the DVD lesson to provide learners with a rich context so that they can relate the classroom Science to their own real world practices in order to achieve the learning outcomes. This suggests that, in this case the DVD lesson acted as a component of a cognitive system that was meant to support learners to understand even more complex concepts that would have been otherwise difficult to understand. The integrated approach also increased the opportunities for learners to interact with each other, the teacher, content and the instructional resources as they were expected to complete certain activities during the lesson as compared to just watching the DVD passively. To a certain extent the teacher's lesson plans incorporated some elements of the distributed cognitive approach. When one looked briefly at the three lessons for instance, the following pedagogical elements which support distributed cognition could be identified:

- Group or Class discussion – These allowed interaction between learners themselves as well as the teacher and hence provided a platform to prompt learners' conceptions and correct them where necessary (lesson 1 and 3). However, it was minimised to just a discussion of answers to the questions at the beginning or the end of the lesson. The lessons themselves were not activity based.
- Question and answer session – These allowed for an interaction between the individual learners and the teacher in the presence of other learners. They provided learners a chance to compare their own ideas with those of other learners (lesson 1 and 3). Therefore, learners in this case could correct their own naive ideas.
- Classroom tasks or exercises given by the teacher or given in the DVD lesson – These allowed for an interaction between learners and the content with the assistance from the teacher and learning tools (lessons 1, 2 & 3).
- Watching the DVD with its multimedia representations for content understanding – provided an interaction between the learners and the technological tool within a created mining context (lessons 1, 2 & 3).

Analysis of the three sampled lesson plans showed that the interaction amongst learners and between learners and their teacher was minimal, that could pose a risk of limiting the learning opportunities that could be offered by a multimedia learning environment. Learning opportunities could be optimised by facilitating activity based learning, where learners interact with the learning environment and work jointly with others to solve problems, while getting the assistance from the teacher and the technology tool. Furthermore their contributions could be evaluated for approval or correction by the entire class. In that way comprehension of the content during the lesson would be scaffolded by the teacher, other learners, the DVD material and other learning resources as a cognitive system (Valanides & Angeli, 2008). The literature suggests that through

the functional interactions within the cognitive system, learners could reach the expected level of understanding and hence achieve learning outcomes.

CHAPTER 5: DISCUSSIONS AND CONCLUSION

5.1. INTRODUCTION

In this chapter I will discuss the findings and present the implications, recommendations and conclusion of my study.

5.2. ANSWERING THE RESEARCH QUESTIONS

- **The first research question -** What influence does a multimedia DVD Science content series have on learners' understanding of some chemical systems concepts? The two-tailed t-test performed on the post-test mean scores of the two groups revealed that statistically there was no significant performance difference between the two groups. That implied that the usage of a multimedia DVD for teaching the chemical systems concepts did not lead to improved test scores amongst the experimental group learners**.** Also descriptive analysis on the pre-test and the post-test data showed that there was an improvement in the quality of responses from pre-test to the post-test, but this improvement was seen in both groups following a similar pattern.
- **The second research question -** What are the attitudes and perceptions of learners with regards to the nature of challenges and benefits experienced when using the DVD material to learn chemical systems topics? To answer this research question, descriptive analysis of learners' questionnaire and interview data was done. The data analysis showed that learners in general held positive attitudes and perceptions about having multimedia supported lessons. Learners chose more positive responses about the DVD-supported lessons during the questionnaire stage. Also during the interviews learners mentioned more benefits than challenges. During the interview stage learners mentioned the following challenges and benefits about the multimedia-supported lessons:

Challenges:

- Non-interactive mode of the DVD since learners had to wait for the explanation time for them to ask their questions. Sometimes when that time arrived learners had lost interest to ask their questions
- Low sound of the DVD player even when the volume was set at maximum level
- fast pace of the DVD lesson made it difficult to understand the explanations
- difficult language (English) used in the DVD also hindered the understanding of content

Benefits:

- Watching how people working with rocks in the mining scenery in the DVD lesson triggered passion and interest to become geologists
- Multimedia brought scenery into the classroom so that learners could see what they were learning about
- Learners appreciated the DVD's graphics accompanied by explanations and learners' activities
- The visual graphics and the playback features of the DVD were mentioned as learning enablers that offered learners an opportunity to understand the gold and phosphate mining processes and that ensured recalling during exams
- Learners acknowledged that the DVD material could supplement what the teacher taught by demonstrating the processes with graphic concrete examples to enforce understanding

- **The third research question -** What are the teacher's attitudes and perceptions about using the DVD material for teaching?

The teacher displayed positive attitude and perception about integrating the multimedia DVD material into his Science lessons. He mentioned the following benefits:

- ICTs promote learning because they show the reality of Science, making it easy for learners to understand the content within an artificial concrete context created by the multimedia DVD.
- Learners enjoyed seeing things happening
- The DVD's graphics and demonstrations made it easy for the teacher to explain concepts
- Through the DVD usage, the teacher was able to handle the third learning outcome as he had always found it difficult to make learners understand and imagine chemical systems concepts
- The teacher's process of lesson preparation was made easy by using the DVD material
- The learners' discipline improved as they had to be attentive to hear the DVD sound

Although he promoted e-Learning, he also mentioned some challenges, most of them were not about the DVD itself but were rather contextual. Some of the challenges are as follows:

- Electricity cut offs delayed or disturbed the lesson
- Sound system of the TV was low
- Lack of concentration from learners lead to drowsiness
- Lack of access to the DVD equipment during the Physical Science periods

5.3. SUMMARY AND DISCUSSIONS OF RESEARCH FINDINGS

This study set out to contribute to a literature that seeks to explore ways of improving Science learning which can lead to improved academic results and increased interest of choosing Science as a subject at high school level. The DoE (2000) has prioritised Physical Science as one of the critical Subjects that needs

serious intervention. This research responded to the DoE's calling of integrating ICTs into the teaching and learning of all subjects including Physical Science (i.e. implement e-Learning) in order to improve the quality of teaching and learning. However the shortage of ICTs in schools especially those that are in the townships and insufficient ICT budget allocation to schools from the government, hinders the immediate implementation of the e-Learning policy. For instance schools only get 6% of their LTSM funds (GDE, 2010) for procuring laboratory equipment. This allocation is not enough considering that generally ICTs are expensive and the 6% is supposed to also cater for Science laboratory equipment. This study then focused on a "case" in one of the under-resourced township high schools aiming to establish if the use an affordable ICT resource, in the form of multimedia DVD lessons, can have a positive influence on the performance scores of learners especially on topics that fall under the core knowledge area of chemical systems. One should explain that topics under this theme tend to be practical and relate to real Science activities that are conducted in the industrial world. Because teachers and learners lack the experience of the outside world, they are likely to find it hard to relate to these scientific concepts and processes. Therefore the DVD lessons used in this study had a potential of bringing the outside world into the classroom in order to close the gap between the classroom and the outside real world. So the DVD lessons were introduced to act as learning enablers that would scaffold the learning process not only for learners but also for the teacher in some instances. Based on the literature that supports the use of instructional technologies in teaching, the study anticipated that the multiple representations of the DVD would provide affordances that would promote the understanding of complex scientific processes and concepts (Kozma, 2000). According to the distributed cognition framework, the DVD as an instructional tool, the content to be learned, the people (i.e. learners and the teacher), cultural background and the learning environment as a context, formed what is known as the "cognitive system" (Chan & van Aalst (2008); Hollan et al., 2000).This means that in order for optimal learning to occur, there should be functional interactions between all the components of the cognitive system.

Deduced from the strong teacher's support that ICTs can enhance teaching that were displayed by the questionnaire and interview data, one expected that the experimental group would perform better than the control group. However statistical test results showed that the performance was not significantly better, which means that the intervention did not have a positive impact on the learning and understanding of scientific content. This finding contradicts the literature findings from a study conducted elsewhere in the world by Jennings et al., (2007) which reported that students showed significant learning gains after using a multimedia DVD for Physical Chemistry. Explaining this finding seemed to be more complex than my study could reveal, so one had to look at the possible factors that might have contributed to it although this dimension was not the focus of this study initially. When looking back at the data from the teacher's interview, lesson plans, and questionnaire, one realised that some contextual factors might have contributed to this finding and hence they needed to be considered when interpreting the results. From the data, the following contextual factors as learning barriers were identified:

- Passiveness of learners during the first multimedia lesson.

Based on the findings, it could be claimed that the passiveness of learners was related to two factors. **Firstly,** the fact that the DVD lesson was not interactive, so all what the learners were expected to do was to sit and watch the lesson from start to finish with only two questions posed to them throughout the lesson. As a result some learners felt drowsy. This claim was confirmed by the teacher and some of the learners during the interview.

"They acted like they were watching a movie, and not taking notes or asking questions" (The Teacher – line 111).

"I *relaxed as it felt like I was at home. I felt asleep due to the lack of interaction. I was not used to that teaching style. I lost focus."* (Learner 1 – lines 64 - 66)

"*I prefer the normal teaching because I can understand better on it. In a multimedia lesson I feel asleep. I cannot focus for a long time. I can ask the teacher questions in the normal lesson".* (Learner 8 - lines 37 - 40)

"*I prefer the traditional teaching; it's easy to ask the teacher questions and exchange questions so that he can also answer them. Multimedia lesson does not cater for that".* (Learner 3 – lines 33 - 35)

Ayersman (1996) supports this claim by stating that those ICT programmes that actively involve learners in the learning process are more likely capable of resulting into higher academic achievement than those that put learners in a passive role. The DVD lessons comprised of explanation of new information by the tutor, demonstrations, scenarios, graphics, animations, explanation by experts in the different fields using concrete examples, questions and answers and learners' exercises. So one could say that learners could participate actively only during the last two stages. Even in those stages it can still be argued that the interaction could have been enhanced by assigning those exercises in groups instead of individual learners so that ideas could be shared to allow cognition to be distributed socially across the learners, content and the learning tools. This is a prerequisite for learning under a distributed cognition learning environment and is explained well by Chan and van Aalst (2008) when they argue that teachers need to create spaces where learners can jointly make meaning because they are not mere information receivers.

I also believe that learning opportunities could have been maximized by assigning group homework activities in some afternoons where learners could be allowed to revisit the DVD lesson on their own to answer the questions maybe after school so that they get an opportunity to manipulate the DVD material to suit their learning needs. Four out of eight learners suggested this during interviews when questioned on how they would like to learn when using the DVD:

"*By using the second and third methods. As a group we have different opinions we can discuss with each other for study purposes.*" (Learner 1- lines 45 - 47)

"To study with group mates, discussing and teaching each other, then watch the DVD again to help each other". (Learner 2 – lines 42 - 44)

"*Studying with the group after the teacher has taught. I like to use it in a group so that we can discuss and always play back to understand better. I liked the playback feature*". (Learner 3 – lines 41 - 43)

"*Actually two options, two and three both of them. I can rely on both of them. I prefer method three i.e. to be used as a group of students, so that we can see if we understood what was taught well and we can also discuss our ideas to check our understanding*" (Learner 4 – lines 44 - 46)

Secondly, the teacher did not prepare his learners for a different learning experience. He did not discuss what will be expected of them in that learning environment, for instance he could have asked them to take notes and jot down their questions to be asked when the lesson ends. That discussion would assist in mapping out the sequence of a multimedia lesson, so that learners could immerse into the lesson for a meaningful learning to take place. Again this is because learners are supposed to be actively engaged in their learning process as their cognition depends on their participation; they are an important component of a cognitive system.

- Lack of teacher's pedagogic ICT skills

During the interview the teacher revealed that when he started to use the DVD lessons, he played the whole lesson continuously until the end and only after this he followed-up with his own supplementary teaching. However after realising that the learners were battling to concentrate, he started to "pause" the lesson from time to time to ask questions, explain concepts and allow learners to ask questions

"*They were playful at first and not interested as they were not used to that type of teaching. They acted like they were watching a movie at first, not learning while some information passed"* (Teacher – lines 111 -112)

His new approach allowed for an active participation of learners. To me, this suggested that at the beginning the teacher did not have sufficient technological pedagogic knowledge of how to effectively and wisely use the DVD lesson to support his teaching. This might be due to the fact that he only attended two days of training on how to use the equipment i.e. to operate the equipment technically, and not how to integrate it into a science lesson in order to achieve the relevant learning outcomes. This might have been problematic because the teacher might have not known how and when he should use the DVD. My opinion is that the teacher gained technological pedagogic skills during this research through trial and error method. It is my argument that introducing the DVD or any other technological tool into a lesson where there is a lot of information given to learners and very little activity does not necessarily lead to better learning. The important realisation is that in a multimedia-supported lesson, teachers need to adapt their lesson plans around the instructional technology at hand. The technological tool itself should inform the instructional method to be used i.e. the nature of learners' activities that will be done by learners during the lesson and the scaffolds that will be employed by the teacher to help learners to complete the given tasks. I think that in this way, full advantage of a multimedia tool can be taken. Stols (2008) and Lim (2002) support this claim by saying that technological tools may fail to support teaching and learning if teachers do not know the benefits, pitfalls and misconceptions of each technology in order to decide when and how to use each tool.

- Lack of access to resources

Although the teacher initially planned to offer multimedia-supported lessons during his normal periods, circumstances forced him to offer them only after school. The ICT resource was physically available and in a good working

condition but the poor organization and management of it made it impossible for the teacher to access it during his teaching periods but only after schools. The likelihood was that by that time learners might have been tired to conceptualise new content. Furthermore, the usage of the resource was limited. He confirmed this when asked if he thinks he used the DVD enough in this research.

