An application of multimedia in English Second Language Mathematics and Science classrooms at George Mhaule Primary School in Mpumalanga Province

by

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DECLARATION

I declare that the mini-dissertation hereby submitted to the University of Limpopo, for the degree of Master of Arts in English Studies has not previously been submitted by me for a degree at this or any other university; that it is my work in design and execution, and that all material contained herein has been duly acknowledged.

Mona E.H (Mr) **2015.08.25**

Abstract

This study argues that Science and Mathematics instructions are best aided by the use of multimedia in impartation of knowledge. The researcher examines the application of text and graphics in the teaching of Mathematics and Science at a poorly resourced primary School. Findings reveal that both learners and their teachers are barely exposed to equipment which could be used for practical tasks, which factor rubs off on the performance of the learners. Multimedia as depicted in work books and prescribed textbooks proved to enhance comprehension and raise the interests of the learners in exploring subject. Teachers' low level of qualification in Mathematics and Science and or lack thereof is a primary source of reluctance and apathy towards the use of graphical representation to illustrate subject matter. There are notable traces of code mixing and code switching between English and the learners' mother tongue in teaching and learning of science and mathematics content. The glaring incongruence between the ordering of the Workbooks provided and the prescribed textbooks creates protracted lessons and does not aid the learning processes.

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CHAPTER 1

INTRODUCTION

1. Background to the study

Worldwide, science literacy has become increasingly vital to both teachers and learners since different institutions have started to place greater importance and emphasis on science (Fischer, 1995; Sessa et al., 2001; Coleman, Tigue, & Smolkin, 2010). For example, weather reports which are frequently displayed on our television screens mainly appear in scientific language and graphic representations.

Such representations need to be indiscriminately read and interpreted by both educated and illiterate people in our society. Adults and younger people have to equally acquire science literacy to help them in their daily lives. As Picciano (2008) points out, there is a need to improve the way children are being taught and introduced to the world of science.

It is generally expected of all learners who have studied Mathematics and Science at primary school to have acquired certain levels of competency or literacy by the time they have completed their primary school education. Whether schools have advanced and modern equipment or not, standards set nationally and internationally remain the same.

While science institutions are not equally resourced, the researcher could not be sure of the equal imparting of knowledge to Mathematics and Science learners by teachers at various institutions to achieve the desired outcome at the end of their studies.

More complex would be the fact that in this study learners in the early stages of learning were taught in English, which was a second or third language. Such learners were also expected to simultaneously learn the English language and use it to study Mathematics and Science content.

Huerta and Jackson (2010) argue that the recent research in high-stakes testing has found that English Language Learners (ELLs) perform poorly in content area exams such as science and math due to lack of academic vocabulary and English Literacy. The focus of Huerta and Jackson's study was on science literacy for English Second Language

Learners, in particular those who came from disadvantaged economic backgrounds with little or no access to technological gadgets. They further sought to evaluate whether the integration of text and the limited number of other forms of media in teaching Science would enhance comprehension of content or not.

In this study the researcher found that, other than using words, Science and Mathematics lessons often integrated Multimedia which involved the use of graphs, pictures, drawings and experiments as means to enhance science and mathematics literacy. Gwekerere and Bailey (2011) observed practical tasks and found that they had a positive impact on school learners. These scholars discovered that picture books could be used to teach children to infer, hypothesize, question, identify, explain and compare. When used in combination with textbooks, science kits and practical experience, the child was more readily assisted in making sense of the world from multiple sources. Some learners, they argued, recalled classroom excursions to a pond as valuable experience for them, while others said that science was a hands-on investigative experience for them.

The study, therefore sought to evaluate the use of multimedia in teaching and learning in English Second Language Mathematics and Science classrooms at George Mhaule primary school in Mpumalanga Province. The extent to which teachers in English Second Language Science classrooms used multimedia such as graphs, tables, drawings and pictures had to be gauged and the effect thereof determined.

2. Research problem

The researcher had noted that Mathematics and Science text books, articles and other academic productions were fraught with multimodal tasks such as practical activities experiments, and outdoor sessions such as gardening projects in which learners were required to show off scientific creations. Such a trend was invariably followed by all schools, irrespective of their geographical situations and, or availability of resources.

Multimedia representations which came in the form of drawings, diagrams, flow charts, graphs and so on were often used to communicate important information. If we wanted to read scientific concepts then we needed to know how to interpret the drawings and diagrams as well as the words, Coleman et al. (2010).

Conceptualising words seemed not enough, hence the introduction of other modes in Mathematics and Science instruction. What remained a problem was whether the continued use of these texts and practical work – which required understanding of multimedia manifestations by teachers at primary schools, where learners used English as a second language and needed the skill to analyse and interpret them – could boost learners' comprehension of Science content.

The researcher acknowledges that in the South African constitution all children have an entrenched right to education but the biggest challenge, as has also been observed in the United States of America, is that not all schools are on the same level, nor have equal education opportunities been made available for the poor, minorities and underprivileged. One manifestation of this inequality is the lack of qualified teachers to teach certain subjects such as science and mathematics in many rural schools (Picciano, 2008).

Schools in formerly disadvantaged areas of South Africa, which register the majority of South African learners, have for a very long period of time been without the necessary teaching and learning resources but continue to enrol learners in subjects which require practical work. Such subjects include Mathematics, Technology and Natural Sciences. Besides lacking the necessary facilities these schools further compound the situation by employing unqualified and under qualified teachers who are expected to deliver similar outputs as their well-resourced counterparts.

After the dawn of democracy on our shores many young people have become exposed to technological gadgets and stand a better chance of doing well in science subjects than their predecessors during the era of racial segregation. Teachers, as well, develop their competencies in areas of the use of graphic representations in the teaching of science to younger learners.

The quarterly publication of the Department of Basic Education, Curriculum News (2011) stipulates that '*learner and teacher support material can play a central role in defining a more structured approach to what subject matter is taught and how it is taught.*'

The statement confirms that levelling the fields in the provision of the curriculum could close the gaps which exist between schools in different areas and uplift the standards of teaching for all teachers. The focus of this study is on the application of multimedia at George Mhaule primary school in the senior grades (Grade 6 and 7) where learners are taught Mathematics, Science and Technology through the medium of English.

If any success in the teaching of mathematics and science is to be recorded, then teachers who teach Mathematics and Science using graphics, tables, drawings and pictures (multimedia) in their illustrations, need a clearer understanding of such representations to facilitate learners' interpretation of scientific data.

3. Review of relevant literature

3.1. Introduction

The literature reviewed pointed at the increased use of multimedia texts, experiments, and activities to foster school Science and Mathematics literacy and their effects in enhancing comprehension. Most of the studies consulted were conducted in areas with varied levels of economic backgrounds with success; hence the need to explore the South African setting in areas of dire need for science resources required for Science and Mathematics teaching.

Learners at the institutions where the studies herein reviewed took place were from different language backgrounds. Certain learners used English as first language whereas for others English was a second language as was the case of participants in this study.

3.2. Policy stipulation

The Department of Basic Education Curriculum policy provided a sound basis for subsequent arguments: "...learners act confidently on their curiosity about natural phenomena; they investigate relationships and solve problems in science, technology and environmental context", National Curriculum Statement- Grades R-12 (2004).

Paying necessary attention to policy relating to teaching and learning of Mathematics and Science shows the level of achievement which learners need to strive towards in order to realise the set outcomes.

The National Curriculum Statement for the senior phase (2004), covering Grades 7, 8, and 9 states that for learners to be regarded as successful in their studies is "when there is a personal experience of objects, materials and situations and when there is an increasing ability to generalise and construct principles which the learner applies to a variety of situations". Multimedia application seems to be central in the teaching of Mathematics and Science thus teachers need to have the necessary expertise to impart scientific knowledge through various forms of texts.

The question that remains, in the case of the South African rural learners, is whether the multimedia approach could have any particular effect on the acquisition of Science content in a context where there may be a problem of English proficiency.

3.3. Use of multimodal communication in science classrooms

Instructional activities containing multimedia products have been increasingly used in Science classes, not only in South African schools but in other developed countries as well. Literature from the United States of America shows that Science teachers apply similar approaches.

Coleman et al. (2010) assert that according to the benchmarks for science literacy in the kindergarten through Grade 2, students are expected to create drawings of a target object or concept and correctly represent the salient features. By the end of the fifth grade, students are expected to create sketches that explain either ideas or procedures as well as make use of numerical data to describe and /or compare objects or events.

These researchers (Coleman et al. 2010), declare that multimodal texts are generally incorporated in science education from the early years of schooling and graded according to their complexity of learners' progress, a situation which was merely observed during the researcher's years of learning and could be relevant to the study and noted for future investigations. Specific attention was paid to ELLs who, often, were confronted by language functions in science instruction used with other "formats" (Coleman et al. 2010). The learners needed to be equipped with language skills and a host of graphical representations to find meaning.

Providing ELLs with opportunities to communicate science content through drawings, charts, tables, graphs, and computer–developed simulations reduce the language load required to participate. The use of icons, graphics, and drawings promotes a focus on communication for understanding, rather than just conveying correct answers (Sessa, et al. 2010).

All of these researchers, whose work was accessed, believed in the promotion of science literacy through the development of instructional material by paying more attention to language proficiency. Their reference to the use of 'multiple representational formats' confirms that such formats are important in science instruction and learning, although some did not indicate whether such texts had any bearing on comprehension or not.

Eshach (2006) felt that learners had to be exposed to the non-verbal knowledge that was inherent in all problem-solving activities and that young children could acquire knowledge through body language, use of visual representations, conceptual models and analogical reasoning. This emphasises the importance of approaching science teaching by means of use of programmes with multiple-media content.

Fisher (1995) outlines how resources, other than the written word, could be developed to help science learners with knowledge acquisition in their daily activities. Developing a stimulating environment for science, involves gathering a range of interesting objects, gadgets, materials, books and pictures for use in the classroom, on the one hand and on the other hand learners have to be able to record findings in charts, drawings, interpret pictograms and bar graphs and line graphs (Fisher 1995). Fisher continues to reiterate the inclusion of multimodal texts and use of apparatus in class. He considers the fact that technological aids, such as computers and other audio visual aids could offer an interactive satisfaction that would motivate children's learning.

That children of colour, children who were English language learners, and children of low-income backgrounds demonstrated lesser proficiency in science, than their peers and that teachers' science knowledge was predictive of children's science learning", was found by (Gropen et al. 2001). As learners and their teachers from a disadvantaged background become increasingly exposed to science instructional material containing multiple representations which require comprehensible interpretation, it is inevitable for such learners to be more scientifically wiser than before.

The findings of this study needs to shed more light in the teaching of Science and Mathematics using multimedia, as the respondents were from disadvantaged communities and learning in a poorly equipped institution.

While all literature reviewed accentuated the use of multimodal texts and the importance of multimedia in the teaching and learning of science, to assist learners in understanding of science, there was limited or no direct reference made to the language background of the learners who were subjects of the studies conducted. Even so, success achieved from using multimedia, was deemed immeasurable as opposed to the use of plain texts and/ or traditional methods of imparting science knowledge.

As a result it became imperative to the researcher to attempt to dig a little deeper and determine whether the multimedia approach to teaching of Science in the English Second Language classrooms, indeed not only aided instruction and acquisition, but also improved understanding and enhanced science literacy. The type, frequency and the level to which multimedia was applied was central to the focus of the study.

4. Purpose of the study

4.1. Aim of the study

The aim of the study was to evaluate the application of multimedia in English Second Language Science classrooms at George Mhaule Primary School in Mpumalanga Province.

4.2. Objectives of the study

- To examine the extent to which multimedia in English Second Language Mathematics and Science Classrooms at George Mhaule Primary School in Mpumalanga Province is applied
- To determine the frequency at which multimedia was used in English Second Language classrooms at George Mhaule Primary School to teach science subjects such as Technology, Physical Science and Natural Science and Mathematics.
- To establish whether the use of multimedia in English Second Language Mathemat ics and Science classrooms, enhanced content and language literacy.
- To establish teachers' views on multimedia.

4.3. Research questions

- Was multimedia applied in English Second Language Mathematics and Science classrooms at George Mhaule Primary School?
- How often were the various forms of multimedia used applied in English Second Language Mathematics and Science classrooms at George Mhaule Primary School?

- Did the application of multimedia in English Second Language Mathematics and Science classrooms enhance science and language literacy?
- What were the teachers' views on the use of multimedia in English Second Language Mathematics and Science classrooms?

5. Methodology

5.1. Research design

A mixed method design which combines collection and analysis of qualitative and quantitative data was used to enable the researcher to answer the research questions. Senior phase classes in the selected primary school were sampled and earmarked for observation and tested and a series of interviews were conducted with mathematics and science teachers. The researcher was convinced that the combination of the observation and interview exercises would yield valid results about the use of multimedia in the English second language mathematics and science classrooms.

The manner in which Mathematics and Science lessons were offered, the type and frequency of multimedia activities used made the study suitable for both qualitative and quantitative methods to be employed. Gauging the manifestations of certain trends, followed by educators in the classes visited created space for choice of non-experimental approach to the collection of data. The decision was firmly based on (Welman et al. 2005) as they asserted that: "if there is a degree of regularity and orderliness in the phenomenon studied, we may obtain highly satisfactory results by means of non-experimental research".

When observing the use of multimedia-aided teaching and learning in the classrooms, the researcher also counted the number of activities used and simultaneously recorded the frequency at which each of the selected media type was employed. Statistical evidence gathered from tests given - in which multimedia representations were used – was subjected to analysis which would reveal if there was any correlation between the use of multimedia and enhanced performance by learners.

Interviews conducted aimed at shedding light on the research problem by revealing the views held by educators on the application of multimedia in their teaching and learning of mathematics and science. Further determination had to be made if such an instructional approach had any effect on the outcome of English Second Language mathematics and science classrooms.

As the study was conducted at a school which had established its annual programmes and lesson designs in Mathematics and Science subjects, the researcher was not in a position to manipulate any of the predetermined schedules of work. Neither could any intervention or disruption take place but the researcher had to adapt to the situation as planned.

5.2. Sampling

Sampling is the act or technique of selecting a suitable representative part of a research population for the purpose of determining parameters or characteristics of the whole population (Mugo 2002). One of the main purposes is to draw conclusions and inferences based on the outcome of the testing of the sample.

The target population of this study is situated in the rural and under-resourced primary school. The institution was particularly chosen on the basis of being the remotest in the area, worst resourced, not easily accessible and less attractive to would-be Mathematics and Science teachers. The target population comprised teachers and learners in the senior phase (186 learners in Grades 6 and 7, ages ranging from 12 to 14) and samples were drawn there from. Only mathematics and science teachers were solicited for the study at the George Mhaule Primary School in Numbi Village.

Target science subjects included Natural Sciences and Technology as they both had practical activities, graphical representations, graphs, pictures, projects and experiments. Mathematics was included in view of the use of drawings, pictures, number-lines and tables for calculations and data presentations.