"*I used it less than 20 days. Not enough because it was used after school. The class that was having the equipment was hosting a different academic grouping of learners, so we had to wait for them to exit the room before using the material. Sometimes they were hesitant to leave because they still did their homework or wanted to study. That consumed time. My learners were mostly tired after school. I would have loved to use it more often."* (Teacher – lines 43 - 51)

Other authors such as Becta (2004); Wekesa, et al., (2006); Gipson (1998) and Nieuwoud, et al., (2007) also confirm that the above factors can indeed act as barriers to effective impact of instructional technologies. In addition they mention the following barriers:

- Lack of general technology proficiency

In this study specifically I can relate to the teacher's ICT anxiety because of the technical problems he experienced during his lessons as a result of the frequent power failures. These disturbed and delayed the lessons. He mentioned for instance that the system took long to upload again and fast forward to where the lesson was at before the power cut. Furthermore there was a number of trouble shooting operations that he was not able to perform:

> *"I would say rewinding the lessons and fast forwarding. Yes troubleshooting also proved to be problematic (Teacher - line 18). The other difficult thing was to load the information from the server to the receiver if you don't want to use the pre-loaded one or you want to update or correct the information that is outdated*." (Teacher – lines 23 - 26)

Another aspect to consider is that the teacher did not have any training on how to use technological instructional tools during his pre-service training. I argue that the two days of training that the teacher had undergone on how to operate the technology was insufficient given the fact that it was not followed by an immediate usage. Stols (2008) argues that teachers need to be empowered with adequate technology skills to use when the technology does not respond as expected.

By mentioning the above contextual factors I am acknowledging that the findings cannot be read in isolation because in the absence of one or all of these factors, the research findings might have been different.

5.4. LIMITATIONS OF THE STUDY

The researcher acknowledges that there were limitations that might have impacted negatively on the findings of this study. Mentioned below are a few that could be identified:

5.4.1. Data collection Instruments:

The researcher relied solely on the data collected through the usage of interviews, questionnaires, teacher's lesson plans, pre-tests and post-tests. There were no observations done by the researcher at all stages of the research. This implied that the researcher got a picture of what was happening in the classroom through the teacher's lesson plans. Although during the interview the teacher affirmed that he used his lesson plans without any adjustments, the rich context of classroom could not be covered in a written lesson plan, so some of the important data might have been missed. Also, the work designation of the researcher put her in a position of power over the teacher as the school fell directly under the district in which the researcher worked. That might have influenced the teacher to respond in certain ways that he thought might sound appropriate.

Questionnaires' Likert scale:

Brunier (1996) argues that Likert scales have a tendency of confusing the respondents in cases where their responses fall in between the categories (e.g. between strongly agreed and agreed or strongly disagree and disagree) resulting in contaminated findings. To avoid that, a 3-point Likert scale was used in this study instead of a 5-point Likert scale that is widely used in educational research. This was done to ensure that the categories differed completely from each other making it easy for respondents to choose. However, It is important to acknowledge that by using a 3-point Likert scale the researcher was only able to measure learners' and educator's attitudes about the multimedia-supported teaching but she could not measure the extent to which the learners or the teacher held those very same attitudes. However this analysis was regarded as sufficient for this particular study given that other attitudes and perceptions data came from interviews, also considering that the study was of a small scope.

5.4.2. Research duration and teaching methods:

The research duration was short (limited to six weeks only) because of the master's course demands. The duration of the course is supposed to be two years for part time students. Of the six weeks, only three weeks of one hour period per day were used for the multimedia-supported lessons, which was not adequate to be in a position to measure its full impact on the teaching of scientific concepts. Even during the two weeks of experimentation, the multimedia lessons for the experimental group could only be administered after school due to the lack of access to a multimedia room during school hours. By that time learners might have been too exhausted to comprehend the content or take full advantage of the DVD's affordances. Also, exposing both groups to the same teaching for three weeks and then repeating the same teaching with one group exposed to the intervention might have had a negative impact on the research findings as learners might have lost interest of learning the same content all over again. This could have been avoided by starting the intervention straight away at the same time as the traditional teaching of the control group.

5.4.3. Research Scope:

Only one school was involved in this study. The researcher acknowledges that there was a likelihood that learners from the experimental group could interact with those of the control group since they belonged to the same school. Also that, through their interactions they could share some information about the multimedia-supported lessons out of the excitement about the intervention as the research literature suggests. However the researcher assumed that this sharing could barely go deeply into the details of the scientific concepts and processes taught during the multimedia supported lessons. Because in this research the focus was on assessing the learning gains in the Science content as a result of the exposure to the intervention, the researcher regarded this limitation as having little or no impact on the study findings. Also only one teacher participated because he taught both grade 11 classes, so only his perceptions were catered for. Therefore the research findings are applicable to this sample only and cannot be generalized to other schools.

5.5. IMPLICATIONS

According to the post-test data, the use of a multimedia DVD lesson did not produce significant positive learning gains for the experimental group. This is regardless of the fact that there were some conceptual shifts displayed by the manner in which learners answered all questions from a level of no understanding to a level of partial or full understanding. However, based on the other findings, especially from the interviews (both teacher and learners) it was evident that the use of DVD lessons seemed to have a potential of improving teaching and learning. This was deduced both from the teacher and learners' positive perceptions and attitudes towards using DVD lessons. Since the study was looking at exploring ways that will positively transform classroom practice, this was interpreted as suggesting that the DVD lessons have a potential of improving the teaching and learning of Science. However the implications pertaining to the effective use of multimedia DVD lessons which were drawn directly from the study are as follows:

Adequate training of teachers on how to use the ICT as an instructional resource is needed.

It is vital to orientate teachers on how the whole system works and to give them tips of how to trouble-shoot. In addition to that they should also be trained on various ways in which the DVD lessons can be used to satisfy the different roles of a Science teacher in a classroom. This can assist to improve the teacher's confidence hence reducing the anxiety of using the resource and increasing the willingness to use it. It is important to also give teachers an on-going technical and pedagogic support as they continue to use the resource. Stols (2008) states that even when the teacher has pedagogical content knowledge and content knowledge he still needs to have technological pedagogical knowledge as well, so that he can know how and when to use the technology resource. The use of an ICT resource should be within other teaching methods such as lecture, group work, tutorials to allow active participation of learners. This would ensure that the teacher uses the resource to meet the different learning needs hence ensuring that the expected learning outcomes are achieved by all learners. Through training, the teacher can gain the skill of using the resource for teaching, assessment and remedial purposes.

Continuous availability and accessibility of the ICT resource to teachers and learners should be ensured.

For all the classes that are entitled to use the resource, the allocation of resource and teaching timetable should cater for that (Stols, 2008). This will encourage the teacher and learners to use the resource whenever convenient and necessary for them. Issues of maintenance of the resource should also be clearly outlined to ensure continuous access.

Good ICT integration plan for the entire school should be in place.

It is important to have an integration plan so that easier integration can be ensured. The plan can outline which ICT resources are available for which subjects and grades so that they can be allocated to those classes. The plan can

cover issues of access, safety and security measures, maintenance and management of the resource. This can address issues of equipment and infrastructure, human infrastructure and support staff as mentioned by Stols (2008).

There should be adequate lesson preparation for appropriate integration and maximised learning.

For successful integration the teacher needs to preview the DVD lesson while preparing his lesson. This will allow him or her time to decide on how he will introduce the lesson and what follow up activities will he employ such as class discussions, or solving problems posed on the DVD lesson or from the textbook. He can develop ways of linking all resources available to assist him in achieving his learning outcomes. For instance, at the beginning of the DVD lesson, lesson outcomes are given to learners (Refer to appendix L for the teacher's lesson plans). These outcomes cater for different skills such as recalling, analysing data, explaining relationships and applying knowledge to different contexts. The task at the end of the lesson provides the teacher with an assessment opportunity. So the success of achieving learning goals depends entirely on how the teacher plans to use the DVD integrated to other available resources to maximise the learning process. Chan and van Aalst (2008) support this notion by stating that in order to make an ICT relevant to education, there needs to be a healthy relationship among pedagogy, content and technology.

5.6. RECOMMENDATIONS

Based on the study findings, recommendations are made to four stakeholder groups namely the designers of DVD lessons, Science teachers, future researchers and the department of education.

My opinion is that the DVD in its current form **has a potential** of improving Science teaching and learning. My argument is that although the academic performance of the experimental group was not significantly better than that of

control group in this study; the performance was not significantly lower either. So, the results of this study did not in any form show that the usage of a multimedia DVD hinders learning such that it can be regarded as a bad instructional tool. In contrary the results showed other affordances that it offered even though they did not lead to improved academic scores. Chan and van Aalst (2008, p. 313) argue that:

"Learning cannot just be measured with academic performance; a complex array of factors and indices need to be examined to trace progress of learning, cognition and understanding"

For instance, the qualitative data showed that within the experimental group there was a significant improvement of test scores from pre-test to post-test. But, considering that there were contextual factors such as the lack of access to the technology that led to the DVD lessons conducted after school instead of during the Science periods, this could have led to a decline of performance scores. In addition, the majority of learners supported most of the DVD's features or aspects such as its teaching style, graphics, demonstrations, scenery and animations. They commended the DVD for exposing them to techniques, experiments and demonstrations that are not feasible to be performed in a classroom environment. They indicated that the DVD demonstrated more than a teacher or textbook would. Qualitative data also showed a strong support for the DVD-supported lessons from the teacher. He actually believed that it offered better learning opportunities. He blamed the lack of improvement on the post-test to other factors such as:

- Time constraints of having lessons after school.
- Tiredness of learners after school.
- Inconvenient accommodation.

Most learners however had a problem with the teaching pace. They said it was too fast for them to understand concepts. So I recommend that the designers of the DVD lessons should slow down the teaching pace. The quality of the sound level

of the system should be looked at in order to improve audibility in larger classes since the teacher and learners complained about the low sound level. My recommendation to the Science teacher is that: over and above the adequate planning of how to use the instructional technology, he can maximise learning by arranging learners into pairs or small groups while working on problem solving activities to promote distribution of cognition. All the classroom activities should be centered on the instructional technology so that there is correlation between pedagogy, cognition and technology (Valanides & Angeli, 2008).

The interview data showed that the majority of learners preferred that the DVD be used as a supplement to the lecture and experimental methods rather than being used in isolation. They also indicated that it can be useful if used to revise the concepts that have been learned already. This is because the DVD lesson was non-interactive, so its success to assist learners to learn better depended on how the teacher created chances for active learner participation during the lesson. For instance, if he used it in isolation from other teaching methods there was a high possibility that some learners would lose focus and fall asleep. Therefore my recommendation is that future studies can look at the impact that can be brought by the DVD lesson if used by learners themselves to reinforce the already learned concepts i.e. for study or revision purposes. The DVD in its current form is designed for teacher use, so the designers can make it more suitable for learner use by creating more interactive chances for learners so that they can control the way they access the information while learning new content or reinforcing the already learned one. Another way of improving the DVD for learner use is to change it into a DVD for exploring or investigation that will help learners to master scientific procedures and make important scientific findings. This is in accordance with Valanides and Angeli (2008) who claim that in order for maximised learning to occur within a distributed cognition environment, the instructional technology should provide working spaces that allow learners to communicate, share ideas and organise information collaboratively so that individual learner's cognition can be distributed across the entire cognitive system

for evaluation and correction if necessary. These authors claim that educational technology that fails to host collaborative interaction can fail to optmise learning opportunities. The other recommendation to the DVD designers is to offer continuous technical and instructional support to the teachers since it is clear that donating instructional technology resources to schools alone will not assist in improving the quality of teaching.

Also because this study was based on one high school in the semi-urban township, it can be important to establish if the impact would be similar if done on a different socio-cultural and economic background i.e. the future study could focus on one urban school and one rural school. The research period can also be increased to measure the full impact of multimedia-supported lessons.

For the DoE, the findings suggest that an integrated plan of resourcing the schools with ICTs will go a long way in ensuring that the e-Learning policy is implemented in public schools. The study revealed that the Science teacher involved in this study was willing to integrate ICTs in his teaching, but for effective integration that will take advantage of all possible benefits; he equally needed necessary professional development. A longitudinal study with more teachers can establish if this interest can be generalised to other teachers, one teacher's beliefs and experience can hardly apply to other teachers.

5.7. CONCLUSION

This study responded to the DoE's initiatives to introduce new content in the secondary schools' Science curriculum and into integrate ICTs in the teaching and learning of various subjects. This study intended to contribute to the literature that explores ways of improving Science instruction around the world. For that purpose it explored the impact that can be brought by the use of multimedia DVD lessons on the learners' understanding of scientific concepts while also assessing the attitudes and perceptions of learners and teachers about using the DVD for teaching and learning. One also sought to take note of the nature of challenges

and benefits that were experienced when using the DVD material as a teaching tool.

The outcomes of the study indicated that the use of the DVD material for teaching and learning had no significant effect on the learners' performance scores. Although the reason for this result was not explored in this study, it would seem that perhaps the spill over effect between the experimental and control groups that was mentioned earlier under the section on limitations was more influential than it was thought to be.

However, of utmost importance, is that the study findings gave an insight that the Science teacher was keen to adopt ICTs as a teaching tool. It showed his willingness to integrate technology into his lessons to transform teaching practice in the Science classroom. The ICTs mentioned here include the hardware and software that is supplied by the government or is procured by the school itself or is supplied by private companies as donations to schools. This confirmation gives hope that schools can implement e-Learning as expected by the government. One of the challenges mentioned as a hindrance to the implementation process is the lack of resources due to the lack of ICT funding from the government in public schools especially in the rural areas. Other challenges include lack of pedagogical ICT skills amongst teachers and poor management of ICT resources in schools. So the plea was for the government to look at including ICT training for teachers during their pre-service training and in-service training for those who are already in the field. The training should focus on empowering teachers with skills to integrate ICTs in their various subjects to enhance learning. Clear guidelines on how to formulate ICT policies in schools could go a long way in alleviating the poor management of ICT resources which will then lead to increased access.

Also, the findings showed that affordable and accessible ICT resources such as the DVD lessons can contribute positively to the teaching and learning of Science. However it was noted that the positive contribution does not necessarily lead to improved learner test scores but may lead to positive attitudes and perceptions of learners about learning real world scientific processes through a multimedia DVD lesson. In this way they are afforded a chance of relating abstract scientific

concepts and processes to practical concrete activities. That can increase learners' chances of achieving the third Science learning outcome that has to do with relating science to the technology, society and environment i.e. learners should be able to identify and critically evaluate scientific knowledge, claims and the impact of this knowledge on the quality of socio-economic, environmental and human development (DoE, 2003).

The DVD lessons in their current form were considered a valuable tool by the teacher and his learners. Amongst the positive features mentioned by learners was teaching style, explanation of content, graphics, demonstrations, scenery and animations. Fast pace of the DVD lesson and the low sound of the system in which the lessons were played was identified as the challenges. Also a strong view came out of the learners that the DVD lessons should not be played in isolation if new content is to be learned, but be integrated into the teacher's lesson so that they can still hear their teacher's explanation of the content and they can also ask him questions whenever is necessary to enforce understanding. It would therefore seem important that educational software developers should put more effort in developing software that is interactive in order to maximise learners' participation. Before the teachers use the software, they should be given orientation and training on how the software works so that they see the benefits it can bring to the teaching of Science. During the process of using the software teachers should be given ongoing technical and pedagogic support to nature their skills to use them to expand learners' cognitive opportunities.

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Appendices

Appendix A: Knowledge Test

TEST [58 MARKS] [DURATION: 60 MIN]

MAME: _____DATE: _____

INSTRUCTIONS

- **This test will not affect your marks; it is for the purposes of the research.**
- **Confidentiality of your results is guaranteed.**
- **Please answer all questions.**
- **For each question, please write as much as you can.**
- **Where you do not know the answer, write "I do not know"**

1.1. Set out in a table:
   (a) Four positive aspects of mining
   (b) Four negative aspects of mining (8)
1.2. Explain three ways in which metals can be extracted from their compound.(6)
1.3. How does the method used to extract a metal from its ore depend on its position in the reactivity series? (2)
1.4. In each of the following cases, suggest a method of extracting involved:
   (a) Silver from silver sulphide (2)
   (b) Zinc from zinc sulphide (2)
   (c) Magnesium from magnesium chloride (2)
1.5. What is cyanidation? (2)
1.6. Write down a balanced chemical equation for cyanidation. (6)
1.7. Explain why although South Africa has large gold reserves, the cost of gold mining in South Africa is not cheap. (4)
1.8. For the reaction of carbon monoxide and iron oxide, write down the:
   (a) Oxidation half reaction
   (b) Reduction half reaction
   (c) Balanced chemical equation. What is the name of this process? (8)
1.9. Explain three steps of phosphate mining. (6)
1.10. What is the biggest pollution problem that phosphate industry in South Africa is currently facing? Give a reason for your answer and supply a possible solution to this problem. (4)
1.11. Calculate the percentage of phosphorus in the fertilizer ammonium phosphate $(NH_4)_3PO_4$? (6)

(NB: Learners were supplied with a separate answer sheet to ensure that they get enough space for answering each question)

Appendix B: Knowledge test memorandum

1.1.

Positive Aspects of mining	**Negative Aspects of mining**
1.Provides raw materials for local manufacturing industries	1. Mining may damage the local communities may have to be moved.
2. The metal extracted can be exported, bringing foreign money into the country	2. In order to mine, local communities may have to be moved.
3. Mining provides employment for many people	3. Mining can de-stabilize the surrounding land.
4. Roads and services which are provided for the mine and to transport materials to and from the mine can benefit local communities.	4. If migrant labour is brought in it may cause social problems, as men are far away from their families and are not part of local communities

1.2**. Heating** – no chemical reaction needed only heating for least reactive metals found bottom of the reactivity series

Heating with carbon or carbon monoxide (reduction) – oxygen that is combined with the metal is removed by using the reducing agent

Electrolysis – for most reactive metals electrolysis method is used where in Electricity is used to separate ions from each other.

1.3. If the metal is high up on the table of reactivity, a strong method of extraction (electrolysis) is required. Midway the table metals can be extracted by reduction and metals low on the reactivity table only require heating.

1.4. (a) heating
(b) reduction
(c) electrolysis

1.5. Cyanidation is the extraction of gold metal from the ore by dissolving the ore in a cyanide solution.

1.6. $4Au + 8NaCN + O_{2} + 2H_2O \rightarrow 4NaAu(CN)_{2} + 4NaOH$

1.7. Gold is now found in deeper levels so expensive cooling equipment and technology is needed to mine gold.
The cost of chemicals, water, electricity and dynamite needed to extract gold has risen and the selling price of gold has dropped.
As society becomes more aware of employers responsibilities, mining companies have to provide more social services for their workers.

1.8. 1.8. $CO \rightarrow CO_2 + 2e^-$ (Oxidation half reaction)

$Fe^{3+} + 3e^- \rightarrow Fe$ (reduction half reaction)

$2Fe^{3+} + 3CO \rightarrow 2Fe + 3CO_2$ (Net balanced reaction)

1.9. The phosphate rock is mined in open cast mines.
Large trucks transport the blasted rock to crushers where it is milled.
The phosphate rock containing clay and sand is mixed with water and filtered to get remove clay from the phosphate and sand mixture.
Floatation process is done to separate sand and phosphate from each other.
This phosphate rock is then reacted with sulphuric acid to get phosphoric acid.
Phosphoric acid is reacted (neutralized) with ammonia to get ammonium phosphate. (6)

1.10. The phosphate mining can lead to the disposal of unwanted gypsum ($CaSO_4$)
i.e. the radioactive gypsum.
It can also lead to leaching of phosphates into subterranean water and rivers.
Although SA is using phosphate based fertilizers to combat the food shortage problems, phosphate fertilizers can lead to the pollution of rivers and excessive algae growth in lakes and dams.

Possible Solutions:

- *Rehabilitation of waste dumps and tailing dams.*
- *Run – off Water should be recycled as far as possible*
- *Tailing dams should be covered with top soil and replanted to prevent pollution.*
- *Only correct amount of phosphate fertiliser should be provided to the soil so that plants can use all of the phosphate to prevent excess phosphate from being washed away.*

(4)

1.11. $M (NH_4)_3 PO_4 = 3(14+4) + 31 + 4(16)$
$54 + 31 + 64$
$149 g/mol$

$$\% \text{ of phosphorus} = \frac{31}{149} \times 100$$

$= 20, 8 \%$

Appendix C: Learners' interview schedule

1. You do physical science as one of your subject, what is your opinion about its level of difficulty? its level of difficulty?
2. Do you have access to educational CD's and DVD's at home?
3. How long have you been using the DVD's or CD's?
4. Do you watch broadcasted television lessons? How often?
5. Have you ever learnt physical science using ICT such as computer software, internet, simulations, etc?
6. *What* did you like most about the multimedia lesson?
7. What were the aspects of the multimedia lessons that you did not like?
8. Between multimedia lesson and your usual lesson, which one do you prefer? Why?
9. What is your preferred method of a multimedia DVD lesson?
    i. Alone in class
    ii. With the teacher, incorporated into the lesson
    iii. For study purposes alone or as groups
10. In your own opinion, did the teacher adequately incorporate the DVD into his lesson?
11. What were the benefits that you experienced when using the multimedia lesson?
12. What challenges did you experience when exposed to a multimedia lesson?
13. Your test scores have improved from pretest to posttest, but you initially did not support the use of multimedia lesson before. Any reason for that?

Appendix D: Learners' interview transcript

LEARNER 1:

1. Interviewer:	You do Physical Science as one of your subject, what is your opinion about its level of difficulty?
3. Learner:	It is not difficult but if you think it is difficult, then it will be. You must have passion for it.
5. Interviewer:	Do you have access to educational CD's and DVD's at home?
7. Learner:	No, I only use textbooks.
8. Interviewer:	Do you watch broadcasted television lessons? How often?
9. Learner:	Yes, matric supplement where a science lesson is taught and two teams from different schools compete by answering questions based on the lesson. I've been there once with a team from my school. We enjoyed it but we lost.
14. Interviewer:	Have you ever learnt physical science using ICT such as computer software, internet, simulations, etc.
16. Learner:	Yes, in the school computer lab where our teacher taught organic chemistry.
18. Interviewer:	Was it good?
19. Learner:	I enjoyed the lesson but the lesson should be taught first, then watch it on the computer, not the other way round. It was a good lesson.
22. Interviewer:	What did you like most about multimedia supported lesson?
24. Learner:	Everything becomes clear. Pictures especially as science is about things you touch, see and feel. When scenery took us to different places that were relevant. Looking at the DVD's examples make me understand better to see things as they happen practically.
29. Interviewer:	What aspects of the DVD supported lesson you did not like?
31. Learner:	I did not like starting with the DVD lesson; or teach before the DVD is played or else the explanation should go with the DVD. The pace was fast, I could understand it after watching it for the second time. Presenters talking very fast.
36. Interviewer:	Between multimedia lesson and your usual lesson, which one do you prefer? Why?
38. Learner:	Both of them, but mostly the usual one because it is easy to interact with the teacher, ask questions whereas that cannot be done in DVD lesson, so integration is better.
41. Interviewer:	What is your preferred method of a multimedia DVD Lesson? i. Alone in class

ii. With the teacher, incorporated into the lesson
iii. For study purposes alone or as groups

45. Learner: Second and third methods. The third method as a group we have different opinions we can discuss with each other for study purposes.

48. Interviewer: In your own opinion, did the teacher adequately incorporate the DVD into his lesson?

50. Learner: Yes it was enough but I would have loved more explanation from the teacher.

52. Interviewer: How did he incorporate it?

53. Learner: The teacher had his own understanding. Introduce the chapter, played the DVD paused, explain further.

55. Interviewer: What were the benefits that you experienced when using the multimedia lesson?

57. Learner: Seeing things happening improved the understanding, DVD pictures promote understanding when concepts go with the relevant graphics.

60. Interviewer: Did he use the DVD print outs?

61. Learner: No we used our textbooks.

62. Interviewer: What challenges did you experience when exposed to a multimedia lesson?

64. Learner: I relaxed as it felt like I was at home. I felt asleep due to lack of interaction. I was not used to that teaching style. I lost focus. The pace was also fast.

67. Interviewer: Was the language fine?

68. Learner: Yes.

69. Interviewer: Your test scores have improved from pretest to posttest, but you initially did not support the use of multimedia lesson before. Any reason for that?

72. Learner: I did not prepare for the second test.

73. Interviewer: Any reason for that?

74. Learner: Due to too much work from other subjects. I thought I was going to pass it because it was the same test as before.

LEARNER 2:

1. Interviewer: You do Physical Science as one of your subject, what is your opinion about its level of difficulty?

3. Learner: Practice and study it every day. I like Physical Science. It is not difficult since from primary school.

5. Interviewer: Do you have access to educational CD's and DVD's at home?

7. Learner: Yes I have cassettes for Maths, Physical science and English CDs.

9. Interviewer: How long have you been using them?

10. Learner: Since from grade 7, I got a file and cassettes from grade 7 to 11 from the bursary.

12. Interviewer: Do you also watch broadcasted lessons?
13. Learner: Yes, Matric uploaded at 12H00 pm on SABC 1.
14. Interviewer: Do you enjoy them?
15. Learner: I write questions from callers and answers from the presenters for myself. I watch every morning.
17. Interviewer: Have you ever learnt physical science using ICT such as computer software, internet, simulations, etc?
19. Learner: Yes, practicals for intermolecular forces and organic chemistry in the science lab. Interviewer:
21. Interviewer: What did you like most about those lessons?
22. Learner: The teacher taught on the chalkboard and referred learners to the computer unlike just computer without teacher's explanation. I like the way the computer showed examples about stuff. It was enjoyable.
26. Interviewer: What did you like most about the multimedia lesson?
27. Learner: Pictures, graphics, content explanations.
28. Interviewer: What were the aspects of the multimedia lessons that you did not like?
30. Learner: When the tutor teaches and does not show examples or pictures.
31. Interviewer: Between multimedia lesson and your usual lesson, which one do you prefer?
33. Learner: Multimedia one.
34. Interviewer: Why?
35. Learner: Because what I see in the DVD I can also see it at home and in my everyday life.
37. Interviewer: What is your preferred method of a multimedia DVD lesson?
    i. Alone in class
    ii. With the teacher, incorporated into the lesson
    iii. For study purposes alone or as groups
42. Learner: I like to use it to study with group mates, discussing and teaching each other. Then watch the DVD again to help each other.
45. Interviewer: In your own opinion, did the teacher adequately incorporate the DVD into his lesson?
47. Learner: Enough – He used DVD with his explanations
48. Interviewer: What were the benefits that you experienced when using the multimedia lesson?
50. Learner: I gained by seeing how processes occur and examples makes it easy to remember the information even for the test and exams can answer questions using DVD examples.
53. Interviewer: What challenges did you experience when exposed to a multimedia lesson?
55. Learner: There was no teaching before the first test. Pace was fast but the teacher paused when learners asked questions.