5.3. Data collection and instrumentation

Information was gathered from classes by means of observation of the teaching processes in mathematics and science classes, experimental projects and field activity that took place at the school. To successfully scan the environment to determine whether it had features of an English language and science learning environment, the researcher fond that observation would be the best option at the beginning of the study. Data collection was in line with research methodology as espoused by (Welman and Kruger 2001). Welman et al. (2001) believe that observations have the advantage of providing the researcher with first hand behavioural patterns or outlook of the population studied. Misleading information from the population has no space in an observation.

Participant observations were followed by interviews with teachers and descriptive statistics provided information on learner performance. The interviews were deliberately placed after the observation for the researcher and the learners to get used to their coexistence in the classrooms and to allay any fears which could hamper the free flow of information. In the interviews the teachers had the option to individually respond to verbal enquiries or answer questions on a provided questionnaire. Teacher profiles were sourced through questionnaires to determine their level of qualifications in the subjects they offered. Further enquiry was made into programmes they were engaged in for their development to ascertain if they were properly equipped to teach science through different modes of teaching.

Tests were to be given to learners to identify multimedia used and attempt to interpret them in words on the one hand and the use of graphical representations to portray given numerical data on the other hand. Certain graphically represented data was converted by the researcher to text forms, as examples, to enable learners to make sense of the questions asked.

5.4. Data analysis

A parallel was drawn between the use of multimedia in mathematics and science English second language classrooms and improved learner performance in the subjects. The types of multimedia used and the frequency of application would be essential to the findings of the study. How teachers felt about the application of multimedia and the manner in which they introduced them to their classes, led to conclusions about science and mathematics literacy and second language at the school in particular and other similar institutions as well.

CHAPTER 2

REVIEW OF RELEVANT LITERATURE

2.1 Introduction

The introductory chapter outlined the background to the study, giving a detailed account of what the study aimed to achieve, the kind of data required, how the researcher had planned to source data, the background of the participants and the way in which the data would be analysed.

In this chapter the researcher captures literature which contains information pertaining to multimedia application in the general teaching and learning process with specific reference to an English second language mathematics and science classroom. For this study, multimedia in learning, amongst others, refers to diagrams, tables, graphs, pictures (static or animated), symbols and charts which are applied during the teaching and learning process. Teachers and learners may spontaneously create suitable multimedia representations during their lessons or have them readily provided in the textbooks and available in practical tasks.

Beyond the parameters set for this study, any material which is a combination of text, graphic and sound presentations is a prime example of multimedia. Multimedia can be visually and orally perceived as animated or static representations. Generally, in mathematics and science, statistical information finds expression in graphs, tables, and other forms of non-textual presentations.

Besides these traditional multimedia types, we can make use of new information tools, such as pod casts, blogs, streaming videos and audio to engage learners and effectively demonstrate science concepts. Added to those could be photo-sharing and map-making to give learners the chance to demonstrate mastery of science concepts (Thoman and Jolls 2004).

Three learning processes in this study ran concurrently and were inseparably linked to one another: science and mathematics content learning, the integration of multimedia, and English second language acquisition. Whereas learners would be faced with the daunting task of acquiring science and mathematics concepts, their teachers were in the process of unpacking science and mathematics using graphical representations. At the same time learners needed to acquire skills to express themselves proficiently in English language.

Both local and international literature on the use of multimedia in the teaching and learning of mathematics and science content receive attention for purposes of locating the study in theory and context. Although there fewer available local multimedia literature - which was an identified gap giving a push for the study to be conducted- an attempt was made to source work from a wide range of scholars, which was put under scrutiny and classified under the following categories:

What multimedia entails and its incorporation in science education, mathematics and science instruction in South Africa, multimedia in lesson planning, integrating content and language learning, science and mathematics learning using videos, use of imagery to improve acquisition and retention of science material, multimedia in informal science education, diagrams in peer instruction mathematics, applying multimedia in view of contextual factors, historical use of multimedia, the role of teachers in applying multimedia in the science classrooms, skills acquired from multimodal text application and the theoretical framework from which the study draws reference.

2.2 What multimedia entails and its incorporation in Science education

Wellington and Osborne (2001) explain that science is taught and learned by combining language with pictures, diagrams, charts, tables, graphs and other specialized scientific and mathematical symbols. This approach places teachers' and students' usage of scientific and everyday language in the real context of the classroom. For instance, dialogues, note taking, group work, practical work, text book reading, reporting and examination writing bring together a combination of language and science in one learning environment.

It is not simply the language use that matters in the classroom but its integration with non-linguistic structures in science education, which becomes something valuable for these scholars. Familiar pictures which are relevant to the science and mathematics content provided are placed in front of the learners in the process of assimilating text messages. Practical work in the teaching of science is either presented in linguistic forms or in visual representations to be read, analysed and applied.

No attempt was made in this study to separate the intricately linked language and science learning. Instead, it seeks to determine the extent to which such a relationship entailed the inclusion of multimedia. The objective was to expand the learners' view and let them have increased comprehension of the science and mathematics content.

Language, as an integral variable in this study, finds its structures and rules placed at the centre of mathematics and science in which multimedia is used. It boils down to how we use language as teachers and pupils to communicate and structure learning and how we learn to use language as scientists themselves do - to name, describe, record, compare, explain, analyse, design, evaluate, and theorize how the natural world appears to us, (Wellington and Jonathan 2001).

Text, at times, is converted to pictures and drawings to enhance understanding through visual presentations (Luthy 2009). Certain parts of language are sometimes easily expatiated through the use of graphics such as drawings, tables, graphs, e.tc. The study of English phrases is but one salient example of a language lesson improved through graphical representations. This researcher has observed how tree-like drawings are used to show phrases in a sentences depicted as branches and the way in which the same phrases, in return, build up a sentence structure or tree.

Luthy (2009) describes graphs as 'non-fiction' texts and acknowledges the usage thereof in the content of mathematics and science education. In this study the view was that the function of mathematics and science instructions which combine content learning with text analysis is to either simplify complex scientific structures or enhance comprehension of content.

Various technological innovations over the years have been promoted to reform education and these technologies, it is believed, could be used to provide opportunities to stimulate the mind to learn. Through such technologies, which have to extend beyond drills and memory games, the mind will visualise, manipulate, and represent information in a new and different format. But identifying effective ways of designing and using these technologies to enhance learning, is a key factor as (Watters and Diezmann 2007) observed.

Innovation in the use of multimedia – such as changing from static to computerised animated visual artefacts - is purely because of the belief that the human eye assists in expediting the registration of graphical representations in the human mind. The application of visualisation processes and computer graphics in mathematics and science for the interpretation of complex data sets relates to human capabilities of seeing visual patterns (Halloran 2005). Multimodal texts therefore play a crucial role in expansion of knowledge acquisition levels.

General educational excursions, practical work, projects, and other field activities are widely considered as part of multimedia. Such classification is informed by the reason that many of these activities have either verbal (textual) instruction, preceding manual tasks or graphics requiring textual explanations.

When learning takes place outside of the classrooms, sensory and perceptual functions take up the centre stage. What the learners perceive is chiefly in non-textual form, but then extends the process of learning the subject content.

Although this research project cannot cover all the literature available on this topic, the literature consulted sheds more light on the subject of multimedia as an aid to teaching science and mathematics in the primary school.

2.3 Mathematics and Science instruction in South Africa

Knowledge of the broader performance of the environment in which the study takes place is crucial to the process of enquiry undertaken by any researcher. A glimpse of the outcome in South African mathematics and science instruction could provide insight into the depth to which research has to go in both subjects.

Mathematics and science have a key role to play in enhancing the image of the country as South Africa has been among countries which have been constantly evaluated on these two subjects. The International Association for the Evaluation of Educational Achievement (IEA) - a body established in 1995 - conducted assessments through Trends in International Mathematics and Science Study (TIMSS) and has included South Africa in surveys since 2002. Contextual factors, language of teaching and learning, geographical location and the public or private status of schools, are considered in the IEA evaluations.

Findings from IEA-TIMSS provide an indication of the success of an education system. A pattern of low levels of performance has been observed in the performance in mathematics and science (IEA-TIMSS 2011). A recently released report of the World Economic Forum (WEF) painted a bleak picture in the performance of learners in science and mathematics and ranked South Africa amongst the lowest performing countries in the world.

In view of the factors taken into account by IEA and the World Economic Forum report, this study is relevant as it focuses on a formerly disadvantaged area. It continues on the path towards seeking solutions to hurdles encountered in the teaching of science and mathematics. The strength of the country's education system cannot be measured only by the performance of the smaller urbanised and well-resourced communities. Properly equipped schools in the rural areas could also perform at acceptable levels in mathematics and science; hence the need for broader research into ways which can develop the instructional programmes for science education, particularly in poorly resourced schools. This study's focus was on what kind of multimedia texts are used, to what extent and whether such applications - if they are in use – enhance science content and language literacy.

On the home front (Makgato and Mji (2006) conducted a study which sought to establish from learners and educators their views on what could be the contributory factors to the high rate of failure in Mathematics and Physical Science. Although Makgato and Mji did not venture into smaller instructional elements of these subjects, the outcomes of their project could still point the way to go and that the usage of multimedia in mathematics is crucial to the development of science literacy and literacy in general.

The results of Makgato and Mji's (2006) study reveal that, direct and indirect influences have an adverse bearing on the performance of learners in mathematics and science. Teaching strategies, use of the laboratory, content knowledge and general language use are among their major findings. Science and language learning are complementary to each other and conscious development of the one could lead to subconscious growth of the other. Experiments in science and other projects in which learners are engaged boost language development in that proper textual definitions have to be sought for graphically presented learning material.

The Department of Basic Education has introduced the Annual National Assessment (ANA) in the General Education and Training (GET) phase as a measure of improving the quality of science and mathematics outcome in the schooling system. The country's performance in the 2012 matriculation was 54% in mathematics and 61.3% in physical science. All of these point to the fact that learner performance in mathematics and science is still not satisfactory.

The poor performance in science and mathematics requires inputs in line with content and application enhancement. This study finds its basis in the inclusion of both content and language in the identifiable areas of concern. While a gloomy picture has been painted by the low levels of performance, continued analysis of the situation and endless research in science, mathematics and language of teaching fields could bring about the desired results.

2.4 Multimedia in lesson planning

Lesson plans are essential for an organised teaching and learning process. Teachers, who spend time preparing lessons, often find the opportunity to place their lessons in context and to find relevant and effective strategies through which they can impart knowledge to the learners. In a bid to promote scientific literacy in their classes (Marks and Eilks 2009) developed lesson plans in a way which provoked interest in students. They did this through the inclusion of issues which they thought revealed the relevance of science in the societal discussion.

It has to be borne in mind that the organisation of the classroom activity for science has to take into account the nature of scientific concepts, scientific language, scientific reasoning and scientific values. It is not enough to ask students to read or study their text books: the teacher has to specifically structure the reading task in such a way that it asks important significant scientific questions. Assigning learners to write a report may not be sufficient but teaching them what the report should respond to, what the connection between answers should be and how each answer and each connection should be put into the right kind of words, sentences and paragraphs (Wellington and Osborne 2001).

This researcher's interest was evinced by how renowned science teachers (Marks *and* Eilks 2009) presented their lesson's plans.

> *Our lesson plans always start with authentic, current and controversial problems being debated within society. These topics must be present in different media sources, such as newspaper articles, brochures from pressure groups, advertisements, reports on TV, and so on, which are used to introduce the lesson plan and provoke a first round of questions and discussion Marks and Eilks 2009).*

Relevant to this study was the teachers' innovativeness that brought multimedia into the science classrooms and allowed learners to engage in processes of using visual representations. Giving learners concrete examples from their outside world where articles, brochures, advertisements and television reports all have pictures, drawings, graphs and tables bring them closer to the main focus of this study.

Learners tend not to look at graphics presented in class with admiration as they may already have the background knowledge on visual representations. This cements the basis laid by the constructivist theory of learning that learners bring into the class with them certain knowledge base and cannot thus be deemed as entirely ignorant. And when the teachers bring familiar learning content into the classrooms, learners become motivated by what they see and that is likely to spur their participation. Such activities may have a positive effect to the teaching and learning environment. Multimedia that promotes interaction by presenting real world situations can enhance learning.

Science and mathematics workbooks and textbooks, for instance: *Viva Mathematics Grade 6* (Austen P, Jones Z, Hechter J and Marchant J 2012); *Mathematics in English Grade 6* (Department of Basic Education 2011); *Natural Science and Technology Grade 6* (Beckett M, Zietsman E, Van der Westhuizen N, Toerien R, Nash B, Williams H and Horner M and *Shuters Mathematics Grade 7*(Burczak L, Cousins L, Msomi D, Prokopiak D, Tonkin R & Tonkin S 2005) for learners used in the classes, targeted for this study contain multiple representations to which teachers can add self-composed drawings during their lessons.

Through the use of these workbooks and textbooks, the study is put in the appropriate context and also made them to be pertinent to modern methods applicable in science and mathematics education circles.

While schools could teach science using multimedia, it is the way in which multimedia is incorporated into the lesson planning that proves to be vital, finds (Flores, Knaupp, Middleton and Staley 2003). Teachers are first supposed to have the understanding of the media to be applied and then prepare their lessons from an informed background. Understanding both static and the electronic multimedia can serve as an advantage to the learners in view of the interpretation given to such varied representations.

As learners bring informal science and mathematics knowledge into the classroom the teacher, through the use of multimedia, has the duty to transform such knowledge to become formal. Flores et al (2003) argue that multimedia cannot impart knowledge on their own but bridges the divide between formal and informal education, when used properly. What was required for this study to achieve its objective was to find a convergence of what renowned scholars discovered and the kind of multimedia chosen for lesson preparation.

There is a common understanding that learners have to be actively involved in the use of different kinds of multimedia, so that they do not remain as passive participants in their education. Schank (1994) firmly believes that active learning using multimedia far outweighs passive assimilation of teaching material imparted to learners by teachers through computer programmes or videos.

Creating educationally effective multimedia programs means taking seriously the idea of learning by doing. Good educational software is active, not passive, and ensures that users are doing, not simply watching. This change by itself will have serious implications for the creation of multimedia technology (Schank 1994).

Planning a lesson using multimedia requires the teacher to consider if the graphical representation to be applied allows the learner to be an active participant or not. The point is that indiscriminate use of any form of multimedia might not yield the desired results and maybe undermine the value of introducing multimedia in the teaching and learning process. Mathematics and science are generally practical subjects and learner participation is not optional but mandatory for improved outcome. So the application of computer software - as it increases in momentum – can only but add value to lessons when learners lively take part in the knowledge exchange programmes.

Computer programmes designed for teaching and learning are worth consideration when they attract learners' interest and bring alterations in the way they learn. Well-orchestrated computer programmes could go to the extent of awakening latent potential in learners who are actively engaged in their lessons. And this, argues (Schank 1994) should be taken into account by any designer of computer generated learning programmes.