57. Interviewer: Your test scores improved just a little bit, what could be the reason for that?

59. Learner: Because I did not study for the second test as we were told that it was same questions as the first test, so I thought I was going to pass.

LEARNER 3:

1. Interviewer: You do Physical Science as one of your subject, what is your opinion about its level of difficulty?

3. Learner: Physical Science is challenging but chemistry is better, physics is complicated. I like chemistry. But I'll make it.

5. Interviewer: How were the test marks up to so far?

6. Learner: March test was okay but I did not prepare well. The June one was okay.

8. Interviewer: Do you have access to educational CD's and DVD's at home?

10. Learner: I have Maths CD from academy of Maths since January 2010. It teaches certain chapters and it's very helpful. My level of Maths has improved because of the DVD.

13. Interviewer: Do you watch broadcasted television lessons? How often?

14. Learner: I watch SABC2 learning channel at 12H00 at night maybe once a week during the week.

16. Interviewer: Have you ever learnt physical science using ICT such as computer software, internet, simulations, etc?

18. Learner: Other ICTs are computer lessons at school covering waves, organic chemistry and even mechanics.

20. Interviewer: What did you like most about the multimedia lesson?

21. Learner: It's interesting because you can see what they are teaching as they teach you, even elements such as lead because we don't know all of them.

24. Interviewer: What else did you like?

25. Learner: They explain content very well. Also there were questions to be answered during the lesson; it's easy to answer because it's something that you saw before. I liked those questions.

29. Interviewer: Between multimedia lesson and your usual lesson, which one do you prefer?

31. Learner: I prefer the traditional teaching.

32. Interviewer: Why?

33. Learner: It's easy to ask the teacher questions, exchange questions so that he can also answer them. Multimedia lesson does not cater for that.

36. Interviewer: What is your preferred method of a multimedia DVD lesson?

i. Alone in class
ii. With the teacher, incorporated into the lesson
iii. For study purposes alone or as groups

40. Learner: I prefer option 3, studying with the group after the teacher has taught. I like to use it in a group so that we can discuss as we are familiar with each other and always play back to understand better. I liked the playback feature.

44. Interviewer: In your own opinion, did the teacher adequately incorporate the DVD into his lesson?

46. Learner: I think it was 50-50 He played enough of DVD lessons accompanied by his explanation.

48. Interviewer: What were the benefits that you experienced when using the multimedia lesson?

50. Learner: Balancing equations was made easier.

51. Interviewer: What else?

52. Learner: Mining of gold was explained well with explanations and pictures that they showed.

54. Interviewer: What challenges did you experience when exposed to a multimedia lesson?

56. Learner: The light was too shinnying for my eyes, some learners ended up sleeping maybe because of boredom.

58. Interviewer: What else about the DVD itself?

59. Learner: Everything else was fine. I liked the video.

60. Interviewer: Why did the test scores in the second test improved when you did not support the DVD earlier in your questionnaire?

62. Learner: I think marks improved due to the multimedia lesson explanation and also my level of preparedness.

64. Interviewer: Anything else you want to say?

65. Learner: I think it would be easier if we could use them in groups after the teacher has taught not for teaching.

LEARNER 4:

1. Interviewer: Which subjects are you doing?

2. Learner: Life Science, pure Maths, Physical science, Geography and Languages

4. Interviewer: What do you think about its level of difficult?

5. Learner: I think it is an easy subject but I need good explanation to understand concepts very well. But I also need to revise concepts and research learned concepts on my own. I like it.

9. Interviewer: Do you have access to educational CD's and DVD's at home?

11. Learner: No I do not have any ICTs at home.

12. Interviewer: Do you watch broadcasted television lessons? How often?

13. Learner: Ya, I do watch TV lessons every day after school from DSTV learning channel and mindset lessons on channel 911 daily if I leave school early.

16. Interviewer: Have you ever learnt physical science using ICT such as computer software, internet, simulations, etc?

18. Learner: Yes my teacher used computer software at school for teaching experiments at school. I love them because when I see them they give me a better understanding than teaching. They give me better understanding. But they are not as good as doing the real experiment. I liked it because it shows the what, how so that I can observe and write conclusions.

25. Interviewer: What did you like most about the multimedia lesson?

26. Learner: I liked the part they taught us about mineral extraction and mining. After I have seen the video my mind changed and now I want to do Geology as a career and I have made my research as well.

30. Interviewer: Between multimedia lesson and your usual lesson, which one do you prefer? Why?

32. Learner: I prefer the multimedia one.

33. Interviewer: Why?

34. Learner: Because I will be repeating them time and time again like I don't forget what I have seen on the Billboards and TV but I will be noting the questions that I will ask to the teacher. So I should be given time to ask questions to the teacher after the lesson.

39. Interviewer: What is your preferred method of a multimedia DVD lesson?

i. Alone in class
ii. With the teacher, incorporated into the lesson
iii. For study purposes alone or as groups

44. Learner: Actually two options, two and three both of them. I can rely on both of them. I prefer method three to be used as a group of students.

47. Interviewer: Why?

48. Learner: So that we can see if we understood what was taught well and we can also discuss our ideas to check our understanding.

51. Interviewer: In your own opinion, did the teacher adequately incorporate the DVD into his lesson?

53. Learner: He played the DVD enough supplemented by his explanations he was pausing and explaining after each and every chapter.

56. Interviewer: How many times have you had multimedia lessons?

57. Learner: For +/- two weeks. Before the first test we were never taught about this topic.

59. Interviewer: What were the benefits that you experienced when using the multimedia lesson?

61. Learner: It gave me a better understanding of science especially when the teacher explained what I have seen on the TV. The pictures and scenery are clearly understandable.

64. Interviewer: What challenges did you experience when exposed to a multimedia lesson?

66. Learner: Some of the learners were making noise and we missed some parts when we kept on calling them into order. The language sometimes was difficult to understand but we asked the teacher during the explanation time.

70. Interviewer: You improved, and you initially supported the multimedia teaching.

72. Learner: I can see that I have improved and I can be able to make it with the multimedia process because it gave me a better understanding of science with the teacher also to ask some questions from my teacher. I did not study if I studied I could have got more marks. I thought I would remember most of the things that I have seen on the DVD. Another thing was that we were told that we were going to write first test

LEARNER 5:

1. Interviewer: You do Physical Science as one of your subject, what is your opinion about its level of difficulty?

3. Learner: It is not challenging you just have to work hard. You just don't have to go to parties.

5. Interviewer: Do you think so?

6. Learner: Yes last year I was not serious so my marks were dropping.

7. Interviewer: Do you have access to educational CD's and DVD's at home?

9. Learner: I do not have any of those even the music CD's.

10. Interviewer: Do you watch broadcasted television lessons? How often?

11. Learner: Yes I do.

12. Interviewer: Which ones?

13. Learner: Matric uploaded every day in the morning. Is it helpful? It is very helpful because if the teacher taught me something that I don't understand like projectile motion I understand from the TV lesson or vice versa. I even ask my friends if they understand it better for me.

18. Interviewer: What time and which channel?

19. Learner: It's on SABC 1 at 5am.

20. Interviewer: Have you ever learnt physical science using ICT such as computer software, internet, simulations, etc?

22. Learner: Yes, Computer software at school by the teacher about momentum and vertical projectile motion, Sci-Bono taught us conservation of energy and momentum. We did practical

on circuit boards in the computer lab as a group of learners with our teacher.

27. Interviewer: Did you understand well?
28. Learner: Yes, the teacher was always mediating the lesson.
29. Interviewer: What did you like most about the multimedia lesson?
30. Learner: I liked it when they were doing practical unlike when you are taught about something that you do not see. It brought a better understanding like the core and the mantle I did not understand it from the book but on the video I saw it.
34. Interviewer: Was it easier to recall the content?
35. Learner: It was better to recall because I still remembered the images and pictures. It took me to the mine; it saves us the money and the time and that was cool.
38. Interviewer: What were the aspects of the multimedia lessons that you did not like?
40. Learner: I could not hear because the sound was low and it goes fast while you are still listening and I missed up on some of the staff.
43. Interviewer: Between multimedia lesson and your usual lesson, which one do you prefer? Why?
45. Learner: I like them both.
46. Interviewer: Why?
47. Learner: Because if I cannot understand this one I can always go to the teacher to ask questions or vice versa so that I can get better understanding.
50. Interviewer: How should it be done?
51. Learner: When the teacher is explaining he can show us the video to show us what is happening so that I can understand.
53. Interviewer: What is your preferred method of a multimedia DVD lesson?
    i. Alone in class
    ii. With the teacher, incorporated into the lesson
    iii. For study purposes alone or as groups
58. Learner: I like the second method better.
59. Interviewer: Why?
60. Learner: Because the teacher is always there to call learners who are not disciplined into order and also he can explain further where we could not understand.
63. Interviewer: In your own opinion, did the teacher adequately incorporate the DVD into his lesson?
65. Learner: He used them adequately.
66. Interviewer: What were the benefits that you experienced when using the multimedia lesson?
68. Learner: I gained that I must listen so that I can understand well. I understood the extraction of gold for me seeing and

listening at the same time increased my understanding. I could always say now I see and that was the best.

72. Interviewer: What challenges did you experience when exposed to a multimedia lesson?

74. Learner: I could not see or hear clearly because I was far from the TV. I loved everything about the DVD but the pace was too fast for me. I think the DVD material was cool everything was clear and understandable.

78. Interviewer: Your second test scores improved, what could be the reason for that?

80. Learner: I think that it was because of the DVD lesson because it gave me a better understanding.

81. Interviewer: Thank you very much

82. Learner: Pleasure

LEARNER 6:

1. Interviewer: You do Physical Science as one of your subject, what is your opinion about its level of difficulty?

3. Learner: To me Physical Science is fair.

4. Interviewer: Why?

5. Learner: It depends on how much you study. It needs someone who studies.

7. Interviewer: Do you have access to educational CD's and DVD's at home?

9. Learner: Yes I have Maths cassette grade 5-9.

10. Interviewer: How long have you been using the DVD's or CD's?

11. Learner: I used for four years.

12. Interviewer: Do you watch broadcasted television lessons? How often?

13. Learner: Yes.

14. Interviewer: Which ones?

15. Learner: I watch study mates on SABC1 for Maths, Science and English.

17. Interviewer: How often do you watch it?

18. Learner: I watch it only during the holidays.

19. Interviewer: Have you ever learnt physical science using ICT such as computer software, internet, simulations, etc?

21. Learner: Yes computer software when we were doing the practicals here at school, seeing how the chemical graphs go. We did it for physics and chemistry.

24. Interviewer: Did you enjoy it?

25. Learner: I enjoyed it because it made me to understand the practical better.

27. Interviewer: What did you like most about the multimedia lesson?

28. Learner: I liked it when they showed how gold is extracted and also the phosphate.

30. Interviewer: Do you think you could have understood it without the DVD material?

32. Learner: I don't think I would have understood it from the book.

33. Interviewer: What were the aspects of the multimedia lessons that you did not like?

35. Learner: It needs the time alone it was fast for me. I could not see some words and could not take some of the notes because it was too fast. It had too much written staff that I could not capture.

39. Interviewer: Between multimedia lesson and your usual lesson, which one do you prefer? Why?

41. Learner: I prefer both of them because when you study alone and after that you can watch the DVD to check if you understood well and you go to the teacher for asking questions if you still have a problem.

45. Interviewer: What is your preferred method of a multimedia DVD lesson?

i. Alone in class
ii. With the teacher, incorporated into the lesson
iii. For study purposes alone or as groups

49. Learner: I prefer the second one.

50. Interviewer: Why?

51. Learner: Because if you start by listening to the teacher once he finishes you go to the DVD to understand better. You do not forget the content, it will stay longer.

54. Interviewer: In your own opinion, did the teacher adequately incorporate the DVD into his lesson?

56. Learner: I think he used it enough.

57. Interviewer: What were the benefits that you experienced when using the multimedia lesson?

59. Learner: Understanding the chemical systems processes like gold and phosphate mining was problematic before but after I watched the DVD lesson I understood better.

62. Interviewer: Do you think it helped when you were writing tests?

Yes I could answer well because I could remember the visuals.

65. Interviewer: What challenges did you experience when exposed to a multimedia lesson?

67. Learner: The challenge was when they used difficult words to explain and I could not ask the teacher at that time but by the time I was allowed to ask questions I had already forgotten what to ask.

71. Interviewer: Your test scores have improved from pretest to posttest, but you initially did not support the use of multimedia lesson before. Any reason for that?

74. Learner: My marks decreased because I did not get enough time to revise the work for the test why? Because there was a lot of work from other subjects like we were writing other tests for Vernac and Maths.

LEARNER 7:

1. Interviewer: You do Physical Science as one of your subject, what is your opinion about its level of difficulty?
3. Learner: It is difficult if you tell yourself it is difficult it will be difficult if you tell yourself it's easy it will be easy.
5. Interviewer: But what should you do to pass it?
6. Learner: You just have to study and practice it every day.
7. Interviewer: Do you have access to educational CD's and DVD's at home?
9. Learner: No I don't have them.
10. Interviewer: Do you watch broadcasted television lessons? How often?
11. Learner: Yes.
12. Interviewer: Which ones?
13. Learner: I watch channel O on DSTV and Matric uploaded.
14. Interviewer: Is it helpful?
15. Learner: It is useful and helpful.
16. Interviewer: How often do you watch it?
17. Learner: I watch Matric uploaded everyday but I watch channel O sometimes.
19. Interviewer: Have you ever learnt physical science using ICT such as computer software, internet, simulations, etc?
21. Learner: Yes, we did electromagnetic last year, this year we did the chemical change and systems at school with our teachers.
23. Interviewer: What did you like most about the multimedia lesson?
24. Learner: I liked when they showed different layers of earth and types of rocks.
26. Interviewer: What else?
27. Learner: Also how gold is extracted. It increased my interest of taking petrology as a career choice. I always thought it is difficult but then I saw that it is easy.
30. Interviewer: Anything else you liked?
31. Learner: I liked when they showed interviews with the university expects and lecturers to motivate us to be like them one day.
34. Interviewer: What were the aspects of the multimedia lessons that you did not like?
36. Learner: The pace was fast making it difficult to understand what they were talking about.
38. Interviewer: What else?

39. Learner: Also when they used the equipment that I saw for the first time in the DVD that was not familiar at our school was problematic.

42. Interviewer: Between multimedia lesson and your usual lesson, which one do you prefer? Why?

44. Learner: I prefer multimedia learning because it uses examples, pictures, practicals and many other things unlike in a book where you just learn things without knowing how they look like. Multimedia learning makes me to understand better when I can see how things work.

49. Interviewer: What is your preferred method of a multimedia DVD lesson?

i. Alone in class
ii. With the teacher, incorporated into the lesson
iii. For study purposes alone or as groups

54. Learner: I would go for the second type.

55. Interviewer: Why?

56. Learner: because when I have watched the DVD and then the teacher explains I will understand it better rather than when I watch it alone I will not understand everything if there are difficult words that I do not understand.

60. Interviewer: In your own opinion, did the teacher adequately incorporate the DVD into his lesson?

62. Learner: He used it adequately.

63. Interviewer: What were the benefits that you experienced when using the multimedia lesson?

65. Learner: I gained the career option I did not know what to do after Matric. It encouraged me to be ambitious when it showed me how mining is done practically. I benefited a lot because I could see those things that were mentioned on the book that I initially did not understand.

70. Interviewer: What challenges did you experience when exposed to a multimedia lesson?

72. Learner: No challenges.

73. Interviewer: Did your test scores improve or not? What could be the reason for improvement?

75. Learner: During the first test I just learned concepts from the book without knowing how they look like but during the second test I could remember the DVD pictures and scenery so that I could answer questions correctly.

LEARNER 8:

1. Interviewer: You do physical science as one of your subject, what is your opinion about its level of difficulty?

3. Learner: I do not think it is hard as long as you commit yourself to the subject you can make it especially the calculations.

5. Interviewer: What should you do to pass it?

6. Learner: You have to study hard, be disciplined, have time management, and study it every day.

8. Interviewer: Do you have access to educational CD's and DVD's at home?

10. Learner: No I do not.

11. Interviewer: Do you watch broadcasted television lessons? How often?

12. Learner: Yes I do and they are very helpful. They are like revision because they can make me understand what I have learned in class. The only problem is that they play them at night so I watch them only during holidays.

16. Interviewer: Have you ever learnt physical science using ICT such as computer software, internet, simulations, etc?

18. Learner: Yes I have used my cell phone for my physical science chlorine information research project and digital camera for my LO project.

21. Interviewer: What did you like most about the multimedia lesson?

22. Learner: When the teacher teaches with the textbook you do not see it but on that day I got to see them practically and then when I write I can be able to remember. Another thing is that the theory part was clear when they explained it. I liked the visuals the most.

27. Interviewer: What were the aspects of the multimedia lessons that you did not like?

29. Learner: When they did the calculations they were very quick I was not able to understand it.

31. Interviewer: Would have liked to view the DVD one more time to catch up?

33. Learner: I would have liked to see the DVD again to revisit what I have missed.

35. Interviewer: Between multimedia lesson and your usual lesson, which one do you prefer? Why?

37. Learner: I prefer the normal teaching because I can understand better on it. In a multimedia lesson I feel asleep I cannot concentrate for a long time whereas I can ask the teacher questions in the normal lesson.

41. Interviewer: What is your preferred method of a multimedia DVD lesson?

i. Alone in class
ii. With the teacher, incorporated into the lesson
iii. For study purposes alone or as groups

45. Learner: I prefer choice number two.

46. Interviewer: Why?

47. Learner: Because if I go there and watch the DVD and the teacher explains at the same time I will understand better.

49. Interviewer:	In your own opinion, did the teacher adequately incorporate the DVD into his lesson?
51. Learner:	I think the playing of the DVD was enough.
52. Interviewer:	What were the benefits that you experienced when using the multimedia lesson?
54. Learner:	What I gained is that I would like to be taught by the teacher and watch the DVD so that if they show me the pictures I can be able to remember well when I write exams.
58. Interviewer:	Did you understand the processes well?
59. Learner:	I understood the processes like gold mining ones I wouldn't have understood them otherwise.
61. Interviewer:	What challenges did you experience when exposed to a multimedia lesson?
63. Learner:	The lessons were too long I could not concentrate for longer in the TV, I fell asleep. The pace was fast.
65. Interviewer:	Your test scores have improved from pretest to posttest, but you initially did not support the use of multimedia lesson before. Any reason for that?
68. Learner:	I did not have much time to study for the first time. I think I improved in the second test I could still remember the DVD's examples and processes so I answered well.

Appendix E: Teacher's interview schedule

Teacher's ICT professional development

1. During your pre-service training were you taught to use any form of ICT for teaching?
2. What kinds of teaching aid do you usually use in your lessons?
3. Did you attend the Mindset teacher training? For how long?
4. How confident are you of using the mindset multimedia teaching equipment?

Teacher's teaching Methods

5. Have you ever used any form of ICT in your science lessons? Which ones? How often?
6. Do you think ICTs promote learning?
7. How often did you use multimedia DVD during your instruction? Do you think you've used it enough?
8. Did you integrate the DVD material as indicated in your lesson plan?
9. Did the multimedia material fit well to your style of teaching?
10. What were the benefits of integrating ICT into your lessons?
11. What were the challenges of integrating lessons into your lesson?
12. How do you think multimedia material can be used to promote understanding of science concepts?

Teacher's attitudes and perceptions about ICTs

13. What would be your concerns about teaching in an ICT teaching and learning environment?
14. What are your opinions about the South African government incorporating ICTs into the curriculum delivery?
15. What is your opinion about learners' attitudes towards using ICTs / multimedia lesson?
16. You strongly supported the use of DVD material to promote learning, but experiment group's performance was not statistically different from that of control group. In your opinion what could be the reason?

Appendix F: Teacher's interview transcript

1. Interviewer:	During your pre-service training were you taught to use any form of ICT for teaching?
3. Teacher:	Not at all, only an OHP overhead projector.
4. Interviewer:	What kinds of teaching aid do you usually use in your lessons?
6. Teacher:	Posters, DVD's, textbooks. I am not sure whether I am correct but we do experiments so we use apparatus.
8. Interviewer:	Did you attend the Mindset teacher training? For how long?
9. Teacher:	Yes.
10. Interviewer:	For how long?
11. Teacher:	1 day in Tembisa in 2008 and another one in centurion in 2002. So two days in total.
13. Interviewer:	How confident are you of using the mindset multimedia teaching equipment?
15. Teacher:	I would say 75% confident.
16. Interviewer:	What other things that you are still not confident about that you would love to?
18. Teacher:	Rewinding the lessons, fast forwarding. Trouble shooting as well. The other thing is we do not have laser pointers to point on the board to emphasise important points.
21. Interviewer:	What components do Mindset equipment composed of?
22. Teacher:	Server connected to the receiver (decoder) connected to the TV. The other thing is that it is difficult to load the information from the server to the receiver if you don't want to use the preloaded one or you want to update or correct the information that is outdated.
27. Interviewer:	Have you ever used any form of ICT in your science lessons? Which ones? How often?
29. Teacher:	Yes, normally I use the computer with DVD that has certain chapters with my big screen 74inch monitor.
31. Interviewer:	Do you use data projector?
32. Teacher:	No data projector.
33. Interviewer:	Other ICTs?
34. Teacher:	Mindset DVD material and cell phones for homework and research using Google after school.
36. Interviewer:	Do you think ICTs promote learning?
37. Teacher:	Yes to make things real. Learners see things happening and believe. When believing they learn better and achieve. It helps to emphasise the reality of science.
40. Interviewer:	How often did you use multimedia DVD during your instruction? Do you think you've used it enough?
42. Teacher:	Less than 20 days +/- 3 weeks. Not enough because it was used after school. The class that was having the equipment was hosting the general subjects' learners, so we had to

wait for them to exit the room before using the material. Sometimes they were hesitant to leave because they did their homework or wanted to study. That consumed time. My learners were mostly tired after school. I would have loved to use it more often. I think the equipment should have been installed it in the lab for easy access; during installation we were not consulted.

52. Interviewer: Did you integrate the DVD material as indicated in your lesson plan?

54. Teacher: Yes, it was possible to integrate as indicated on the lesson plan. I was using the DVD straight forward, pause to explain and answer questions from learners as I told them to raise hands if they had questions. I told learners to raise their hands if they did not understand.

59. Interviewer: Did the multimedia material fit well to your teaching?

60. Teacher: Yes, it fitted well, it was relevant.

61. Interviewer: What were the benefits of integrating ICT into your lessons?

63. Teacher: Learners enjoyed seeing things happening and they learned better. Explaining concepts became easy for me when using the DVD's graphics and demos. The DVD made it easy for me to handle LO3 was always difficult to make the learners understand and imagine chemical concept processes. My preparation of the lesson was also made easy. Their attention improved in order to hear the DVD. Discipline improved. The type of questions they asked showed that they were thinking.

72. Interviewer: What were the challenges of integrating lessons into your lesson?

74. Teacher: Electricity cut off was a challenge. It delayed the system to start again; it took approximately 20 minutes to start. After starting I still had to be fast-forward to where I was before taking more time.

TV's sound was low

Pace and language were fine, I could pause or rewind.

During the first day I was challenged by learners' sleepiness but on the second day I became clever I used the pause button and ask learners questions to avoid drowsiness so they did not have chance of sleeping.

84. Interviewer: How do you think multimedia material can be used to promote understanding of science concepts?

86. Teacher: Location of the material should make the equipment to be accessible. Management and security of the equipment should be monitored. Learners should be showed the importance of the equipment to avoid theft.

90. Interviewer: When the location is right what other things should we do to improve the lesson?

92. Teacher: When preparing the lesson the teachers should first check the DVD information that he is going to use and supplement it with the textbook one. Also the duration of the DVD lesson should be checked to estimate time for other activities.

97. Interviewer: What would be your concerns about teaching in an ICT teaching and learning environment?

99. Teacher: No concerns.

100. Interviewer: What are your opinions about the South African government incorporating ICTs into the curriculum delivery?

103. Teacher: I think It's a good idea, it improves access to the information anywhere anytime for learners like Google.

105. Interviewer: What should the government do to make it happen?

106. Teacher: The government should provide resources like internet and computers. Cheaper technologies like mindset ones could be helpful as a start for underprivileged areas.

109. Interviewer: What is your opinion about learners' attitudes towards using ICTs / multimedia lesson?

111. Teacher: They acted like they were watching a movie, and not taking notes or asking questions at first. They later became interested and enjoyed it. They asked a lot of questions when I paused.

115. Interviewer: Did they give you feedback about those lessons?

116. Teacher: Yes they kept on asking why they can't use it for revision because I also showed them DVD lessons of the lessons already taught.

119. Interviewer: You strongly supported the use of DVD material to promote learning, but experiment group's performance was not statistically different from that of control group. In your opinion what could be the reason?

123. Teacher: It's probably because they acted like they were watching a movie at first, not learning while some information passed.

125. Interviewer: What else?

126. Teacher: Time constraint of having lessons after school. Tiredness of learners after school, inconvenient accommodation, and negative attitude of other learners saying that they think they are better resulted into low morale the environment was not conducive.

131. Interviewer: Any other thing you want to say?

132. Teacher: Mindset should fix the equipment and I'll take responsibility for the equipment to avoid theft. It is a valuable teaching tool; I would love to use it again.

Appendix G: Learners' attitudes and perceptions questionnaire

(Adapted from Thomas & Emereole, 2002)

Name of the school:……
Name of the Learner:……..
Date:……

Please complete the following questionnaire based on your experience of a multimedia DVD supported science instruction by **ticking (√)** the correct box. This questionnaire asks you to describe the important aspects of the classroom you are in right now. There is no right or wrong answers. Your opinion is what is wanted. Your answers will enable us to improve future science teaching. Your answers to this questionnaire will be treated confidentially and will be used strictly for the purpose of this research.