Schank (1994) continues to proclaim that intelligently designed computer programs can make a significant and positive difference in the way we teach children and train adults. Such technology engages users by drawing upon and cultivating people's natural inclination to learn.

Multimedia systems should support the cultivation of individual initiative – the same initiative at work when people took their first step or spoke their first words. For many, this has lain dormant since childhood, stifled by the inflexible education system. We can do better, and we now have the technology to help us.

Interactive processes which help learners to be directly involved in their learning form a strong basis for successful science education and further motivate scientific enquiry (Jewett 2011). Even though the environment where the study was located did not have an adequate supply of multimedia generating facilities, excursions, small scale experiments and self-constructed graphical representations, still serve as multimedia representations.

2.5 Integrating content and language learning

As this study focused on the application of multimedia in mathematics and science English second language classrooms, content and language learning ran simultaneously with the teaching of these subjects. Certain earlier research projects have explored this domain (Pea 1991). Learners in English second language classrooms made out the target population of this study and should have acquired, in the end, certain levels of scientific literacy through the use of multimedia.

Holbrook and Rannikmae (2009) briefly explain scientific literacy as 'knowledge of the substantive content of science and the ability to distinguish from non-science'. Although this definition is not the sole definition of the science literacy phenomenon, it firmly laid the basis for the enquiry of this study.

Science and mathematics' content learning and English language development runs concurrently, particularly in the formal education. Evidence by (Uesaka and Manalo 2004) indicates that diagram use can be promoted via a combination of two interventions: verbal encouragement from the teacher (to enhance students' perceptions about the efficiency of the use of diagrams) and training in drawing (to improve their diagram construction skills).

Vavra et al. (2011) provides information which shows how various forms of media were used in different forums, as a strategy to teach and enhance scientific literacy for students with varying levels of English proficiency. The complexity and simplicity of the visual representations applied is often in line with the school grade(s) in which the learners are. Thus it is confirmed that academics or authors of science and mathematics material are conscious of the fact that, at a certain age or grade level, learners could be in a position to interpret some multimedia and use it for successful learning.

Holbrook and Rannikmae (2009), like other authors, believe that science learning cannot be restricted to theory only, but also concerns the use of multimedia. When learners acquire science through education they are equipped with communicative skills related to oral, written and symbolic, tabular, graphical formats as part of systematic science learning. This directly links itself to this study as the use of all these forms of media was studied.

With the study of the English language at the centre, the fact that learners are expected to understand this language in its oral and written forms makes it crucial for the interpretation of science concepts. Visual representations such as tables, graphs, symbols and drawings used in science teaching and learning as integral part of science education, add to the list of science literacy requirements.

Stoddart, Pinal, Latzke and Canaday (2002) - having observed teaching practices which separated language teaching and learning from the teaching science content - approached the teaching of science and language as an integrated process which is thought to enhance the development of the two at the same time.

Stoddart et al. detected the problem faced by second language learners in traditional teaching environments. Learners in English second language classrooms have to concentrate on learning the language prior to engaging with science and mathematics or other subject content.

Stoddart et al. (2002) realised that learning for English language learners was more complex and complicated than it was made out to be. Qualities of integration of language and content are often observed in the science and mathematics classes.

Roseberry, Warren, and Conant (1992) make the following observation:

> *The education of English language learners is complex because it involves teaching academic subjects to students while they are developing a second language. English language learners fall behind academically if they do not learn the content of the curriculum as they acquire English.*

The target population for this research project faces the same predicament. English is the medium of instruction from Grade 4 in the school where the research was conducted as is the case in all schools in Mpumalanga Province. As English language learners doing science and mathematics in a second language, they have to learn the content of these subjects at the same time acquiring the English language.

Learning science and mathematics in English as a second language is not a new practice, as it has been done in other non-English speaking countries. Malaysia adopted English as a medium of instruction for mathematics and science in 2003 as they wanted to 'keep abreast with scientific and technological development that is mostly recorded in the English language' (Pandian and Ramiah 2004). These scholars further assert that:

In this case, teaching mathematics and science in English provides a rich context for genuine language use and as such serves as a focal point around which oral language and literacy in English can develop (Pandian and Ramiah 2004)

The challenge faced by the Malaysians of learning science and mathematics in English, which is a second language, is similar to the one encountered by the respondents to this study. Teachers and learners grapple with teaching and learning concepts which are in English second language which learners have not yet mastered.

Added to their task of language learning, is the responsibility to learn to use specific concepts of science and mathematics, to assist them in their day to day interpretation of phenomena. Nonetheless, the same science and mathematics content, as taught to first language speakers, has to be learned and mastered without alterations.

The science and mathematics teachers are not spared from teaching language as they run through their subject matter. It becomes imperative for the science and mathematics teachers to not only know the content of their science subject, but also to have an adequate level of competence in the English language.

Integrated teaching and learning practices are made possible as some of the activities carried out in content and language classes are similar. English language teachers have room enough to incorporate non-verbal graphics in their lessons for in-depth analysis and interpretation of the content.

> *Inquiry Science, which promotes students' construction of meaning through exploration of scientific phenomenon, observations, and hands-on activities, provides an authentic content for language use...... the context of language use refers to the degree to which language provides learners with meaningful cues, concrete objects, and hands-on activities .... [Language learners] can communicate their understanding in a variety of formats, for example, in writing, orally, drawing, and creating tables and graphs (Stoddart et al. 2000).*

This argument provides reason enough for the integration of subjects in the study and confirms that learning can take place in science and language at the same time. Faced with experimental tasks, learners are required to possess knowledge of subject specific concepts to interpret graphically presented tasks and express such interpretations using grammatically sound expressions explanations.

Conversely, certain word processes are best comprehended when transformed into visual representations or augmented by graphical representations. Thus words amplify graphically presented learning content whilst graphics, in return, complement text. Intricately linked verbal and non-verbal presentations are all rich in content and when they are relevantly used, they serve as an effective instructional strategy.

Levin and Wagner (2006) submit that '*the* relationship between science learning and language learning is thus regarded as reciprocal and synergistic: writing can be a powerful tool in helping children to learn science'. One way or the other science education has become intensively linked with language and the two are inseparable. When the one is exclusively disengaged from the other, the learners' opportunities of enhancing their integration skills are minimised.

For English Second Language Learners the separation of language learning from science content instruction can only retard progress in both subjects, whereas integration of teaching and learning of both subjects enables the learners to master both learning areas simultaneously. Complexity of the English language used develops from the level of the learner to a slightly higher pedestal at a gradual pace. Thus learners should not be left behind as their learning moves progressively from one level to another.

> *Effective linguist scaffolding by teachers is key to making school science accessible to ELLs, as teachers use language that matches students' levels of communicative competence in length, complexity, and abstraction, and ideally communicate at and slightly above students' communicative competence (Lee and Avalos 2003).*

Teachers develop learning content with the 'competence' of the learner in mind for the effectiveness of their input. Integration mooted herein can take various forms of instructional approaches.

Multimedia representations could be used in an approach where learners are required to provide linguistic interpretation to given scientific phenomenon or verbally present science related excursions' experiences in English. Exercises of this nature offer the learner the opportunity to be vigorously engaged in their own development and become active participants.

So both Science literacy and language learning have received a lot of attention in this study and in the literature under review. Communicative competence in language cannot be separated from content acquisition. Development of the one is as a result of the other. Although Science has content specific concepts, they are better understood when simplified and explained in conventional language.

2.6 Science and Mathematics learning using videos

Mathematics and science education in a class which also grapples with acquisition of the language of teaching and learning (English in this case) requires more of the strategically selected and developed technological creations. Indiscriminate inclusion of multimedia representation may not necessarily assist in the improvement of teaching and imparting of knowledge.

Video representations form an important part of educational multimedia and their multi-facet nature makes them a worthy tool for instructional delivery. Videos comprise audio and visual material and contain texts which at times give explanations to images depicted in class. They have the potential to expand comprehension. When animated graphics are used in multimodal texts they are likely to stretch written expressions.

Designers of learning content therefore have the privilege to create video material which best suit the environment in which they apply them and can ensure that such material is at the level of comprehension of the learners and aesthetically appealing to them.

The implications for designers of instructional multimedia are that the learning process should be foremost in the design process, and the technology should be used selectively to enhance the learning process (Waters and Diezmann 2007).

Meticulously selected words, added to images for successful integration, could elicit an approach which presents the learner with a wealth of knowledge in a concentrated space. Through coordinated interpretation the learner also gets fascinated and actively takes part in integrating the knowledge at his/her disposal with his/her knowledge base (Stemler 1997).

A recent study carried out by (Wyss, Heulskamp and Siebert 2012) investigated ways to curb the decline in numbers of young mathematics and science learners who were interested in science careers. Their concern was that they would 'have a difficult time filling Science, Technology, Engineering, and Mathematics (STEM) classes that would be vacant due to retirements and a decrease in student interest in STEM'.

As this study has done, science and mathematics classroom practical activities were among teaching methods studied to arrive at conclusions.

> *"...techniques that frequently appear in STEM education literature include Project-based learning and hands-on activities, active-learning, concept mapping, and student-centred learning. These techniques are studied across all subject areas and age groups and frequently demonstrate that students' experiences in the classroom are enhanced through these techniques...in the second phase of the study the videos were shown to middle-school students over an eight-week period.*

The students' interest in STEM careers was measured via survey at three intervals before viewing the videos, after half of the videos were viewed, and after all of the videos were viewed (Wyss et al. 2012).

The researcher in this study observes the value placed on the use of media, not only in classroom teaching processes but also in the fields of science orientated research works which produced positive results by increasing, among young learners, the need to pursue science, technology, engineering and mathematics careers.

Wyss et al. (2012) explicitly emphasises the need for applying multimedia in making learners understand science careers better than they would without video clips about science. Questions about the relevance of the use of multimedia are, in some way, answered by this study (Wyss et al. 2012).

Restricting learners to print and static media undermines the need for learners to keep abreast with technological development which is a key factor in their quest to achieving science literacy.

2.7 Use of imagery to improve acquisition and retention of Science material

While this study focuses on the overall application of multimedia at the identified target research location, studies conducted elsewhere point out that the interventions in science and mathematics classes through the use of images produced positive outcomes.

By integrating imagery in learning imparting, acquisition and retention of subject matter is virtually enhanced.

Since vocabulary is such an integral part of the Science content it is important to incorporate images when instructing students on new meanings. Mental imagery, creating images in one's mind, is a quasi-perceptual occurrence that closely resembles the actual experience of perceiving some object, event, or scene, but which occurs in the absence of relevant actual stimuli (Cohen and Johnson 2011).

The literature adds to the significance of multimedia, the value of imagery and mental pictures in science education. Images are perceived as representations of reality and provide the learners with figures to which they could refer and which could enhance their comprehension of subject content (Cohen and Johnson 2011).

In the classroom reality is absent, yet mental pictures and imagery paint scenes which could be linked to what is taught in the class and bring reality closer. The ability to visualise the science phenomena brings a sense of comprehension of content and simplifies complex leaning processes.

> *Because pictures or illustrations are analogies of experience and are only one step away from actual events, these visual representations may be able to capture and communicate the concrete experience in various ways (Stokes 2001).*

Pictures and illustrations become more relevant when depicting a familiar science situation in the classroom. They are able to concretise theoretical information. The study pays attention to science and mathematics graphics which could be presented in the class with learners responding to things they could see while the teachers are in the process of teaching.

However, the complexity of forming mental pictures comes with careful and in-depth thinking, coupled with the skill of associating imaginary features with live subjects. Cognitive development is bound to take effect in view of the deeply rooted thought process applied when mental images are to be put to use.

2.8 Multimedia in formal and informal Science education

Using multimedia to aid teaching of science and mathematics comes in a multidimensional way and provides space for several role players. Teachers prepare the forms of media to use and learners also have the opportunity to interact with the media in use. Both formal and informal teaching and learning milieus have equal value in the impartation of science and mathematics content through the use of multimedia.

With the growing technological advancement around the globe, where every corner of life has experienced the influence of multimedia, the science classroom does not become an exception. Thoman and Jolls (2004) observe that our learners in science education will need to become media literate and well versed in the many modes of communication that surrounds them to be able to sort through information coming to them via multimedia.

Pea (1991) finds the use of multimedia as an integral part of teaching and learning especially when learners become part of developers of multimedia learning products.

> *Society has come to regard multimedia literacy as essential as writing is today. The Multimedia Works Project focuses on enabling students to create and use multimedia documents…learners need to control computer-controlled multimedia to communicate their own understanding of information. Multimedia objects (text, pictures, video clips, and so forth) are important building blocks for developing students' understanding* (Pea 1991).

In formal classroom presentations of science matter, learners generally receive tuition handed down by their teachers from their prescribed textbooks and multimedia presentations. Pea (1991) advocates for the direct involvement of learners which, he believes, improves learning. This view spreads to all subjects in the school and may go beyond. While context may vary from one learner population to another, certain aspects of use of multimedia may be common or different but yielding similar results.

Field trips in which multimedia may be used to gather information can be carried out by language and science learners and the information gathered could be analysed by participants at common points of convergence. In such forums learners and teachers would share their understanding of the subject matter. Learners will therefore require clear understanding of the science concepts, skills to interpret the multimedia data and language proficiency for completion of such a task.

With this understanding the researcher believes contextual differences would have little bearing on enhancement of understanding. In the population under study participants could use available resources – though limited- to gather information which would be vital for understanding the subjects at hand.

Pea's key point is the direct involvement of learners in the use of multimedia for purposes which all teaching and learning communities could be capable of doing. Information is not handed down for consumption but guiding tips are necessary for structured student mini research projects. In this scenario multimedia extends the limited bounds of the text books.

Liu (2009) observes how science is not only learned within the precincts of the school but also in the public arena where informal events, processes, excursions and other human activities promote science literacy. He finds that students encounter science outside school at all times and in all forms. For example, television programs, both science-explicit and implicit in content, convey important scientific knowledge and ways of thinking. Weekend or summer visits to the beaches, museums, and national parks provide learning opportunities for both school children and adults. Informal science educators call science learning outside schools free-choice science education.

Furthermore (Liu 2009) acknowledges that free-choice science education is self-paced, voluntary, mostly free, non-sequential, and social: it takes place outside school and is facilitated by museums, science centres, print and electronic media to name just a few

While this research project occurred within the confines of the class and focused on the limited scope of multimedia, it had links with out of class activities. Advanced and more comprehensive media is best employed outside of the classroom as opposed to the static pictures, graphs and drawings on which this study concentrated. Although (Liu 2009) expanded the horizons of science education and covered a broader spectrum outside the classroom milieu, he still propounded the use of multimedia in science instruction by including excursions.

Ventures may be widely regarded as relaxed activities which do not command detailed concentration but if properly carried out they lay a firm foundation for teaching and learning.

Apart from the sightseeing and encounters with non-human species, asserted (Liu 2009), outside education also uses print and electronic media which are sources of both animated and static representations. Such privileges offer the learners the opportunity to make choices of what to pay attention to and learn from, while respondents in this study were faced with media that were pre-determined and cast in stone.

Liu (2009) added to his media choices for science in public the use of the Internet for "seeking science related information". It's a necessary information medium flooded with loads of science information which could be used at school for formal science education.

The gap between informal and formal science education can be bridged by using the Internet and afford the school going science learners the chance to be exposed to the vast unrestricted media found in the outside world.

Considering (Liu 2009) input, billboards which are widely used by business and authorities to entice consumers, can effectively feature as valuable multimedia tools for science content and language learning. The presence of billboards in the environment of the population selected for this study also provides an immediate point of reference of multimodal representations. Developers of billboards often take into account the correctness of the language used combined with the visual representations and learners are likely to benefit there from.

2.9 Diagrams in Mathematics peer instruction

As this research project seeks to determine whether the use of diagrammatic representations enhance literacy or not in the rural school identified, other studies conducted elsewhere in economically advanced countries prove that the use of diagrams indeed increased learners comprehension of subject matter, particularly in Mathematics.

Uesaka and Manalo (2004) conducted a study in which participants were required to present their problem solving methods to their peers using diagrams and produced results which supported what they had learned about from earlier programmes.

> *Diagrams are generally considered as one of the most effective tools in problem solving....diagrammatic representations are superior to sentential representations because they help reduce mental computational loads associated with searching and processing. As a sub-category of diagrams, those that are self-constructed are especially effective (Uesaka and Manalo 2004).*

The findings of the study conducted by (Uesaka and Manalo 2004) confirmed that indeed diagrams, as multimedia, were used not only in science but also in mathematics. It emerged that not all diagrams used were sourced from prescribed texts but others were also constructed by the teachers.

What was of grave importance in the study was the use of diagrams by learners themselves when they went through their own work. Progress was portrayed in the understanding of mathematics and science content. Other than the progress shown in learning depicted by (Uesaka and Manalo 2004) in their research project, the kind of multimedia used also formed an integral part of this study.

2.10 Applying multimedia in view of contextual factors

Science and mathematics lessons have their own complexities which the educator needs to simplify and bring closer to the learners' level of understanding. If all to be learned, were to be entirely abstract to the learners and not related to any prior knowledge which they are likely to obtain from their immediate environment, learning would become a long haul. Lack of interest would set in and science literacy would be partially achieved or not at all.

Two major concessions made in a study by Eilam (2013) which are in line with this research study and its target population, allude to the success of the use of multimedia which take into account the contextual factors in a learning environment.

Eilam (2013) argues that learning with multiple representations involving visual representations, has long been proven empirically, in particular conditions to promote students' construction of knowledge, understanding, and transfer of the represented information. Accordingly, such learning involves the processing of the visual external representations – as stimulus perceived from multiple representations- for the construction of internal representations.

Learning through multimedia takes place internally and externally. Even if the media used is perceived from the outside it is still processed mentally. Visual presentations help learners as they refrain from constructing mental pictures to make meaning of any verbal presentations. Images are a stark resemblance of reality and the objects or processes to which they directly refer. Meaningful ideas are easily constructed when visual representations are presented for analysis and description of phenomena. Where learning takes place multiple modal texts do not only initiate the thinking process, but also stimulate discussions.

In order to effectively assist learning of science, the choice of all visual representations must simply relate to the learners' immediate environment for easy processing. This view finds support when (Hatano and Inagaki 1994) assert that with regard to difficulties related to context, researchers indicated that learning is embedded, and that to achieve successful learning outcomes, instructional practices and beliefs must entail translation into students' local culture and alignment with their beliefs and attitudes for learning

The socio cultural background of the learners and that of the teachers has to be linked to global socio cultural contexts in order to enable local and wider world views and interpretation of instructional matter to take effect. Ultimately, the success of educational visualization, regardless of the form, depends on what the learners bring to the task in terms of background knowledge, Visio-spatial skills and interpretive ability. Thus a thorough understanding of the nature of visualization objects, their function and the interpretive skills essential to access the plausibility, validity, and value of visual images is critically important (Vavra et al. 2011).

Not only does the use of imagery and multimedia have to consider the socio-cultural context of their immediate environment but also the ability of the learners to interpret and effectively use them. Different socio cultural backgrounds are likely to influence the learning process in varied ways. In urban science environments the contextual factors faced by learners are not similar to those experienced by the rural learning population selected for this study. Interpretation skills are bound to vary as a result such variables.

2.11 Historical use of multimedia

The archives of history confirm that multimedia representations are not a new feature and can be traced to earlier years. Literature (Stokes 2001) portrays pictures and drawings as ancient forms of communication, which were used to convey messages just as they are used in the modern day era. Interesting was the aim for which graphical representations were used as opposed to the general thought of enhancing meaning. Multimedia was used to represent words and to compress large forms of data into smaller but still comprehensible representations.

Leonardo da Vinci, in recognizing the impossibility of recording volumes of data, translated words into drawings from different aspects. As history repeats itself, we may find that a great deal of information is better presented visually rather than verbally (Stokes 2001).

This study sought to determine whether learners were able to decode meaning encoded in graphics, a process which was long started by renowned historical figures for portability of information. Combining words and pictures are key elements for both language development and reading of graphics; but pictures alone could still tell large stories as compressed versions.

2.12 The Role of teachers in applying multimedia in the Science classroom

Teachers, whose role is to impart scientific knowledge, have a critical part to play in guiding learners and explaining multimedia used in their classes. Such a responsibility requires them to possess the knowledge themselves to help their learners to achieve the levels of success required.

Wellington and Osborne (2001) emphasize that all teachers look and hope for scientific forms of expression and reasoning from their pupils, but few have been taught specific techniques for supporting learners' use of scientific language.

With adequate background knowledge it will be easy for "teachers to be more flexible in their teaching methods" (Finlayson and Farren 2005). Other scholars such as (Stokes 2001) have expressed the same thought after their studies that students need to learn visually and teachers need to learn to teach visually. In order for visual enhancements to be used most effectively, teachers should possess skills that include the language of imagery as well as techniques of teaching visually.

Precisely because of the fact that the teachers serve as vehicles between the learners and the content, they should be at an indisputable level of understanding of the subject matter to be effective. Using multimedia in the science classrooms would not only become the learners' task but the teachers' proficiency is also called into the fray. Either group stands to gain from the setup.

Mathematics teachers are not left out in the cold when it comes to literature, because they also use graphics like circles, number lines, graphs, squares, tables, triangles, drawings and pictures in their lessons to convey meaning.

Mathematics teachers use numerous diagrams for explaining how to solve problems in class and this practice contributes to the promotion of students' understanding of the process involved (Uesaka and Manalo 2004).

Teachers directly provide a supporting role to learners through their self-created graphics and through those found in the learners' books. When students actively take part in their learning they ease the role played by their teachers in the mathematics and science classrooms. If teachers are deprived of developing valuable and relevant visual skills of interpreting visual representations, that on its own, amounts to denying learners the opportunity to find a viable alternative to resolving their learners' science and mathematics problems.

Expertise expected from teachers range from the ability to select relevant multimedia for their subject(s), correct interpretation of the multimedia used, and knowledge of the level of learners for whom the multimedia would be used.

Relevance of multimedia will take into consideration of the context in which the teaching takes place and the link between the type of multimedia applied and the content of the exercise given. It is also important for the teachers to have knowledge of their learners' ability, as the constructivism theory stipulates, to ascertain compatibility of any developed material to the level of competence of the class. Well-equipped and confident teachers will eventually unleash a wealth of information which would take learners to unimaginable heights as scientists.

2.13 Skills acquired from multimodal text application

Apart from adding to the knowledge base of the learners, multimedia learning equips learners with lifelong reading, visualising, interpreting, integrating, inquiry, and analytical skills. Once applied, text and media instructional designs leave the recipients with a multiliteracy background enabling them to have the ability to read analyse and interpret a range of multimodal texts.

In the process of multimedia usage, first comes the reading and interpretation of the text, followed by the analysis of the accompanying visual representations and then the creation of a comprehensible link which broadens the narrow conceptions borne separately by the words and the graphical representations. Failure to understand multimedia enriched texts may narrow down the understanding to separate conceptualisation of the text apart from the graphical component. Successful learning therefore comes as a result of the association and interpretation of the several modes fused in one lesson presentation.

Luthy (2009) established that a variety of multimodal texts pose inevitable challenges which need to be overcome in the way to multiliteracy.

> *A sampling of math and science items…revealed the following literacy demands: establishing a purpose for reading, decoding and comprehending unfamiliar vocabulary terms, interpreting complex graphics, determining the importance of information synthesizing for note taking or for writing a response, ….form mental models and visual images while reading, making connections to previously learned concepts and comparing and contrasting information etc.*

The process of finding meaning to a multimodal text is quite an arduous task and a patient build up teaching and learning activity simplifies it. Learners must be stimulated towards reading so as to take the process further by increasing their eagerness to interpret the read content. Reading of text which is aimed at achieving comprehension calls for thorough analysis and interpretation of data. That achieved, it makes readers to draw conclusions from an informed basis.

Schools which lay the foundation on the use of multimedia prepare their learners for future engagement with multimedia texts. Teacher self-developed graphics and those provided in textbooks which are blended with text are not readily intelligible to learners. Such texts need of teachers to be taken through some introduction and orientation into multimedia work.

Requisite skills and knowledge to interpret multimodal texts improve other areas of learning. Presentation proficiency is acutely necessary for science projects and can be acquired in a language classroom. Hence building familiarity with graphics and analytical problems through the use of textbooks and ancillary materials develop students' confidence in reading and communication information.

The skills required for comprehending mathematics and science content are not likely to be taught in English classrooms. Students will benefit most from the meaningful integration of literacy strategies into math and science instructions that is designed to improve their learning of that content (Luthy 2009). Integration of learning content, according to (Luthy 2009), is not an option but a necessary step towards improved language learning and content assimilation.

Practically, mathematics and science comprise concepts unfamiliar to the language learner, which might require explanation and understanding through the use of conventional language. Thus science and mathematics content and concepts tend to be blended with language structures. Writing in the mathematics and science classrooms is not devoid of rules of grammar and other syntactical requirements and successful completion of any mathematical or science project rest on comprehensible linguistic expression.

As actively as learners engage with mathematics and science content and practical works, so should they with language learning simultaneously. Integration of content and language teaching and learning is the responsibility of both the teachers and their learners.

2.14 Theoretical Framework

Various learning theories underlie teaching and learning for different fields of study and multimedia, which is a combination of pictures, drawings, graphs and text in teaching and learning is no exception. Renowned scholars contributed to the development of multimedia theories for teaching and learning and this study is based specifically on the Cognitive Theory of Multimedia Learning (CTML), developed by (Mayer 2001).

The choice was mainly encouraged by the relevance of the theory. It acknowledged the idea that learning was significantly enhanced through the incorporation of multimedia than when only one 'channel of presentation' was employed. Mayer (2001) found that people learn deeply from words and pictures than from words alone. Words, (Mayer 2001) concedes, have been the major format for instruction thousands of years back and still are today. Even with further technological advances, pictorial forms of instruction are becoming widely available, including computer-based graphics.

While in the earlier days, limited genres of multimedia could have been available, the availability of any form of multimedia in the teaching and learning environment in the present day is just an extension or continued application of valuable tools for the enhancement of teaching and learning. Processes involved in the interpretation of multimedia require the learners to organise images and words and integrate them for analysis.

The manner in which the processes of organising are arranged determine whether the process of learning would be successful or not. Speedy animated integration of pictures and words which require dual decoding may lead to loss of meaning and subsequent failure of the learning process.

The study pursued, therefore, may become pertinent to the contribution towards improved knowledge on the use of multimedia in teaching with special emphasis on mathematics and science English Second Language classrooms. Having been an educator for more than a decade the researcher has been able to observe, use and evaluate, inadvertently though, the use of multimedia in the English Second Language classroom.

Other teachers also presented their own content through either self-constructed multimedia elements or referred to those used in texts prescribed for learners. Learners perceived what was presented to them in the form of words (ears) and when multimedia texts were added the visual (eyes) representations were registered in the mind and then analysed for further comprehension.

Added to the dual decoding process envisaged by the Cognitive theory of multimedia learning is the integration of the multimedia presentation unit with prior knowledge of the learners. It was prudent therefore to observe if multimedia used (if any) at the school considered the prior knowledge of the learners or if the set works used had images and text familiar to the learners or not Mayer (2001).

The Cognitive theory further considers that the simple inclusion of multimedia in the process of teaching and learning does not translate into improved learning as 'all media are not equally effective'. Generalising on the success of multimedia application is rebuffed by this theory which puts the study into the right perspective.

Irrelevant and unappealing multimedia could confuse learners or distract them from acquiring knowledge presented through such media. This argument paves way for inclusion of teacher and/or student generated multimedia to increase chances of the media used to be relevant and effective in imparting the presented knowledge.

In the process of looking at the type of media employed in the classroom, the researcher at the same time found the opportunity to lightly gauge their effect through the responses from the learners. The advantage that learners have when engaged in learning, which involves multimedia, is that they (learners) have the opportunity to visualise what is presented and or make sense of the concrete evidence.

The theory backed the idea that if learners could see, feel, touch or hear, they are quite likely to produce positive outcome from the learning situation. Text only can fade from the memory as quickly it is registered but the same cannot be said of multimedia enriched instructional content.

Principles on which the Cognitive Theory of Multimedia Learning is based have three key distinguishing features: dual channels for visual/pictorial and auditory/verbal processing (i.e., dual-channels assumption); each channel has a limited capacity for processing (i.e., limited capacity assumption); and the active learning entails carrying out a co-ordinated set of cognitive processes during learning (i.e., active processing assumption), as Mayer (2001) distinctly points out. Multimedia presentations received are arranged as pictorial and text forms received through the eyes and ears for cognitive processing and integration with existing learners' knowledge.

However, each category is received to a limit of the capacity of the cognitive space. This means that certain information can exceed the mental capacity of the learner and cannot be stored in the memory. In the event of overly flowing information, learning may not be possible. In the last feature that distinguishes the Cognitive Theory of Multimedia Learning the learner is assumed to possess an active processing cognitive capability which is readily awaiting incoming presentations to work on.

A firm basis has been laid for a relevant approach to any future enquiry, aimed at the use of multimedia in the mathematics and science English Second Language classrooms. Pictures and words are received through different channels at a limited quantity for processing and integrated through the active processing assumption for comprehension to take effect.

Whereas there could be room for receiving loads of multimedia representations, the reality is that the human mind is not bottomless. And this compels designers and developers of graphically enriched curricular content to consider the age levels and capacity of the consumers of multimodal texts.