No	**Items**	**Agree**	**Undecided**	**Disagree**
1.	The use of the DVD for learning purposes was an exciting experience.			
2.	In understanding the concepts of the chapter, the multimedia-supported way of presenting materials is better than the traditional classroom presentation.			
3.	The multimedia-supported approach provides a greater collaboration between me as the learner and my teacher.			
4.	My level of motivation in this learning area has increased with the use of a multimedia material.			
5.	The DVD information in all the units of the chapter was clear and unambiguous.			
6.	The amount and quality of content material in the DVD were just about right compared with what would be normally covered in a traditional classroom.			
7.	The use of the DVD materials has increased my degree of interest in Physical Sciences.			
8.	In a multimedia-supported lesson I get to think deeply how to become a better learner.			
9.	The pace of the DVD lesson was appropriate for clear explanation of			

	concepts.			
10.	The use of multimedia during the physical science class made me to be more creative.			
11.	I learned more materials through the use of the DVD method than I would have when using traditional methods.			
12.	I would like to commend the use multimedia DVD methods in the teaching and learning of Science and other subjects as well.			
13.	I would like the traditional method of teaching to be supplemented by the multimedia DVD method.			
14.	The DVD diagrams / charts / animations / visual aids were useful to enable better understanding of concepts.			
15.	I find that working with the multimedia program shows how complex real-life is.			
16.	I find that working with the multimedia program presents data in meaningful ways.			
17.	The DVD questions allowed me to think deeply about my own understanding.			
18.	I find that working with the multimedia program presents realistic tasks.			
19.	I found the print supplements (notes) to be useful to reinforce content understanding.			

Appendix H: Summary of learners' questionnaire responses (experimental group)

No	Items	Agree	Undecided	Disagree	Blank
1.	The use of the DVD for learning purposes was an exciting experience.	15	9	6	-
2.	In understanding the concepts of the chapter, the multimedia-supported way of presenting materials is better than the traditional classroom presentation.	10	9	11	1
3.	The multimedia-supported approach provides a greater collaboration between me as the learner and my teacher.	20	7	3	-
4.	My level of motivation in this learning area has increased with the use of a multimedia material.	12	6	12	-
5.	The DVD information in all the units of the chapter was clear and unambiguous.	18	4	7	1
6.	The amount and quality of content material in the DVD were just about right compared with what would be normally covered in a traditional classroom.	14	9	6	1
7.	The use of the DVD materials has increased my degree of interest in Physical Sciences.	19	6	3	2
8.	In a multimedia-supported lesson I get to think deeply how to become a better learner.	23	4	3	-
9.	The pace of the DVD lesson was appropriate for clear explanation of concepts.	10	6	13	1
10.	The use of multimedia during the physical science class made me to be more creative.	17	9	4	-
11.	I learned more materials through the use of the DVD method than I would have when using traditional methods.	14	11	5	-
12.	I would like to commend the use multimedia DVD methods in the teaching and learning of Science and other subjects as well.	18	4	8	-
13.	I would like the traditional method of teaching to be supplemented by the multimedia DVD method.	7	11	11	1

14.	The DVD Diagrams/charts/animations/visual aids were useful to enable better understanding of concepts.	18	9	3	-
15.	I find that working with the multimedia program shows how complex real-life is.	25	3	2	-
16.	I find that working with the multimedia program presents data in meaningful ways.	14	9	5	2
17.	The DVD questions allowed me to think deeply about my own understanding.	20	5	5	-
18.	I find that working with the multimedia program presents realistic tasks.	21`	7	2	-
19.	I found the print supplements (notes) to be useful to reinforce content understanding.	14	7	9	-

Appendix I: Teacher's attitudes and perception questionnaire

Name of the school:……
Name of the Educator:……..
Date:……

Please complete the following questionnaire based on your experience of a multimedia DVD supported science instruction by **ticking (√)** the correct box. There is no right or wrong answers. Your opinion is what is wanted. Your answers will enable us to improve the design of future science ICT resources. Your answers to this questionnaire will be treated confidentially and will be used strictly for the purpose of this research.

No	**Items**	**Agree**	**Undecided**	**Disagree**
1.	The DVD material is a valuable facilitation tool that I can use to support my classroom teaching.			
2.	The teacher video guide is a valuable lesson preparation tool.			
3.	The multimedia DVD material enhanced my content knowledge of the new curriculum topics.			
4.	I find that the DVD material exposed me to new teaching methodologies.			
5.	I find the content to be appropriate for the targeted level of learners.			
6.	I used the DVD content only for introduction and revision purposes.			
7.	The DVD pause button feature allowed me to use the DVD content anytime during the lesson, depending on the desired outcome.			
8.	I would recommend the DVD material to other teachers.			
9.	I find that the DVD graphics/ chart/animations/visual aids were useful to enforce understanding of concepts.			
10.	I feel that the outcomes for the lessons showed how the DVD content linked with the curriculum requirements.			
11.	I find that the language used in the DVD was difficult for second language learners.			

12.	I find that the videos were interesting and engaging for my learners.			
13	Demonstrations, experiments and site visits that are included in the lessons supported learning for my learners.			
14.	The use technology to explain curriculum aspects instilled positive inquisitiveness amongst my learners.			
15.	The DVD questions were useful to assess learners' understanding of concepts.			
16.	The DVD question answers were a useful assessment tool.			
17.	I found the DVD content to be useful, well-structured and appealing.			
18.	Multimedia supported learning improved my learners' attitude to learn.			
19.	Multimedia-supported teaching improved participation of my learners in class.			
20.	Multimedia-supported teaching improved academic achievement in physical sciences.			

Appendix J: Teacher's questionnaire responses

No	Items	Agree	Undecided	Disagree
1.	The DVD material is a valuable facilitation tool that I can use to support my classroom teaching.	X		
2.	The teacher video guide is a valuable lesson preparation tool.	X		
3.	The multimedia DVD material enhanced my content knowledge of the new curriculum topics.	X		
4.	I find that the DVD material exposed me to new teaching methodologies.	X		
5.	I find the content to be appropriate for the targeted level of learners.	X		
6.	I used the DVD content only for introduction and revision purposes.		X	
7.	The DVD pause button feature allowed me to use the DVD content anytime during the lesson, depending on the desired outcome.		X	
8.	I would recommend the DVD material to other teachers.	X		
9.	I find that the DVD graphics/ chart/animations/visual aids were useful to enforce understanding of concepts.	X		
10.	I feel that the outcomes for the lessons showed how the DVD content linked with the curriculum requirements.		X	
11.	I find that the language used in the DVD was difficult for second language learners.			X
12.	I find that the videos were interesting and engaging for my learners.	X		
13	Demonstrations, experiments and site visits that are included in the lessons supported learning for my learners.	X		
14.	The use technology to explain curriculum aspects instilled positive inquisitiveness amongst my learners.		X	
15.	The DVD questions were useful to assess learners' understanding of	X		

	concepts.			
16.	The DVD question answers were a useful assessment tool.		X	
17.	I found the DVD content to be useful, well-structured and appealing.		X	
18.	Multimedia supported learning improved my learners' attitude to learn.	X		
19.	Multimedia-supported teaching improved participation of my learners in class.	X		
20.	Multimedia-supported teaching improved academic achievement in Physical Sciences.	X		

Appendix K: Consent forms for research participants

1a. Information to Experimental Group Learners

University of the Witwatersrand, Johannesburg, South Africa
School of Education
Private Bag 3
Wits
2050

MASTER OF SCIENCE IN SCIENCE EDUCATION RESEARCH PROJECT

Subject Matter: Request for consent to participate in a research

Introduction
I am a student at the University of the Witwatersrand in South Africa, studying MSc in Science Education. As part of the requirements for the programme, I am undertaking a research study on multimedia based teaching in the Gauteng Province. The research is primarily aimed at improving Physical Science teaching and learning through the use of ICTs in South African secondary schools, especially those in the rural areas. Specifically, I am looking at practices related to how multimedia assisted teaching impacts on learners' understanding of scientific concepts. Your school has been selected as the site for the research. The Principal has granted permission to conduct the study in your school and your Physical science teacher has given his consent to participate in the research.

Description and Invitation
You are hereby invited to participate in the study as part of learners who will be in the experimental group. Learners in the experimental group will be taught some of the chemical systems concepts using the Mindset multimedia DVD. The study will take place in the 2nd term of 2009 school year. You will be exposed to multimedia DVD supported lessons for three weeks. Thereafter, you will be requested to write a pre and a post-test on chemical systems concepts of which your responses will be analysed as part of the research data. However, the research results will not form part your performance report in the Physical Science class. I will interview selected learners; you might also be part of those learners. You will also be requested to complete a questionnaire based on your attitudes and perceptions about multimedia supported learning of Physical Science.

Risks and benefits
There are no foreseeable risks involved in participating in the study. No remuneration will be due to you for participating in this study. Benefits will be in terms of being exposed to a multimedia instruction, which will give you information in different forms which might improve your understanding of scientific concepts, which might then lead to improved academic achievement in physical science. Through this different method of Science learning you might develop more interest to study Science even in the future grades and studies. Should you have any concerns or questions about participating in the proposed study, please contact me. My contact details are given at the bottom of this information sheet.

Time involvement
Multimedia based instruction will be conducted during your normal class times, i.e. normal Physical Science periods. I may have to check and photocopy some parts of some learners' notebooks. Interviews will only be with selected learners and will be conducted during break times or after school. Questionnaire about your attitudes and perceptions of using the multimedia DVD learning material will be completed by all experimental groups' learners after school as well.

Participants' rights
Participation in this study is strictly optional and at your personal discretion. If after reading this information, you decided to participate in the study and give consent to that effect, your participation is voluntary and can be withdrawn at any point without any consequences. You also have the right to refuse to answer any question and or withdraw from part of the study without facing any penalty. Anonymity and confidentiality of your participation and information collected from you is guaranteed, and hence unless you request otherwise, your name will not be used in my report and other academic writings about the study.

Audio recordings
The interviews for selected learners will be audio-taped. The audio-tapes taken during the interviews will be destroyed once the tapes are no longer needed for research, publications, and teaching purposes. This will be a maximum of five years after the completion of this study.

Consent
After you have read, understood and made necessary clarifications about this research, please complete, sign and return the attached forms. Please, note that if you do not return the attached forms by 27 February 2009, it will be assumed that you have not given consent to participate in the study.

Thank you.

Yours sincerely,

_____

Portia Mngenela
E-mail: portia.mngenela@gauteng.gov.za
Tel no: (011) 666 - 9198

1b. Consent form for experimental group learners to participate in the study

I, ……..……of ……(school) have read and understood the procedures involved in the study and what is expected of me as a participant. I willingly give the following consents:

Please put a tick (√) in the appropriate box

☐ I am willing to participate in the study (which may include: being interviewed, completing the attitudes and perceptions questionnaire and answering the pre and post knowledge tests).

☐ I am **not** willing to participate in the study.

☐ I give consent for my notebook and physical science workbook being checked and made copies of if necessary.

☐ I **do not** give consent for my notebook and physical science workbook being checked and made copies of if necessary.

☐ I give consent for my test scripts to be analysed for the purpose of this study.

☐ I **do not** give consent for my test scripts to be analysed for the purpose of this study.

The extra copy of this form is for you to keep.

Thank you.

---------- ----------

Learner's signature ***Date***

Name *(Please print)*

1c. Interview and Recording Consent form for selected experimental group learners

Please put a tick in the appropriate box

☐ I am willing to be interviewed on how I solved or answered some chemical systems content related problems and questions during the pre and post knowledge tests.

☐ I am **not** willing to be interviewed on how I solved or answered some chemical systems content related problems and questions during the pre and post knowledge tests.

☐ I am willing to be involved in lesson reflection interviews.

☐ I am **not** willing to be involved in lesson reflection interviews.

☐ I give consent for being audio taped during interviews.

☐ I **do not** give consent for being audio taped during interviews.

☐ I give consent for such audio recordings resulting from this study to be played at academic conferences, workshops and seminar

☐ I **do not** give consent for such audio tapes resulting from this study to be played at academic conferences, workshops and seminars

☐ I give consent for such audio tapes to be used for purposes of research, publications, teacher education and training programmes

☐ I **do not** give consent for audio tapes resulting from this study to be used for purposes of research, publications, teacher education and training programmes

☐ I give consent for such audio tapes resulting from this study to be kept for up to five years if necessary

☐ I **do not** give consent for such audio tapes resulting from this study to be kept for up to five years if necessary

The extra copy of this form is for you to keep.

Thank you.

---------- ----------

Learner's signature ***Date***

Please print your name

1d. Information to the Experimental group's Parents/Guardians

University of the Witwatersrand, Johannesburg, South Africa
Wits School of Education
Private Bag 3
Wits
2050

MASTER OF SCIENCE IN SCIENCE EUCATION RESEARCH PROJECT

Subject Matter: Request consent to participate in a research

Introduction
I am a student at the University of the Witwatersrand, Johannesburg in South Africa, studying MSc in Science Education. As part of the requirements for the programme, I am undertaking a research study on multimedia based teaching in the Gauteng Province of South Africa. The research is primarily aimed at improving science teaching and learning through the use of ICTs in South African secondary schools, especially those in rural areas. Specifically, I am looking at practices related to how multimedia assisted teaching impacts on learners' understanding of scientific concepts. Your school has been selected as the site for the research. The Principal has granted permission to conduct the study in your school and your Physical science teacher has given his consent to participate in the research.

Description and Invitation
Your child is hereby invited to participate in the study as part of learners who will be in the experimental group. Learners in the experimental group will be taught some of the chemical systems concepts using the Mindset multimedia DVD. The study will take place in the 2nd term of 2009 school year. Your child will be exposed to multimedia DVD supported lessons to learn some of the chemical systems concepts for three weeks. I will interview a selected number of learners; he / she might also be part of those learners. Your child will be requested to write a pre and a post-test on chemical systems concepts of which his or her responses will be analysed as part of the research data. However, the research results will not form part of his or her performance report in the physical science class. Your child will also be requested to complete a questionnaire based on his / her attitudes and perceptions about multimedia supported learning of Physical Science.