Teachers at schools have to consider limitations which their learners might have and the complexity of the multimedia used compatible to the ages of the learners. Understanding the processes of content assimilation in multimedia learning intensifies long held assumptions on the usefulness of graphical representation in teaching and learning, Mayer (2001).

Certain logical deductions are borne out of other relevant theories which explain how learning takes place. Although some theories may be generalising on the process of learning, they virtually find particular relevance when applied to mathematics and science learning.

The constructivism learning theory which augments propositions of the Cognitive Theory of Multimedia Learning, advocates the idea that learners build up knowledge, rather than just taking up and preserving what the teacher imparts to them in a formal classroom situation.

The Cognitive Theory of Multimedia Learning is complemented by the Constructivism theory, which claims that knowledge is actively constructed by the student, and not passively absorbed from textbooks and lectures. Since the construction builds recursively on knowledge (facts, ideas, and beliefs) that the student already has, each student will construct an idiosyncratic version of knowledge. Any construction of knowledge passes through the cognitive process as explained by the Cognitive Theory of Learning and may add to enhancement of comprehension (Ben-Ari 1998).

Learners, in accordance with the constructivism, are not entirely ignorant when faced with multimedia texts or any other form of learning material, but bring fundamental knowledge on which all new inputs could be based. Basing the research project on the Cognitive Theory of Multimedia Learning augmented by constructivist approach enabled the researcher to work within parameters of understanding on how multimedia in content and language learning are applied.

Science methods based on a holistic, constructivist approach can reform and enhance teacher knowledge, confidence, and attitude and can lead to the adoption of effective strategies in teaching science in the elementary science classroom, argues (Kelly 2000).

Though falling short of evaluating the manner in which learners acquire knowledge through multimedia, this study in the least, focused its attention on the type, the frequency and sourced the views of science teachers and learners on multimedia applied in their English second language classrooms.

2.15 Conclusion

In the on-going review of relevant literature for this study, the different kinds of multimedia explored ranged from static to animated media. Visual representations, imagery, self-constructed, print and electronic forms of media have received attention from a host of scholars who regard media as a crucial tool for science and mathematics education (Cohen and Johnson, 2012; Laplante, 1997; Holbrook and Rannikmae, 2009; Flores, Knaupp, Middleton and Staley, 2002; Vavra, Janjic-Watrcich, Loerke, Phillips, Norris and Macnab, Norjihan and Ibrahim, 2005; Vergis, 2011; Pandian and Ramiah, 2003).

The literature accessed widely confirms that there is an increased use of multimedia in their various forms in mathematics and science instruction. The Cognitive Theory of Multimedia Learning, on which this study is based, shows how the research community expressly acknowledge the evolvement of multimedia products from purely static to animated multimedia types. Both static and animated kinds of multimedia serve various purposes in the expansion of knowledge bounds of the learners.

Simplified interpretation (reading and comprehensible analysis) of data, enhanced problem solving skills, and concentration of information into manageable multimedia representations are very useful approaches to complex learning material. Content with graphical depictions of processes and concepts are common features in modern mathematics and science education. The main reason advanced by many scholars for using visual and auditory representation is the advancement of comprehension of content in the science and mathematics classrooms (Mayer 2001).

In situations where multimedia was used outside of the class, the goal, however, still remained linked to the application in class. There is unlimited availability of a variety multimedia for use in teaching and learning science and mathematics.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

In the previous chapter the study focused on what various scholars in their studies did to find information on the use of multimedia in science and mathematics education. This chapter outlines the processes the researcher followed in collecting data from the school environment and the participants.

The study followed the process as outlined by Leedy and Ormrod 2012).

Research design

Population and sampling procedures

Instruments and data collection activities

Class observation

Document analysis

Interviews with teachers

Tests

Methodical reasoning

Limitations of the study

Data analysis

Ethical considerations

3.2 Research design

A mixed method approach - qualitative and quantitative - was used for this study based on a local South African study conducted by (Webb 2009). Webb's study was carried out in a similar environment of previously disadvantaged rural South African communities where teaching and learning of science and mathematics was done in English.

The observation schedule, questionnaires and document analysis related to the qualitative research approach whereas the frequency counts and the tests were categorised as the quantitative aspect of the study.

The two pronged approach provided answers which were subjected to quantitative analysis on the one hand (frequencies), and observations and interviews with teachers who gave the researcher an in-depth insight into how mathematics and science educators viewed the use of multimedia in multimodal texts when they impart knowledge, on the other hand. The data collected from interviews and observations lent itself to qualitative scrutiny.

3.3 Population

The population selected comes from a background classified as previously disadvantaged and non-urbanised population groups. The aim was to observe how poorly resourced schools performed in mathematics and science, when using multimedia. Added to the challenge of lack of resources is the fact that the participants were English Second Language learners who had to master the science and mathematics content as well as master English.

The George Mhaule Primary school, with a total enrolment of seven hundred and eighty nine (789) learners, was selected for the study as it suited the criteria of rural schools and had all its learners coming from non-urbanised family units. A rural Mpumalanga or Limpopo school is a school without adequate infrastructure, such as laboratories, and is also situated in a non-urbanised environment. In the context of this study the identified school was classified as rural, because it is remotely situated from towns or urbanised areas, without good road infrastructure, and with non-modernised and ill-equipped buildings.

3.4 Sampling

Various types of probability and non-probability sampling methods were considered to find the relevant respondents who could yield results (Leedy and Ormrod 2012). Amongst others, theoretical, discriminant and purposive sampling were taken into account. Theoretical sampling which is used by researchers to unearth grounded theory was not suitable to the study and was disregarded. For increased chances of getting relevant responses which would answer the research questions, purposive sampling was chosen.

As the study relied, to a certain extent, on work done by other previous researchers in the field it was necessary to use this approach Welman et al. (2012). The sampled population had a greater chance of being representative of a rural, ill-resourced and Mathematics and Science English language learners.

Three (3) classes of eighty-seven (87) sixth grade and seventy-one (71) seventh grade learners took part in the study. The school is situated on the edge of the village with poor housing facilities. This poverty extends to the learning environment: classes are in a state of disrepair and there is a general lack of infrastructure. For example, one classroom has been partitioned into a small clerk's and a principal's office.

Thus the study was appropriately placed as it is typical of many rural schools which are resource impoverished. With limited resources and being placed remotely from any urbanised environment the school best suited the study than any other in the vicinity.

3.5 Instruments

3.5.1 Observation schedule

Parts of the objectives of this research project were to examine uninterruptedly the application of multimedia in the mathematics and science classroom environment and to determine the frequency of application. The observation schedule augured well for collection of data as not only were classes observed but the surroundings were also scanned to establish if they were conducive to practical learning of science and mathematics.

3.5.2 Questionnaire

A questionnaire was developed and used to gather information about personal qualifications, biographical and subject content from the teacher participants. Open ended and closed questions were combined in order to widen the scope of the reach of the study into knowledge base, views and attitudes of these teachers towards the use of multimedia in the teaching of mathematics and science (See annexure 4.)

3.5.3 Test papers

Two forms of assessment for each subject (Mathematics and Science) were designed for learners to be given to them at different times. The first was administered as a text only lesson and the second had similar content but with graphic content. This was done to determine if there would be any significant difference in the achievement of the same learners with attention also paid to their language skills and comprehension.

A combination of scores from two tests given to learners was used to determine the effect that multimedia had on the learning and teaching of mathematics and science. Added to the values derived from the test and the conclusions drawn there from, a combination of language and visual representations was administered to the participants to either text or graphics (See annexures 5&6.)

3.6 Data collection and procedures

The Department of Education in Mpumalanga has set out rules and procedures to be followed before any research study may be conducted at their schools. The sole aim is to keep track of all research projects conducted within the department and to receive feedback from researchers which could assist the department in bridging gaps identified by the studies conducted.

For this study the researcher made an application to visit the research site – George Mhaule Primary School - and waited for the approval by the head of the department. When approval was granted arrangements were made with the school for the participants and those around them to be aware of the presence of the researcher and to make room for class visits. (See annexures 1&2.)

When the study finally took place it was conducted at two separate time schedules with an interval in between to allow time for reflection on the findings and to refine certain aspects where it was necessary. It was important for the research study to use the provided timetable for class attendance and be slotted into the programme of the school in order to minimise disruptions.

A combination of scores obtained from two tests in mathematics and a pair in Science given to learners was used to determine the effect that multimedia had on the learning and teaching of mathematics and science. Added to the values derived from the test and the conclusions drawn there from, a combination of language and visual representations was administered to the participant for converting to either words or to graphic representations.

3.6.1. Classroom observations

Three Grade 6 and 7 classes in which Mathematics, Technology and Natural Science were being taught were targeted for observation. In the process teachers and learners were allowed to continue with their day-to-day activities without any interference.

An observation schedule which focused on class activities and the frequency of use of graphical representations were employed to ascertain whether a structured process was followed. The observation process focused on how the educators imparted subject content to their classes and how the learners responded during teaching and questioning times in the same lesson. Important for the researcher was the application of multimedia in each selected class (See annexure 7.)

Besides in-class activity, the researcher observed science and mathematical projects taking place within the school environment, but outside of the bounds of the classrooms. It was first to be determined if any of these activities taking place outside had been commissioned by the selected teacher population and that they were legitimate science or mathematics related projects. The latter were selected as they give learners the opportunity to be actively engaged in practical tasks.

3.6.2 Document analysis

The researcher took time to read prescribed text books and quarterly workbooks - all written in English, the language of teaching and learning, to determine the type of multimedia used for the phase or level of the learner participants.

Analysis of these documents stretched further to cover the types of multimedia contained in the prescribed textbooks and observed how learners were prompted to use such multimedia in their respective classes and levels.

Focus was also placed on how pictures, drawings, tables and graphs were integrated with the language use for the purpose of interpretation of the science and mathematics content.

3.6.3 Interviews with teachers

From the sampled population of science and mathematics teachers, six teachers were selected for interviewing. A questionnaire / interview guide was employed to probe the respondents and encourage them to say more on the subject content, the use of graphics they used and the practical work that they're involved in?

Teachers were further requested to list the various multimedia representations they used in their classes and to give an estimate of the regularity of use of such activities as well as the exercises through which they put their learners.

Teachers were asked if they ever brought any multimedia material (such as pictures or artefacts) related to Science, Maths and Technology into their classrooms? From their own experience, teachers had to share their views on the teaching and learning of science and mathematics using graphical representations? This was to understand whether such use had any influence on learners' performance and to determine if ever graphics were used or not in the identified population.

For reliability purposes, the information sourced from teachers was tested when three selected groupings of five learners were randomly given pictures, sketches, drawings, and graphs which teachers were reportedly using in class to find out if they recognised them or not. Responses received were for the purpose of the findings of the study and were not returned to the educators. The confidentiality of information given as promised to participants was kept.

3.6.4 **Tests administered**

Learner participants were placed into groups of five for each subject and given two sets of tests which varied from questions based on text only content to multimedia infested content which required interpretation.

Six different pictures (see annexure 4) were placed in a mixed-up order in the first week for learners to rearrange them in the correct order. The second group of pictures were arranged in terms of differing sizes and learners were requested to explain them in formal English.

Subsequent to the picture exercises learners were required to convert given sets of numbers into a diagram depicting a soccer or netball field and were also asked to provide miniature drawings of the expected number of players. The choice was based on gender sensitivity and the familiarity of such sporting codes in the area.

All questions asked were to test the learners' general understanding of multimedia commonly used in science and mathematics classrooms. For purposes of fair responses and to limit apprehension, participants were informed, prior to writing the tests, that the tests would have no bearing on their continuous assessment year marks.

The selected groups of learners were purposefully sampled from three classes and tested for thorough interpretation of visual representations, linking provided media to science processes and step by step analysis of pictorially given data. Certain numerical data had to be labelled on number lines and graphical representations to determine use and comprehension thereof.

3.7 Methodical Reasoning

Data collection and analysis had to be spread over two approaches, because statistical data and data from which inferences could be made were combined. Frequencies of regularity and kinds of multimedia needed the quantitative approach whereas data collected from observation and interviews required qualitative analysis. A combination of the two methods became necessary.

The study focused on three classes of sixth and seventh grade learners doing Mathematics, Technology and Science. Texts containing pictures drawn from learners' workbooks which had been used in previous lessons as strategies to improve their understanding of science and mathematics content were reintroduced to the selected respondents to ascertain regularity of the method.

Teachers who further drew their own graphs, pictures and tables which were jointly labelled with their learners as classes were in progress, were asked if any samples of previous lessons were handled in the same approach. This was done to verify if teachers were not reacting to the study as explained to them by the researcher but continuing with strategies which they may have been employing over the past period of time.

The response rates of learners when they were regularly brought into discussions and at times required to respond to questions based on visual representations depicted in their workbooks, were closely monitored. Leading statements were made which sought to introduce learners to discussions and to determine if multimedia representations referred to were comprehensible to learners or not.

At some point the researcher became interested in knowing if there were free-running questions asked. Such questions needed learners to interpret multimedia that they observed using English language as a means of expressing their views. Embedded in this were questions of language fluency, adherence to grammatical rules and application of language structure.

3.8 Limitation of the study

Unavailability of resources and material for the Technology teacher and her learners made it impossible for the study to cover the class. Learners did not have either text books or workbooks for the quarter to refer to and all information was supplied by their only source, the teacher. The school did not have a science laboratory so it was not possible to carry out any systematic observations of practical work.

Due to the obvious lack of proper fencing and housing facilities at the school, there were little or no chances for setting up of major science projects which could provide opportunities for practical activities. Participants were all restricted to the use of in-house small operations.

The official language for teaching at the school was English; yet as a result of poor levels of English competency it was envisaged that certain levels of code mixing and code switching would frequently be applied by the various teachers in the process of explaining concepts to learners. Thus it was anticipated that the process of defining certain texts, processes and linking them to multimedia phenomena would also pose a challenge in English only.

The effect of the use of one code for teaching mathematics and science with the inclusion of multimedia representations could only be determined at the time when comprehensive assessment would be done.

3.9 Data Analysis

The researcher took time to constantly refer to and read textbooks and work books made available by the school which were also used during lessons by both learners and teachers in the target classes. Such prescribed text books and workbooks had been supplied by the Department of Education. An operational plan, referred to as the work schedule, was also provided.

Regularly used multimedia representations were classified and inserted into a graph to measure their relative frequency of use and conclusions were drawn from that process. Information gathered from interviews and observation processes was juxtaposed to determine if there were any forms of corroboration between what was being said and what the researcher observed in the actual teaching and learning process.

Observations carried out on activities taking place outside of the classroom, were recorded and examined to ascertain if they had any traces of multimodality in the teaching of science and mathematics. The effect of such a process on the impartation and acquisition of science and mathematics knowledge was gauged through tests given to the respondent learners. The language, in which learners responded to questions posed by teachers during teaching time, revealed that classes were not exclusively conducted in English but with the use of the mother tongue.

Interviews held with teachers had to be closely to establish if they had the necessary qualifications and knowledge to carry out the responsibility of imparting science and mathematics knowledge to learners using multimodal texts.

3.10 Ethical considerations

A consent form was distributed to the relevant teachers, which described the purpose of the study. In clear terms teachers had the option to take part in the study or to pull out if they felt they did not want to continue participating. Learners who were selected for observation and testing were unequivocally informed of the study, its purpose and that it would have no bearing on their continuous assessment task outcome.

All participants were assured of the confidentiality of the information they divulged and that their personal circumstances - relating to qualifications, content knowledge and experience in teaching the subject - would not be published in the final report.

3.11 Conclusion

A combination of instruments including the observation schedule, tests and interview questionnaire was used to source information from teacher and learner participants. Observations instruments focused on both inside and outside class science activities to determine the availability, type and frequency of use of science related multimedia.

Interview instruments consisted of structured questions which prompted respondents to point out at the nature of multimedia used in the teaching and learning of science and mathematics, the frequency of application of such multimedia and the impact on acquisition of knowledge of science and mathematics.

Environmental scanning was conducted for science-inducing learning activities which could promote learning outside of the classroom. All three activities - observation, interviews and environmental scanning - gauged learner involvement and participation in any science and mathematics activities which incorporated multimedia.

In the subsequent chapter four the statistical and empirical data collected through observations, interviews and testing will be analysed, discussed and interpreted. The mean, mode and median statistical analysis approach will respond to the research objectives and conclusions will be based on participants' input and observations.

CHAPTER 4

FINDINGS AND INTERPRETATION

4.1 Introduction

The previous chapter outlined how data was collected. In this chapter data collected on the application of multimedia in English second language Mathematics and Science classrooms is presented and analysed. For pertinent alignment and interpretation the data is generally arranged in terms of subtopics.

4.2 Biographical information of the school

George Mhaule Primary School was named after the late local Chief George Mhaule when it was established in 1995. That was a way to ease off overcrowding at the neighbouring Mthimba Primary School and to alleviate long distances travelled by learners on daily basis from Numbi Village. The school is situated about 13 kilometres west of a small town called Hazyview along the R533 road 3km from the Numbi gate of the Kruger National park. The enrolment at the school stood at seven hundred and forty two (742) learners, three hundred and seventy seven (377) girls and three hundred and sixty five (365) boys. Twenty four (24) teachers, eight (8) of whom were male and sixteen (16) female, staffed the teaching personnel.

The learner participants in the study were sampled from one hundred and eighty six (186) in the senior phase doing Mathematics, Natural Science and Technology (grade 6), Natural Science (grade 7) and Technology (grade 7).

Four blocks of sixteen classrooms had been built of which three have been converted into a staff room, principal's office and a store room respectively. There were no science laboratories for practical work and no library for references. The school was poorly resourced with no sport fields or administration block. Outside of the classroom there are no activities such as gardening, which could have formed an integral part in explaining processes of the ecosystem, gaseous exchange and experiments verbally referred to in the Science classroom.

This finding did not augur well for Science and Mathematics teaching and learning in line with the conclusion in the study by (Mji and Makgato 2006) (see Chapter 2, section 2.3: 17) who believe that such a deficiency has a negative bearing on the results.

Learners at George Mhaule Primary School had no benefit of electronic media or educational visits to museums, science centres, beaches and national beaches. Liu (2009) (see Chapter 2, section 2.8: 32) propagated excursions as a valuable strategy for science learning. Other than asking questions for clarity and responding to their educators' questions they had nothing to add to the content of the subject matter or choose the kind of media they would have wished to be exposed to. The department of education in the province rolls out a satellite link in mathematics, science, technology and English only to one hundred schools. A host of schools including George Mhaule are left out of this programme. It could be worthwhile for the same project to be extended to all needy schools in order to bridge the gap of supply of resources. One major importance of the programme is that it uses Internet links which are multimedia in nature.

4.3 Classroom observation

All classrooms visited during data collection did not have Science and Mathematics posters, drawings, tables, paintings or any other visual aids aimed at enhancing science and mathematics literacy. Outwardly, the classes did not resemble any Science and Mathematics learning environment. Learners had been able to produce conventional mathematical sets of instruments which the department of education freely supplies to schools every year. Teachers' drawings and scaling of lines were based on estimated calculations because they did not have the necessary rulers or T-squares. Eilam (2013) confirmed that multiple representations are an effective way of teaching while Thoman and Jolls 2004) added by asserting that traditional multimedia must be augmented by newly modernised multimedia. (See Chapter 2, sections 10: 30 and 2.1:11 respectively). Training of teachers on multimedia is a necessary step towards resolving the situation of lack of knowledge on the part of the teachers. After a success of such intervention learners are likely to benefit.

Learners and teachers used diagrams provided in their work books throughout the learning process, as teachers would only redraw what was already depicted from these materials when they presented and explained the subject matter. Learners were generally not engaged in the reading of the graphics but sat as observers when learning was underway. None of the learners was given the opportunity to draw pictorial representations.

Pea (1991) believes that learners were not supposed to be passive participants in the process of their own learning but had to be directly involved in their development. Moreover Science, and Mathematics are lessons, which require intense learner involvement and the researcher agrees with (Pea's 1991) (see Chapter 2, section 2.8: 30) assertion *(See table 1 below.)*

Due to the poor conditions alluded to earlier on all media used in the classrooms were static and non-animated. Digital media such as projectors, television screens, videos and computers were glaringly absent and this limited learners to print media only.

In all classes observed conventional Mathematical and Science teaching was mainly chalk board theory, instead of the expected practical engagement. The practicality of science teaching was thus compromised let alone reference to and use of the provided pictures, diagrams, drawings and graphs. This pointed to earlier in this study to the lack of requisite skills by teachers to impart science literacy.

The apparent lack of science equipment and computers which could aid science and mathematics learning at the school fell short of confirming the belief by (Watters and Diezmann 2007) (see Chapter 2, section 2.2: 16) that relevant technology enhanced visualization of the subject matter. Static multimedia drawn from textbooks and workbooks was applied. Whilst the school may be without the necessary multimedia to assist learning, excursions to libraries, practical sites, using mobile laboratories supplied by the Department of Education in the province as well as intensified use of the available multimedia representations such as bill boards, pictures etc. These worthwhile exercises are also espoused by (Jewett 2011). (See chapter 2 section 2, 4: 19)

Table 1: Frequency counts for use of graphical representations in class

Key:

1 = None

2 = Less than five representations per lesson

3 = Regular (more than five representations per lesson)

Graphical representation	Category Content	Frequency Counts	Frequency Counts	Frequency Counts
		Natural Science	Technology	Maths
Pictures	Simple Maths/Science representations	1	3	1
Cross section diagrams	Analytical Science	2	1	1
Tables	Tables in Maths and Science	1	1	3
Scale diagrams	Mass Measurements	1	1	2
Bar graphs	Graphs in Mathematics	1	1	2
Line graphs	Graphs in Mathematics	1	1	2
Drawings	Process representations	3	3	2

4.4 Documents

4.4.1 Natural Science and Technology Textbook Grade 6a

Two subjects, Technology and Natural Science, were combined and one textbook was prescribed for use in the class. Teachers shared the task in line with their competencies. Texts, tables, pictures and different kinds of drawings were commonly depicted throughout the prescribed text for teachers and learners to use. Teachers talked learners scantily through pictures which suggested that there was serious lack of knowledge to interpret graphics. Such knowledge is a requisite factor for successful imparting of knowledge to learners as suggested by (Stokes 2001). (See chapter 2, section 2, and 11:31).

4.4.2 Technology Textbook Grade 7

Technology in grade seven was offered as an independent subject from Natural Sciences. The textbook prescribed for learners in Technology had more real pictures in colour than any other form of visual aid. Learners were presented with familiar scenes and phenomena from which they could make deductions. All forms of machinery and mechanical processes are in pictures with words added as captions. This discovery was in line with the propagation by (Levin and Wagner 2006) that language learning and science content acquisition cannot be separated. It is an integration which is best expressed through the use of multimedia. Graphic representations are explained through language and language expressions are summarised by using multimedia. (See chapter 2, section 2, and 5:22-23)

4.4.3 Natural Science Textbook Grade 7

The teacher is represented by a picture of an instructor who either asks a question or gives an instruction which opens the lesson to follow. Various forms of non-textual representations are provided to aid the teaching and the learning process. Processes and experiments are given as a mixture of text and other more comprehensible modes. The teachers had no additional multimodal texts to support those in the book. In explaining the content certain elements of the learners' home language were used. After the imparting of science and mathematics content in the English language learners turn to their mother tongue, which switchover, enables further clarity on the subject matter. Because this enhances understanding, it becomes an important learning strategy.

4.4.4 Mathematics Textbook Grade 7

Drawings, tables and pictures are a permanent feature in the mathematics grade seven learners' book. The book is easily applied as all the activities which come in the words and / or numbers are further presented alongside visual aids. The book is absolutely multimodal. In-boxed texts often guide the users on the approach they need to take when using the text books. It is an easy to use textbook which could assist in the comprehension of the content. Learners have keen interest in the book and references to the book attract their attention maximally.

4.4.5 Mathematics Workbook Grade 7

The Mathematics workbook delivered to the school by the Department of Education in Mpumalanga Province had been developed for two terms of the academic year. The workbooks are an extension of the textbook in that exercises given in class were to be filled the workbook.

In the main, the mathematics content is reflected in the form of blank tables, incomplete figures and pictures or drawings without inscriptions. Each task comes with an instruction which could be a combination of text and non-textual representation. Speech bubbles inserted made the text to be user friendly for the teachers and the learners. Both the teacher and the learners had fun in using the textbook which intensely captured the attention of the learners. Learners showed excitement at the speech bubbles used to give instruction. The researcher believes the more the learners were attentive the better the outcome would be. Multimodal texts actively engage the learners in their learning and minimises the chances of the teacher being the sole centre of concentration in the class.

4.5 Interviews with teachers

Six teacher participants gave responses to questions ranging from knowledge of multimodal texts, the frequency of use of text with other visual aids, their competencies in application of such representations, to promotion of language learning in their science and mathematics classrooms.

Teachers agreed that the reason for poorly constructed graphical representations in their classes was their lack of knowledge of using them. They also viewed their limited theoretical and practical background as a serious drawback. The teachers acknowledged the lesser extent to which they involved learners in practical tasks and ascribed that to lack of facilities.

They felt that Technology tasks required more practical exercises in fully fledged laboratories. In the light of the responses from the teachers, the researcher believes that providing training interventions and equipping the school with relevant multimedia producing technology could assist the institution. Multimedia is an innovation which extends the meaning beyond what words can tell and then widens the scope of interpretation of the subject matter.

Conversion of words to non-textual forms was noted by teachers as a major challenge for learners (Coleman et al. 2010) (see Chapter 1, section 2:2). There were admissions from teacher participants to lack of adequate graphic representations analysing skills. All respondents agreed that the provided textbooks and workbooks were user friendly and adequate for the teaching of science and mathematics.

The study discovered that not all teachers had relevant qualifications for the subjects they taught, and were rarely engaged in self-development on the subject matter but were waiting for government skills development programmes. Only one had a Bachelor of Arts in science. If the teachers had adequate background knowledge on multimedia and use thereof it would have be easy for them to be 'more flexible in their teaching methods' as seen by (Finlayson and Farren 2005) (see Chapter 2, 11:31) (Stokes et. al 2001) (see Chapter 2, 2, 11: 31) said the same after their studies unearthed the fact that learners needed to learn visually and teachers needed to learn to teach content visually *(See table 2 below)*.

Teachers argued that poor reading skills and comprehension levels of learners created a gap in the learning process. Participant teachers complained of the large class sizes which they felt hampered individual attention to learners – a requirement in an ideal science classroom.

The researcher believes it is prudent that joint intervention be implemented by English language teachers and mathematics and science teachers to ensure simultaneous content acquisition and language development. Continued polarisation of these subjects disadvantages the learners and does not bode well for integrated teaching and learning.

TEACHER PROFILE

KEY:

√ = Applicable

N = Not Applicable

Teacher Code	TEACHERS' LEVELS OF QUALIFICATION							
	3 Year Diploma	3 Year Degree	BSc Degree	4 Year Qualification	ACE	OTHER	GRADE TAUGHT	YEARS EXPERIENCE
A	✓	N	N	N	✓	N	6	16
B	✓	N	N	N	✓	✓	6	24
C	✓	N	✓	✓	✓	N	6	11
N	✓	N	N	N	✓	N	7	18
N	✓	N	N	N	✓	N	7	21
F	✓	N	N	N	✓	✓	7	26

4.6 Tests administered

Twenty four learners were sampled from the three classes for the purpose of testing them in each subject – Mathematics and Natural Science and Technology. Each subject was allocated twelve participants. Two sets of tests in Mathematics and Technology were given wherein learners were initially exposed to numbers / text only assessment and later to tests enriched with graphical representations.

The time taken to write the first test was surprisingly shorter as opposed to time spent in the multimodal test. Concentration was increased when the visual attachments were used in the second assessment tasks. Performance scores were slightly different and improved in the second tests for some learners. Language used in responding to questions which required brief explanations showed low competency levels. Simple conventional and standard rules of English grammar such as punctuation and spelling were flouted.

In Mathematics tests, 25% of the participants showed no improvement in their performance with the second test. Learners had the same scores in both assessments. From the same mathematics tests 50%of the participants in mathematics showed improved performance when multimodal assessments were given. Performances below the 40% pass mark score were recorded for 25% of the learners in mathematics. A total of 8, 3% of the scores in the Technology tests given were the same. Of the total of participants in the Technology tests 25% of the participants' scores declined in test two, whereas 66% improved on their performance.

Table 3: Scores in Mathematics and Science tests each out of 25

LEARNER CODE	MATHEMATICS			SCIENCE		
	TEST 1 (T1)	TEST 2 (T2)	DIFFERENCE (T1 & T2)	TEST 1 (T1)	TEST 2 (T2)	DIFFERENCE (T1&T2)
A	12	13	1	06	10	4
B	11	14	1	09	11	1
C	08	18	10	08	09	1
D	7	13	6	07	15	8
E	12	12	0	06	11	5
F	12	12	0	10	12	2
G	15	14	-1	07	04	-3
H	16	10	-6	05	05	0
I	12	11	-1	05	14	9
J	14	15	1	07	04	-3
K	16	16	0	09	13	4
L	16	17	1	12	05	-7

4.7 Interpretation of data

The surroundings of the school did not reflect any possibility of effective teaching and learning of science and mathematics. The dominance of the teacher in the process of teaching and learning continued to deprive learners of the opportunity to show off and enhance their science and mathematics skills.