Risks and benefits
There are no foreseeable risks involved in participating in the study. No remuneration will be due to you for participating in this study. Benefits will be in terms of being exposed to a multimedia instruction, which will give learners information in different forms which might improve their understanding of scientific concepts, which might then lead to improved academic achievement in Physical Science. Through this different method of Science learning learners might develop more interest to study science even in the future grades and studies. Should you have any concerns or questions about your child's participation in the proposed study, please contact me. My contact details are given at the bottom of this information sheet.

Time involvement
Multimedia based instruction will be conducted during your normal class times, i.e. normal Physical Science periods. I may have to check and photocopy some parts of some students' notebooks. Interviews will only be with a selected number of learners, and will be conducted during break times or after school. Questionnaire about your child's attitudes and perceptions of using the multimedia DVD learning material will be completed by him or her.

Participants' rights
Participation in this study is strictly optional and at your personal discretion. If after reading this information, you decided that your child will participate in the study and give consent to that effect, his/her participation is voluntary and can be withdrawn at any point without any consequences. Your child also has the right refuse to answer any question and/or withdraw from part of the study without facing any penalty. Anonymity and confidentiality of his / her participation and information collected from him / her is guaranteed, and hence unless you request otherwise, his/her name will not be used in my report and other academic writings about the study.

Audio recordings
The interviews for selected learners will be audio-taped. The audio-tapes taken during the interviews will be destroyed once the tapes are no longer needed for research, publications, and teaching purposes. This will be a maximum of five years after the completion of this study.

Consent
After you have read, understood and made necessary clarifications about this research, please complete, sign and return the attached forms. Please, note that if you do not return the attached forms by 27 February 2009, it will be assumed that you have not given consent for your child to participate in the study.

Thank you.

Yours sincerely,

_____

Portia Mngenela
E-mail: portia.mngenela@gauteng.gov.za
Tel no: (011) 666 - 9198

1e. Consent form for Minors' participation in the study (to be completed by experimental groups' parents or guardians)

I,……..……..……of

……...(Address)

have read and understood the procedures involved in the study and what is required of my child as a participant. I willingly give the following consents:

Please put a tick (√) in the appropriate box

☐ I am willing to allow my child to participate in the study

☐ I am **not** willing to allow my child to participate in the study

☐ I give consent for my child's physical science notebook and workbook being checked and made copies of if necessary.

☐ I **do not** give consent for my child's physical science notebook and workbook being checked and made copies of if necessary.

☐ I give consent for my child's test scripts to be analysed for the purpose of this study.

☐ I **do not** give consent for my child's test scripts to be analysed for the purpose of this study.

☐ The extra copy of this form is for you to keep.

Thank you.

---------- ----------

Signature of parent/guardian ***Date***

Name of parent/guardian *(Please print)*

Name of child *(Please print)*

Signature of child

1f. Interview and Recording Consent form for selected Minors in the Experimental group

Please complete the form below:

Please put a tick in the appropriate box

☐ I am willing to allow my child to be interviewed on how he / she solved or answered some chemical systems content related problems and questions during the pre and post knowledge tests.

☐ I am **not** willing to allow my child to be interviewed on how he / she solved or answered some chemical systems content related problems and questions during the pre and post knowledge tests.

☐ I allow my child to be involved in lesson reflection interviews.

☐ I **do not** allow my child to be involved in lesson reflection interviews.

☐ I give consent for my child to be audio taped during interviews.

☐ I **do not** give consent for my child to be audio taped during interviews.

☐ I give consent for such audio recordings resulting from this study to be played at academic conferences, workshops and seminars

☐ I **do not** give consent for such audio tapes resulting from this study to be played at academic conferences, workshops and seminars

☐ I give consent for such audio tapes to be used for purposes of research, publications, teacher education and training programmes

☐ I **do not** give consent for audio tapes resulting from this study to be used for purposes of research, publications, teacher education and training programmes

☐ I give consent for such audio tapes resulting from this study to be kept for up to five years if necessary

☐ I **do not** give consent for such audio tapes resulting from this study to be kept for up to five years if necessary

The extra copy of this form is for you to keep.

Thank you.

---------- ----------

Learner's signature ***Date***

Please print your name

Name of parent/guardian *(Please print)*

Name of child *(Please print)*

Signature of child

1g. Minor's assent form

My teacher and my parents have explained this research to me. I am aware that my Physical Science notebooks and workbook may be checked regularly and part(s) of them may be photocopied if necessary. They have explained that I will complete a questionnaire about my attitudes and perceptions of multimedia supported learning and that I will write a pre and post knowledge tests which will not form part of my physical science progress report. They also explained to me that I may be interviewed as well if I am selected. They also said that the research would be conducted during the second term of the school year. My parents/guardians have consented to my participation in the research. I agree with this decision of my parents/guardian.

Name of the learner *(Please, print)*

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Signature of the learner ***Date***

1h. Information to the Control Group Learners

University of the Witwatersrand, Johannesburg, South Africa
School of Education
Private Bag 3
Wits
2050

MASTER OF SCIENCE IN SCIENCE EDUCATION RESEARCH PROJECT

Subject Matter: Request for consent to participate in a research

Introduction
I am a student at the University of the Witwatersrand, Johannesburg in South Africa, studying MSc in Science Education. As part of the requirements for the programme, I am undertaking a research study on multimedia based teaching in the Gauteng Province of South Africa. The research is primarily aimed at improving science teaching and learning through the use of ICTs in South African secondary schools, especially those in rural areas. Specifically, I am looking at practices related to how multimedia assisted teaching impacts on learners' understanding of scientific concepts. Your school has been selected as the site for the research. The Principal has granted permission to conduct the study in your school and your Physical Science teacher has given his consent to participate in the research.

Description and Invitation
You are hereby invited to participate in the study as part of learners who will be in the control group. Your school has received a Mindset multimedia DVD content for teaching Physical Sciences. My aim is to evaluate if multimedia supported lessons can assist learners to learn and achieve better or not. To this regard two classes will participate in the research, one as an experimental group and the other one as the control group. Learners in the experimental group will be taught some of the chemical systems concepts using the Mindset multimedia DVD for three weeks while learners in the control group will be taught the same content without using the DVD content in their lessons. Control group learners will not be exposed to the DVD lessons during the research because their pretest and posttests scores will be compared with those of the experimental group in order to establish if the usage of the DVD content had a positive impact or not. However, once the research is completed learners in the control group will also undergo the same DVD lessons that will be used by the experimental group during research. The study will take place in the 2nd term of 2009 school year. After you shall have been taught in a normal traditional way, you will be requested to write a pre and a post-test on chemical systems concepts of which your responses will be analysed as part of the research data. However, the research results will not form part your performance report in the Physical Science class.

Risks and benefits
There are no foreseeable risks involved in participating in the study. No remuneration will be due to you for participating in this study. There is no direct benefit for participating in the study, benefits might be in terms of being exposed to a multimedia supported instruction once the research is completed, which will give you information in different forms which might improve your understanding of scientific concepts. Should

you have any concerns or questions about participating in the proposed study, please contact me. My contact details are given at the bottom of this information sheet.

Time involvement

This research will be conducted during your normal class times, i.e. normal Physical Science periods. I may have to check and photocopy some parts of your notebooks and workbooks.

Participants 'rights

Participation in this study is strictly optional and at your personal discretion. If after reading this information, you decided to participate in the study and give consent to that effect, your participation is voluntary and can be withdrawn at any point without any consequences. You also have the right to refuse to answer any question and or withdraw from the study without facing any penalty. Anonymity and confidentiality of your participation and information collected from you is guaranteed, and hence unless you request otherwise, your name will not be used in my report and other academic writings about the study.

Consent

After you have read, understood and made necessary clarifications about this research, please complete, sign and return the attached forms. Please, note that if you do not return the attached forms by 27 February 2009, it will be assumed that you have not given consent to participate in the study.

Thank you.

Yours sincerely,

_____

Portia Mngenela
E-mail: portia.mngenela@gauteng.gov.za
Tel no: (011) 666 - 9198

1i. Consent form for Control Group learners to participate in the study

I, ……..……of ……(school) have read and understood the procedures involved in the study and what is expected of me as a participant. I willingly give the following consents:

Please put a tick (√) in the appropriate box

☐ I am willing to participate in the study (which may include answering the pre and post knowledge tests).

☐ I am **not** willing to participate in the study.

☐ I give consent for my notebook and physical science workbook being checked and made copies of if necessary.

☐ I **do not** give consent for my notebook and physical science workbook being checked and made copies of if necessary.

☐ I give consent for my test scripts to be analysed for the purpose of this study.

☐ I **do not** give consent for my test scripts to be analysed for the purpose of this study.

The extra copy of this form is for you to keep.

Thank you.

---------- ----------

Learner's signature ***Date***

Name *(Please print)*

1j. Information to Control group's Parents/Guardians

University of the Witwatersrand, Johannesburg, South Africa
Wits School of Education
Private Bag 3
Wits
2050

MASTER OF SCIENCE IN SCIENCE EUCATION RESEARCH PROJECT

Subject Matter: Request for consent to participate in a research

Introduction
I am a student at the University of the Witwatersrand, Johannesburg in South Africa, studying MSc in Science Education. As part of the requirements for the programme, I am undertaking a research study on multimedia based teaching in the Gauteng Province of South Africa. The research is primarily aimed at improving science teaching and learning through the use of ICTs in South African secondary schools, especially those in rural areas. Specifically, I am looking at practices related to how multimedia assisted teaching impacts on learners' understanding of scientific concepts. Your school has been selected as the site for the research. The Principal has granted permission to conduct the study in your school and your Physical Science teacher has given his consent to participate in the research.

Description and Invitation

Your child is hereby invited to participate in the study as part of learners who will be in the control group. Your school has received a Mindset multimedia DVD content for teaching Physical Sciences. My aim is to evaluate if multimedia supported lessons can assist learners to learn and achieve better or not. To this regard two classes will participate in the research, one as experimental group and the other one as the control group. Learners in the experimental group will be taught some of the chemical systems concepts using the Mindset multimedia DVD for three weeks while learners in the control group will be taught the same content without using the DVD content in their lessons. Control group learners will not be exposed to the DVD lessons during the research because their pretest and posttests scores will be compared with those of the experimental group in order to establish if the usage of the DVD content had a positive impact or not. However, once the research is completed learners in the control group will also undergo the same DVD lessons that will be used by the experimental group during research. The study will take place in the 2nd term of 2009 school year.

After your child shall have been taught in a normal traditional way, he/she will be requested to write a pre and a post-test on chemical systems concepts of which his/her responses will be analysed as part of the research data. However, the research results will not form part his/her performance report in the Physical Science class.

Risks and benefits
There are no foreseeable risks involved in participating in the study. No remuneration will be due to you for participating in this study. There is no direct benefit for participating in the study, benefits might be in terms of being exposed to a multimedia

supported instruction once the research is completed, which will give your child information in different forms which might improve his/her understanding of scientific concepts. Should you have any concerns or questions about your child's participation in the proposed study, please contact me. My contact details are given at the bottom of this information sheet.

Time involvement
This research will be conducted during normal class times, i.e. normal Physical Science periods. I may have to check and photocopy some parts of some learners' notebooks.

Participants' rights
Participation in this study is strictly optional and at your personal discretion. If after reading this information, you decided to allow your child to participate in the study and give consent to that effect, his/her participation is voluntary and can be withdrawn at any point without any consequences. He/she also has a right to refuse to answer any question and/or withdraw from part of the study without facing any penalty. Anonymity and confidentiality of his/her participation and information collected from him/her is guaranteed, and hence unless you request otherwise, his/her name will not be used in my report and other academic writings about the study.

Consent
After you have read, understood and made necessary clarifications about this research, please complete, sign and return the attached forms. Please, note that if you do not return the attached forms by 27 February 2009, it will be assumed that you have not given consent for your child to participate in the study.

Thank you.

Yours sincerely,

_____

Portia Mngenela
E-mail: portia.mngenela@gauteng.gov.za
Tel no: (011) 666 - 9198

1k. Consent form for Minor's participation in the study (to be completed by control group's parents or guardians)

I,……..……..……of

……...(Address)

have read and understood the procedures involved in the study and what is required of my child as a participant. I willingly give the following consents:

Please put a tick (√) in the appropriate box

☐ I am willing to allow my child to participate in the study

☐ I am **not** willing to allow my child to participate in the study

☐ I give consent for my child's physical science notebook and workbook being checked and made copies of if necessary.

☐ I **do not** give consent for my child's physical science notebook and workbook being checked and made copies of if necessary.

☐ I give consent for my child's test scripts to be analysed for the purpose of this study.

☐ I **do not** give consent for my child's test scripts to be analysed for the purpose of this study.

The extra copy of this form is for you to keep.

Thank you.

---------- ----------

Signature of parent/guardian ***Date***

Name of parent/guardian *(Please print)*

Name of child *(Please print)*

Signature of child

1l. Minor learners' assent form

My teacher and my parents have explained this research to me. I am aware that my Physical Science notebooks and workbook may be checked regularly and part(s) of them may be photocopied if necessary. They have explained that I will write a pre and post knowledge tests which will not form part of my physical science progress report. They also said that the research would be conducted during the second term of the school year. My parents/guardians have consented to my participation in the research. I agree with this decision of my parents/guardian.