Science classes without periodic tables and other forms of visual representations had a negative bearing in the process of encouraging learners to become scientists (Stemler 1997); (see Chapter 2, section 2.6: 27). There were no English language posters reflecting structures which could have served as reminders for second language learners.

The population of this study had at its disposal text books and workbooks fraught with pictures, graphs, tables and drawings for use in teaching science and mathematics, yet (Flores et al. 2003) applies computers for lesson planning which are adaptable to the environment in which they are to be used. (See chapter 2, section 2.5: 19)

All six teachers in the subjects earmarked for the study used workbooks exclusively from the prescribed textbooks for the learners. These texts had been delivered prior the commencement of the first quarter of the academic year and could have been synchronised for the benefit of the learners. There were notable discrepancies between the chronological arrangement of the workbooks and the prescribed textbooks due to separate development of both materials (Wellington and Osborne 2001) (see Chapter 2, 12:32) found that Science was best imparted using graphics combined with language. This study confirmed the assertion as textbooks and workbooks were all fraught with multimedia wrapped in text. These texts raised visible interest in the learners who eagerly participated when the scarce opportunity emerged.

Three major areas of focus for this study were English Language Learners, multimedia and science and mathematics instructional techniques. The population identified had to learn English at the same time as they acquired science and mathematics content.

It was noted during the progress of this study that there were traces of use of mother tongue in the interpretation of certain Science and Mathematics concepts which takes on another dimension which can be for future consideration. It was therefore a dual language learning process which has to be integrated with science and mathematics content acquisition.

Although there were times when code mixing and switching took place teachers attempted, at some point, to use English exclusively when imparting knowledge. English language learners' education is complex as discovered by (Roseberry, Warren and Conant 1992); (see Chapter 2, 5:21). Roseberry at al argue that the mixing and switching of codes hampered progress in the learning process and may cause learners to fall behind academically. To the contrary the researcher believes code switching by learners could help enhance meaning and improve learners' chances of understanding the content.

In essence learners showed interest in the multimedia used in their text and workbooks and improved performance in the application of multimedia in their classrooms when the tests were given. However the low levels of improvement in the tests could be ascribed to the limited application of multimedia by their teachers observed during the study.

Learner participants performed poorly in questions where multimedia had to be converted to language forms. A link could be drawn between their poor language skills and their dismal performance in the conversion structures.

With the minimal focus placed on using multimedia and sticking to theory the learners experience science and mathematics as theoretical subjects only and cannot see the subject application in practice. Lack of adequate skills to analyse graphic representations limits the scope for learners to expand their knowledge and adversely affects the teachers' effective imparting of knowledge.

Non availability of visible visual resources such as wall charts, tables and science and mathematics related material was in stark contrast to recommendations by (Marks and Eilks 2009). The pair of researchers felt that in-class topics had to be in different media sources, newspapers, brochures, adverts and TV reports. None of these resources could be detected at the school during the progress of the study.

Equipment which could have served as motivational features for teachers and learners had not been supplied by the education department. George Mhaule Primary School had seemingly been neglected and thus would not be expected to promote scientific literacy or language development. In essence the environment hampers learners' development.

Conclusion

The study confirmed findings of an earlier research study by (Uesaka and Manalo 2004), (see Chapter 2, section 2.9: 33), that the application of multimedia representations in science and mathematics classrooms improves comprehension. In addition (Uesaka and Manalo 2004) discovered multimedia sourced from teachers had a positive effect on the comprehension of the science content. Teachers in this study were not able to produce multimedia to aid their learning in their classrooms. In-service training for teachers could assist in bringing the much needed and vital knowledge on multimedia.

The environment in which science and mathematics are offered – with limited or abundant multimedia – has a bearing on the performance of the learners. George Mhaule Primary School was poorly resourced and learners' performance in science and mathematics was not satisfactory. Vavra et al (2011), (see Chapter 2, section 2.5: 23) argue that knowledge of the learners' background was vital for the acquisition of science and mathematics content. The results of this study confirmed the validity of the argument in that poor knowledge skills of learners were exposed in the outcome of the tests given to the learners.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The aim of this study was to evaluate the application of multimedia in English second language mathematics and science classrooms. A route was mapped out in the previous four chapters and the current chapter concludes with the findings and suggests recommendations to ease off identified challenges.

5.2 Overview

Chapter 1 portrayed the outline of the study, objectives, aims, proposed methodology and the manner in which data would be interpreted.

Subsequently, Chapter 2 provided a wide ranging literature review which concentrated on work done by various local and international scholars. The literature reviewed pointed out the impact which the integration of multimedia has in the teaching and learning of science and mathematics. Strict attention was paid to English Second Language learners whose mother tongue did not feature in Science teaching and learning. All levels of schooling were scrutinised in the literature accessed.

In Chapter 3 the methodology used to collect data through the sampled population was identified and implemented to ensure maximum participation. Instruments such as test papers, observation schedules, interviews and questionnaires were used in the collection of data. The environment of the school was scanned for compatibility to the teaching of Mathematics and Science and for multimedia features used.

Chapter 4 was basically for presentation, analyses and interpretation of collected data. The collected data was presented in descriptive paragraphs and supporting tables which gave summary of the detailed account of the findings. The data was duly analysed, interpreted and juxtaposed with existing literature findings.

5.3 Research questions

This study was guided by the following research questions

- How is multimedia applied in English Second Language Mathematics and Science classrooms at George Mhaule Primary School?
- How often various forms of multimedia are used in English Second Language Mathematics and Science classrooms at George Mhaule primary school?
- Does the application of multimedia approach in English Second Language Mathematics and Science classrooms enhance literacy?
- What is the teacher's view of the use of multimedia English Second Language Mathematics and Science classrooms?

5.4 Findings of the study

In the area where the school is situated, there were no signs or indications that it was a science mathematics and English language learning centre. There was neither a laboratory nor equipment for science practical work.

The main findings of the study were that the application of multimedia at George Mhaule Primary School in the classrooms was sparsely carried out. Measurements in mathematics exercises were done by way of estimation. Dual media of teaching was used to impart science and mathematics knowledge to English second Language learners. Learners were scarcely involved in practical work but mainly reduced to spectators in the process of learning.

What the findings showed was that the teachers were not adequately qualified in the subject. Teachers were either ignorant of the abundance of multimedia in the learners' workbooks and prescribed textbooks or lacked the requisite skills to impart subject matter through the use of multimedia.

Learner performance was slimly influenced by the use of multimedia. The unavailability of animated multimedia limited the scope of the study to focus only on static multimedia.

5.5 Recommendations

- All English second language, science and mathematics classrooms need to be encouraged to have large print posters as a minimum requirement relevant for t he enhancement of teaching and learning of these subjects.
- As provided with the supply of and training on the use of workbooks teachers must receive up to date training on multimedia interpretation and creation of their own materials.
- All schools must be equipped with projectors, screens and videos improved interpretation of graphical representations and make it possible for teachers to sho w learners the pictures and images they may need to interpret.
- Schools which offer science and mathematics and are without laboratories or equipment need to be subsidised to take two annual excursions to fully fledged laboratories e.g. UL's Centre for Science Education.
- Exclusive monitoring of primary schools' adherence to measures promoting the teaching and learning of science must be carried out by relevant departmental officials.
- Code switching and code mixing must be discouraged for proper language development of English second language learners.
- Development programmes for science, mathematics and English teachers must be registered as continuous features in the work place skills plan of the department of education in Mpumalanga Province.
- Research at secondary schools and tertiary levels is direly needed to assess the quality of graduates who enter the markets, which are filled with multimodal arte facts; in this context, the skills teachers bring to the classroom are of utmost importance.
- Language competence for science and mathematics students goes beyond the classroom precincts. This is a factor which paves the way for extensive research into science literacy in English in view of the reported low numbers of engineers in the country.

Conclusion

The study sought to examine the application of multimedia in mathematics and science English second language classrooms. In the process of application of selected multimedia it was also necessary to determine the regularity of the use of the identified multimedia. It was inevitable to observe how the target group of English second language learners adjusted to the dual process of language learning and science and mathematics content acquisition.

Through observations, tests, interviews and document analysis it was discovered that the school had not been well equipped. The poor state of the classrooms and congestion exacerbated the repulsion of the situation. Teachers, most of whom were inadequately qualified, taught through dual medium of instruction and did not give learners the opportunity to practically engage with the subject matter.

Multimedia were either used to a limited extent or not applied at all. Furthermore, competence in the language of teaching and learning – English, in this case – posed a serious challenge for teachers who had to mix or switch codes and learners who had difficult in expressing themselves properly.

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APPENDIX A

CORRESPONDENCE

P.O. Box 184

White River

1 2 4 0
2013.01. 07

The Head of the Department
Department of Education
Private Bag x 11341
Nelspruit

Dear Madam/Sir

Application for approval to conduct an educational MA research at George Mhaule Primary School in 2013

I am currently registered at the University of Limpopo for a Master's Degree in the School of Languages and Communications and have in my possession an approved Research proposal for a research project funded by the VLIR- IUC Belgian Scholarship.

Set as the main prerequisite, is the selection of a rural school in Limpopo province (where the University is situated) for student research projects. However an exception was granted in my case to alleviate inconveniences and for comparative and diversity reasons. I have, as a result, identified George Mhaule Primary School in White-Hazy circuit, Ehlanzeni district, for my science instruction modes in an English Second Language Senior Phase band.

I therefore formal ask for permission to visit the school for a period not exceeding ten (10) working days to conduct my research.

Hereto attached is an abridged copy of my proposal with the relevant attachments for your attention.

I hope you will heed my request.

Yours faithfully

Mona Elmon Henis

2013. 01. 07
DATE

education
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MR. MONA E.H.
P.O. BOX 184
WHITE RIVER
1240

RE: APPLICATION TO CONDUCT EDUCATIONAL RESEARCH STUDY (MA) AT GEORGE MHAULE PRIMARY SCHOOL.

Your application dated 07 January 2013 to conduct educational research for MA program on the topic: "An application of multimedia in English Second Language Mathematics and Science classrooms at George Mhaule Primary School in Mpumalanga Province" was received on the 14 January 2013.

Your detailed research proposal and the accompanying instruments research gives an impression that your study will benefit the department especially the curriculum division and language studies. Given the motivation and the anticipated report of the study, I approve your application to conduct your research study in the selected school and the circuit

You are further requested to read and observe the guidelines as spelt out in the attached research manual. It will be appreciated if you present and share your findings in electronic form and make formal presentation to the strategic planning's research unit and the curriculum sections of the department in particular the language section.

For more information kindly liaise with the department's research unit @ 013 766 5476 or a.baloyi@education.mpu.gov.za.

The department wishes you well in this important study and pledge to give you the necessary support you may need.

RECOMMENDED/~~NOT RECOMMENDED~~.

The study is recommended as it is in line with the curriculum needs of the department.

[signature] 14/01/2013

MR. A.H. BALOYI DATE

RESEARCH SUBDIRECTORATE

APPROVED/~~NOT APPROVED~~:

[signature] 15/1/13

MRS MOC MHLABANE DATE

HEAD OF DEPARTMENT

Information and Consent Form

TITLE: An application of multimedia in English Second Language Mathematics and Science classrooms at George Mhaule Primary School in Mpumalanga Province

I, **Elmon Henis Mona**, working as a deputy Chief Education Specialist at the Department of Education in Mpumalanga Provincial office was granted permission by the head of the department to conduct an academic study at this school.

The study aims at determining the frequency, regularity and level of use of multimedia (i.e. pictures, graphs, tables, and other visual representations) to improve comprehension of Science and Mathematics.

As an educator of Mathematics and Science I would like you to take part in the study and assist me in gathering relevant data. If you decide to take part, you are therefore requested to carefully read through and complete this consent form – a copy of which will be given to you to keep and refer to at any time. I am prepared to answer any question you may have pertaining to the study.

Please make your selection by circling your answer:

Have you received sufficient information about the study and the intended Use of the information collected? YES NO

Do you understand that you are free to withdraw at any time, without having to explain your withdrawal? YES NO

Do you understand that you will not be disadvantaged in any way Regardless of whether you take part or if you do not take part? YES NO

Do you consent to take part in this study? YES NO

Please fill in:

(NB* Personal information will be kept confidential and not used in the final report)

Surname: .... **Initials:** ....

Signature: .... **Date:** ....

For the researcher to sign:

I confirm that I have carefully explained the nature and demands of the study to this informant.

Signature: .... **Date:** ....

APPENDIX B

TABLES

RESEARCH INSTRUMENT

Table 1: Environmental scanning for multimedia compliant infrastructures

ITEMS	CONDITION					
Buildings	Needs renovation	X	Good condition			
Surroundings	Welcoming		Hazardous		Untidy	
Laboratory	Available		Not available	X	Need repairs	
Library	Available		Not available	X	Need upgrading	
Water	Available		Not available		Erratic supply	X
Electricity	Available		Not available		Need repairs	X
Sanitation	Sufficient		Not sufficient	X	Not available	
Sports grounds	Available		Not available		Need upgrading	X
Schedule of educational excursions	Available		Not available	X		

RESEARCH INSTRUMENT

Table 2: Frequencies of use of multimedia in classrooms

Graphical representations	**Moline category content**	**Natural Science %**	**Physical Science %**	**Mathematics %**
Pictures	Simple Science			
Cross section diagram	Analytic Science			
Tables	Table Science			
Scale diagrams	Simple Science			
Bar graphs	Graphs in mathematics			
Line graphs	Graphs in mathematics			

RESEARCH INSTRUMENT

Table 3: Interviews with teachers; their views on frequency of multimedia usage

Key : **1** = seldom; **2** = rarely; **3** =sometimes; **4** =frequently

Frequently 4	Sometimes 3	Rarely 2	Seldom 1	Response /Rating
1. Do you point out to graphic representations in the text books which you use in class?				
2. Are learners given the opportunity to link information in row or column headings in a graph to make meaning?				
3. Do learners get exercises in which they use cross section diagrams to explain concepts or objects' internal and external structures?				
4. Is there a way to in which learners explain concepts or objects concepts or objects depicted (shown) in graphical representations?				
5. Do your learners take information from graphical representations and convert it into words or numbers?				
6. Are learners given tasks to draw relationships between lines and in a line graph?				
7. Do learners undertake class exercises in which they are required to provide produce graphical representations from written texts?				
8. Do you, the teacher, instruct learners to draw and label details of a graphical representation?				
9. Do pictures form part of your instructional material in your classroom(s)?				
10. Have you ever been able to establish a relationship between learner performance and the use of multimedia from the instructions or assessments given in your classroom(s)?				