Name of the learner *(Please, print)*

---------- ----------

Signature of the learner ***Date***

2a. Consent form for teacher's participation in the study

I …… of ……. (School) have read and understood the procedures involved in the study and what is expected of me as a participant. I willingly give the following consents:

Please put a tick (√) in the appropriate box

☐ I am willing to participate in the study by integrating the mindset DVD content in my lessons to teach some of the chemical systems concepts

☐ I am **not** willing to participate in the study

☐ I give consent for completing teachers' questionnaire

☐ I **do not** give consent for completing teachers' questionnaire

☐ I give consent for my lesson plans and notes to be photocopied and used as part of the research data.

☐ I **do not** give consent for my lesson plans and notes to be photocopied in order to be use for the purpose of the research.

The extra copy of this form is for you to keep.

Thank you.

---------- ----------

Teacher's signature ***Date***

Name *(Please print)*

2b. Teacher's consent form for Interview and recording

Please complete the form below. *Please put a tick in the appropriate box*

☐ I give consent to be audio taped during interviews.

☐ I **do not** give consent to be audio taped during interviews.

☐ I give consent for such audio recordings resulting from this study to be played at academic conferences, workshops and seminar

☐ I **do not** give consent for such audio tapes resulting from this study to be played at academic conferences, workshops and seminars

☐ I give consent for such audio tapes to be used for purposes of research, publications, teacher education and training programmes

☐ I **do not** give consent for audio tapes resulting from this study to be used for purposes of research, publications, teacher education and training programmes

☐ I give consent for such audio tapes resulting from this study to be kept for up to five years if necessary

☐ I **do not** give consent for such audio tapes resulting from this study to be kept for up to five years if necessary

The extra copy of this form is for you to keep.

Thank you.

---------- ----------

Teacher's signature ***Date***

Please print your name

Appendix **L***: Teacher's lesson plans*

PHYSICAL SCIENCE LESSON PLAN 1
GRADE 11

CORE KNOWLEDGE AREA: CHEMICAL SYSTEMS

TOPICS: MINERAL RESOURCES OF THE LITHOSPHERE
GOLD MINING

CURRICULUM LINKS

LO 2: Constructing and applying scientific knowledge
AS 1: Recalling, stating and discussing prescribed concepts
AS 2: Explain relationships

LO 3: The nature of science and its relationship to technology, society and environment
AS 2: Evaluating the impact of science on the environment and sustainable development

LO 1: Scientific enquiry and problem-solving skills
AS 3: Solving problems
AS 4: Communicate and present scientific information and arguments

LESSON OUTCOMES:
By the end of the lesson learners should be able to:

- State what a mineral resource is
- Explain simply how mineral resources form in the rocks of the lithosphere
- Identify positive and negative aspects associated with recovery and use of minerals Describe how gold is mined
- Draw a flow chart to show how gold is extracted from its ore and purified.
- Use chemical equations to explain the chemical reactions taking place during these processes.

EXPOSITION:

- Play DVD lesson about the mineral resources of the lithosphere (20 min).
- Follow by playing DVD lesson about mining and extraction of gold (20 min).

DVD question 1: Why should the milling process take place before leaching?

Expected answer: during the milling process the gold bearing ore is crushed to a powder to increase the surface area allowing the extraction to be more efficient during the leaching process i.e. the large the surface are, the faster the reaction.

DVD question 2: Write a balanced chemical equation for cyanidation or leaching process.

Expected answer: $4Au_{(s)} + 8KCN_{(aq)} + 2H_2O_{(l)} + O_{2(g)} \rightarrow 4KAu(CN)_2 + 4KOH_{(aq)}$

ASSESSMENT TASK:

In your usual class groups answer the following task. N/B: the last question should be completed as homework since it requires research.

1. Draw up a spider diagram or mind map to show the positive and negative aspects of the recovery and use of minerals on society and the environment.
2. Here is the balanced chemical equation for the reaction of zinc and potassium gold cyanide:

   Zn (s) + 2KAu (CN) (aq) → 2Au (s) + Zn (CN) 2 (aq) + 2KCN (aq)

   (a). Identify the oxidation and reduction half reactions taking place.

   (b). Identify any redox reactions taking place during the extraction and purification of gold.

   (c). Research the zinc process and write a report about why this process was phased out by most gold mining companies and replaced by the charcoal filtration process.

PHYSICAL SCIENCE LESSON PLAN 2
GRADE 11

CORE KNOWLEDGE AREA: CHEMICAL SYSTEMS

TOPICS: GOLD MINING

CURRICULUM LINKS

LO 2: Constructing and applying scientific knowledge
AS 1: Recalling, stating and discussing prescribed concepts
AS 2: Explain relationships

LO 1: Scientific enquiry and problem-solving skills
AS 3: Solving problems
AS 4: Communicate and present scientific information and arguments

LESSON OUTCOMES:
By the end of the lesson learners should be able to:

- Describe how gold is mined
- Draw a flow chart to show how gold is extracted from its ore and purified.
- Use chemical equations to explain the chemical reactions taking place during these processes.

EXPOSITION:

- Through a class discussion, learners should give answers for the questions asked during the previous lesson about redox reactions. The answer to the question should state that the old extraction method was not as efficient as the new one since it had wastage of 0.4 g per ton as compared to the new one that only has wastage of 0.08 g per ton.
- DVD lesson etiquettes: Listen attentively, make notes of important concepts and ideas, note down your questions to ask at the end of the lesson, be ready to answer questions when the teacher pauses the lesson.

1. STEP BY STEP EXPLANATION OF GOLD EXTRACTION AND PURIFICATION:

Milling → Slurry
↓
Filtering ← Leaching
↓
Charcoal filtering → Elution → Electro-winning
↓
Purification ← Purification
Stage 1 Stage 2

Milling process involves the crushing of the gold bearing ore into a powder.

Leaching process involves dissolving gold out of the powdered rock using the solution of potassium cyanide.

Gaungue is the insoluble crushed rock left from the leaching process

Adsorption is the process by which one substance accumulates on the surface of another substance.

Elution is the process whereby the highly concentrated gold cyanide complex is washed off the charcoal.

Electro – winning is the process whereby electricity is used to recover the elemental gold from the gold cyanide solution

2. Revise the rules of assigning oxidation numbers and balancing redox reactions using the chemical equation for the leaching process.

   Final equation: $4Au_{(s)} + 8KCN_{(aq)} + 2H_2O_{(l)} + O_{2(g)} \rightarrow 4KAu(CN)_2 + 4KOH_{(aq)}$

   Electro-winning: iron is oxidized and the gold ion is reduced to elemental gold

   $Fe \rightarrow Fe^{3+} + 3e^-$

   $3Au_{(aq)} + 3e^- \rightarrow 3Au_{(s)}$

   Purification stage 1: The base metals react with chlorine gas forming metal Chloride, Iron, lead and zinc form gaseous chlorides at such high temperatures and evaporate from the melt. Copper and silver form liquid chlorides at this temperature. They are less dense than the molten gold and are poured off the top.

   Reduction: $Cl_2 + 2e^- \rightarrow 2Cl^-$

   Oxidation: $Pb \rightarrow Pb^{2+} + 2e^-$

   Use the DVD to reinforce the content learned i.e. fast forward to the extraction and purification of gold.

ASSESSMENT TASK:

Complete the following as homework.

1. Briefly explain how gold-ore is mined.
2. Draw a flow chart to show how gold is extracted from the ore and purified.

3. Use a balanced chemical equation to represent the chemical reaction that takes place when gold is extracted from its rock.
4. Define the following terms relating to the extraction of gold:
    (a) milling
    (b) Leaching
    (c) Gangue
    (d) Adsorption
    (e) Elution
    (f) Electro-winning

PHYSICAL SCIENCE LESSON PLAN 3
GRADE 11

CORE KNOWLEDGE AREA: CHEMICAL SYSTEMS

TOPICS: IRON AND PHOSPHATE MINING

CURRICULUM LINKS

LO 1: Scientific enquiry and problem-solving skills
AS 1: Conducting an investigation
AS 2: Interpret data to draw conclusions
AS 4: Communicate and present scientific information and arguments

LO 2: Constructing and applying scientific knowledge
AS 1: Recalling, stating and discussing prescribed concepts

LESSON OUTCOMES:
By the end of the lesson learners should be able to:

- Describe open pit mining
- Explain using equations, iron and phosphate extraction.
- Investigate the effect of the amount of fertilizer used on plant growth

EXPOSITION:

- Play the DVD lesson only iron mining
- Pause the DVD lesson to explain the following equations:

Carbon + oxygen → carbon dioxide

$C_{(s)} + O2_{(g)} \rightarrow CO2_{(g)}$

Carbon + carbon dioxide → carbon monoxide

$CO2_{(g)} + C_{(s)} \rightarrow 2CO_{(g)}$

Iron (III) oxide + carbon monoxide → Iron + carbon dioxide

$FeO_{3\ (s)} + 3CO\ (g) \rightarrow 2Fe_{(s)} + 3CO_{2\ (g)}$

- Identify oxidation and reduction half reactions from the above equations.
- Play the rest of the DVD lesson that covers the phosphate mining.
- Pause to solve the problem posed on the lesson.
- Explain how to calculate the percentage of phosphorous from the ammonium phosphate fertilizer.
- Draw a skeletal flow chart representing steps that should be followed in phosphate mining on the board and allow learners to fill in the missing steps.

ASSESSMENT TASK: Homework

On the flow chart that you just completed include chemical equations in all the relevant steps.

Appendix M: Application letters to conduct a research

82 Langa Street
Endulwini Section
Tembisa
1632
9th July 2008

Mindset Network
P O.Box 4635
Randburg
2125
South Africa

Dear Sir / Madam

RE: Application to use Mindset DVD material and equipment for my research.

I am a Master's Degree student at the University of Witwatersrand. My research is for the purpose of fulfilling the requirements for obtaining the Master's degree in science education.

My research is aiming at firstly, evaluating the impact of using Mindset material on learners' understanding of chemical systems concepts. Secondly, it is aiming at evaluating the attitudes and perceptions of teachers and learners about the usefulness of Mindset DVD content series for teaching and learning Physical Science. The overall objective is to expose township secondary schools to the available ICTs.

Two classes will be used in the study, one as **experiment** and the other one as **control group**. One class will be used whereby a quasi-experiment research design will be followed. The lesson plans for the lessons conducted in the experiment class will be analysed to determine if the material was used during the Science lessons. Learners in both classes will write a pre-test before they are taught, with the use of the material in the experiment class and without the mindset material in the control class. They will also write a post-test as soon as the lessons are completed. Performance scores and change of responses in the pre and post tests for both groups will be analysed and compared. Follow up semi-structured interviews will be conducted for a few selected learners from the experiment class to allow more probing in order to ensure respondent validity. Interviews will be audio-taped and later analysed. Finally attitudes and perception questionnaire will be completed by the teachers and learners in the experiment class to elicit their opinions about the usefulness of the material.

The information that will be collected for this research will be used only for the purpose of this study. The names of the schools, learners and teachers that will be involved in this study will not be revealed when reporting the research findings. All collected information will be kept safe and destroyed after a period of five years.

Should you have questions or concerns please contact me or my supervisor on the following contact details:

Supervisor: Prof Ian Moll
Tel no: 011 717 - 3194
E-mail: ian.moll@wits.ac.za

I hope that my request will be accepted

Yours faithfully

_____
Portia Mngenela
E-mail: portia.mngenela@gauteng.gov.za
Tel no: (011) 666 - 9198

24 Fredman Drive
Sandpark building
Sandton
2146
09 July 2008

The Principal
Anonymous Secondary School
165 – 12 Avenue
Alexandra
Johannesburg
South Africa

Dear Madam

RE: Application to conduct a research at your school.

I hereby request permission to conduct a research in your school using the Mindset educational material for teaching grade 11 Physical Science. As an e-Learning coordinator this research is for establishing whether the Mindset material can provide an accessible e-Learning solution for enhancing teaching and learning especially for our under resourced schools. I have registered for a Master's Degree student at the University of the Witwatersrand therefore this research will also be used to fulfill requirements for obtaining a Master's degree in science education.

My research is aiming at firstly, evaluating the impact of using Mindset material on learners' understanding of chemical systems concepts. Secondly, it is aiming at evaluating the attitudes and perceptions of teachers and learners about the usefulness of Mindset DVD content series for teaching and learning Physical Science.

As your school is one of the Mindset pilot schools, your grade eleven classes will be used as an experiment groups in this research. Your physical science teacher's lesson plans for the lessons conducted while using the Mindset material will be analysed to determine how he/she used the Mindset material during the science lessons. Participating learners from your school will write a pre-test before the use of the material and a post-test as soon as the experimental lessons are completed. Performance scores and change of responses for individual learners will be compared to elicit if there will be any learning gains amongst them. Follow up semi-structured interviews will be conducted only for few selected learners in order to ensure respondent validity. Interviews will be audio-taped and later analysed. Finally attitudes and perception questionnaire will be completed by the teacher and learners that participated in this research to elicit their views about the usefulness of the multimedia DVD teaching material. Classes and learning will not be disturbed for the purpose of this research as learners will be following their normal lessons covering their normal syllabus topics.

The information that will be collected for this research will be used only for the purpose of this study. The names of the schools, learners and teachers that will be involved in this study will not be revealed when reporting the research findings. All collected information will be kept safe and destroyed after a period of five years.

Should you have questions or concerns please contact me or my supervisor on the following contact details.

Supervisor: Prof Ian Moll
Tel no: 011 717- 3194
E-mail: ian.moll@wits.ac.za

Portia Mngenela
E-mail: portia.mngenela@gauteng.gov.za
Tel no: (011) 666 - 9198

Thanking You

Yours faithfully

_____
Portia Mngenela
DCES: e-Learning