APPENDIX C

ADDITIONAL INSTRUMENTS

RESEARCH INSTRUMENT

Teacher Questionnaire

Enquiries: Mona EH
Cell: 082 484 9913

Frequency of use of graphical representations in subject instructional activity and the number of learners per class

Subject Class	**No. learners**	**Frequently %**	**Sometimes %**	**Rarely %**	**Never %**
1. Do you point or refer to graphical representations in text books which you use in class?					
Mathematics7a					
Mathematics7b					
Natural Science7a					
Natural Science7b					
Physical Science7a					
Physical Science7b					
Technology 7a					
Technology 7b					
2. Have your learners the opportunity to link information in cells, row headings, columns headings in a graph to make meaning?					
Mathematics7a					
Mathematics7b					
Natural Science7a					
Natural Science7b					
Physical Science7a					
Physical Science7b					
Technology 7a					
Technology 7b					

3. Are leaner given exercises in which they use cross-section diagrams to explain concepts or object's internal and external structures?					
Mathematics7a					
Mathematics7b					
Natural Science7a					
Natural Science7b					
Physical Science7a					
Physical Science7b					
Technology 7a					
Technology 7b					
4. Do you make learners explain concepts or objects depicted (shown) in graphical representation?					
Mathematics7a					
Mathematics7b					
Natural Science7a					
Natural Science7b					
Physical Science7a					
Physical Science7b					
Technology 7a					
Technology 7b					
5. Do your learners take the information from a graphical representation and convert it into words?					
Mathematics7a					
Mathematics7b					
Natural Science7a					
Natural Science7b					
Physical Science7a					
Physical Science7b					
Technology 7a					
Technology 7b					

Mathematics7b					
Natural Science7a					
Natural Science7b					
Physical Science7a					
Physical Science7b					
Technology 7a					
Technology 7b					
10. Do you draw any relationship between learner performance and the use of multimedia from your classroom instructions?					
Mathematics7a					
Mathematics7b					
Natural Science7a					
Natural Science7b					
Physical Science7a					
Physical Science7b					
Technology 7a					
Technology 7b					

RESEARCH INSTRUMENT

OBSERVATION ACTIVITY FOR CONDUCIVENESS OF SCHOOL TO SCIENCE AND ENGLISH LANGUAGE EDUCATION

1. Are there any outward practical activities which can be linked to science teaching and learning?

 ____

2. Do the mathematics, English and science classrooms have any wall charts hanging as teaching and learning aids?

 ____

3. Do the teachers apply, consistently, any particular kind of multimedia in teaching mathematics, science or English?

 ____

4. Are there activities which actively engage learners in the teaching and learning of mathematics, science and English?

 ____

5. Is there a library at the institution?

 ____

6. Does the school have a science laboratory?

 ____

Test 1 Text only

Multimedia in Mathematics and Science English 2nd language classroom

1. **Use your ruler to draw either a football field or a net ball field. The length of the sides must be 60m and the width 25m. A scale of 1cm = 5m must be used.**
2. **A farmer had to travel 20km to an Agricultural show but realizes at 12km that he has left behind his entry ticket and returns home to meeting his manager who has to meeting at a corner 5km from the farm. Plot the actual distance covered by the farmer on a number line where 1cm = 2km.**
3. **The Weather Bureau recorded 75mm of rainfall over the months of September, October and November. Draw a line graph which mirrors the 25mm which was received in September followed by 35mm in October and the remaining 15mm in November.**
4. **Draw a circle which represents a cake of any measurement and divide it into four shares two of which are of equal sizes.**
5. **Use a table of five columns and four rows to allocate your classmates Mpho, Tshidi, Nompilo and Marvin rooms and duties for the Easter holiday camp. Cleaning, cooking, washing and ironing are duties to be distributed**
6. **Draw a circuit diagram which depicts the picture below**

Look at the picture of the circuit below.

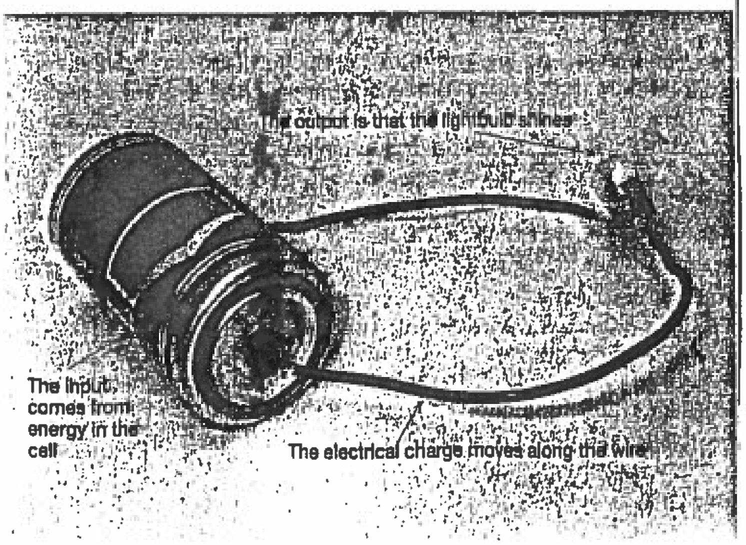


Figure 1 A simple circuit

We can draw what happens in the circuit as a systems diagram.

Multimedia in Mathematics and Science English 2nd language classroom

1. Write down the fraction, percentage and decimal for the shaded areas in the picture marked "A".
2. Carefully read the picture provided and marked "B" and name the objects in order of the numbering.
3. From the combination of the phenomena in the given picture "C" select the correct measurement for the length.
4. Study the "D" pictures below and complete the accompanying table.
5. Study the bar graph named "E" and answer the questions.
6. Read the pictures and fill the blank spaces in "F".
7. Analyse the given food distribution chart "G" and answer the questions set on it.

   7.1. Which food group(s) needs high and equal consumption volumes?

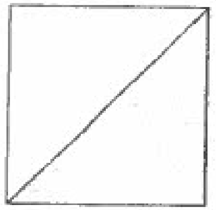
   7.2. If you could take protein only what percentage would the remaining groups come to?

   7.3. Which content is common between dairy products and sugar and fats?
8. Match the item in "H1" with the relevant instruments in "H2"

*** USE THE PICTURES ON THE NEXT PAGE**

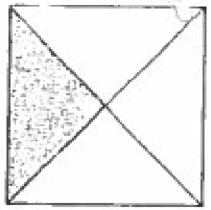
A

a.



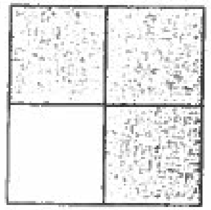
Fraction ☐
Percentage ☐
Decimal ☐

b.

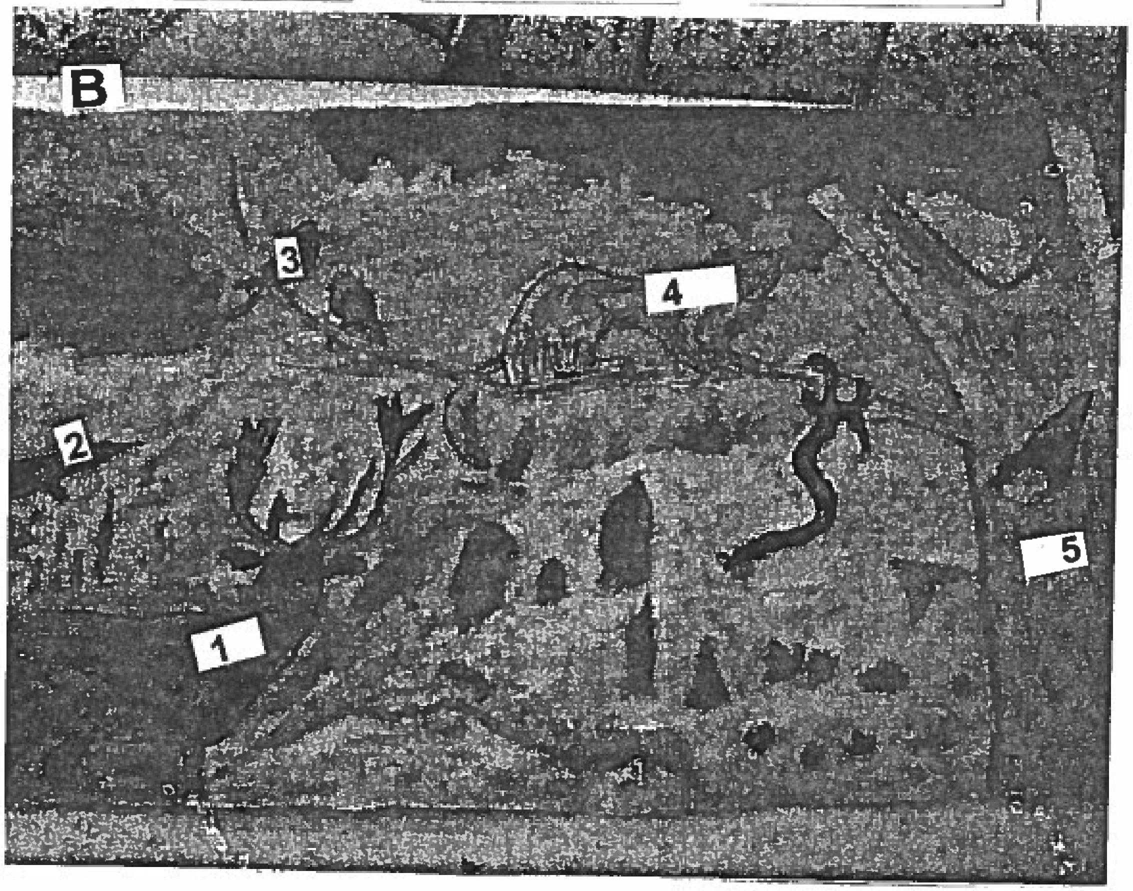


Fraction ☐
Percentage ☐
Decimal ☐

c.

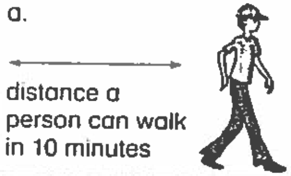
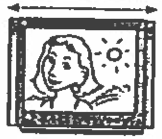
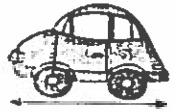
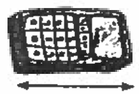
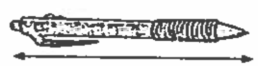
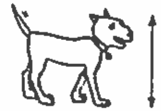


Fraction ☐
Percentage ☐
Decimal ☐

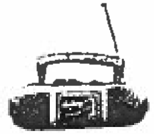


C

1. Choose the correct measurement

a.	b.	c.
 distance a person can walk in 10 minutes	 length of TV	 height of house
15 cm 20 m 1 km	60 cm 12 cm 3 cm	1 m 6 m 20 m
d.  length of car	e.  length of cellphone	f.  width of CD
1 m 4m 10m	10 cm 20 cm 30 cm	2 cm 24 cm 12 cm
g.  thickness of book	h.  length of pen	i.  height of dog
3 m 40 cm 2 cm	1 cm 18 cm 13 cm	2 m 4 cm 50 cm

D


R300 (20% off)


R100 (25% off)


R200 (10% off)


R600 (40% off)


R60 (5% off)


R20 (30% off)


R400 (75% off)

Copy and complete the table. Show your working in your book.

	Item	Cost	Discount	Sale price
Example	radio	R300	$\frac{1}{5}$ of R300 = 60	R300 – 60 = R240
a.	soccer ball			
b.	tennis racket			
c.	paint			
d.	T-shirt			
e.	chocolates			
f.	watch			

G

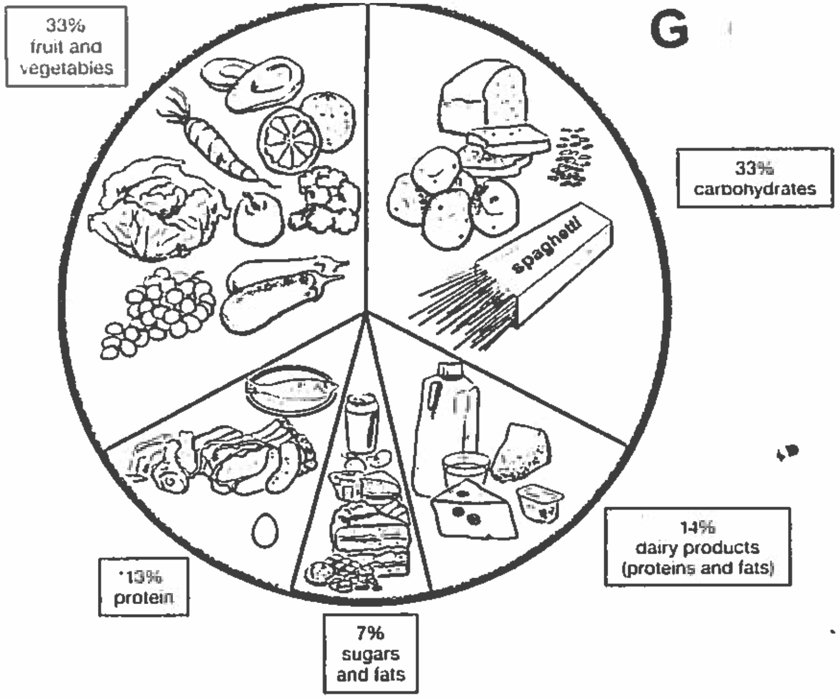
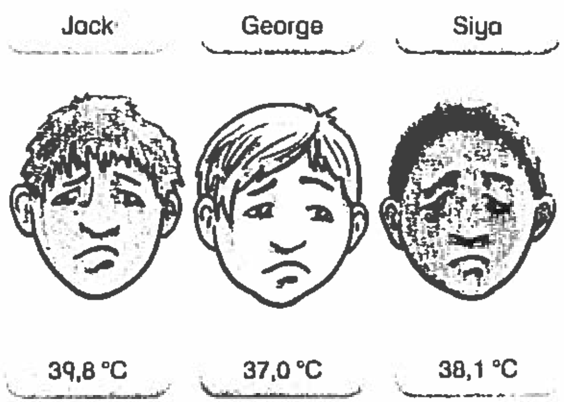


Figure 3 The ideal percentage of each food group in a balanced meal

F

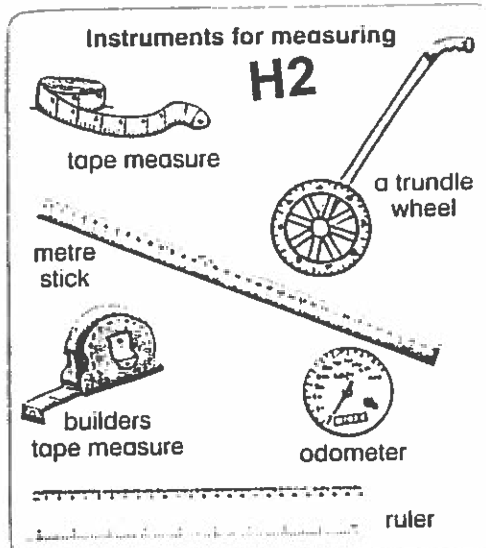
Digital thermometer



Copy and complete.

1. a. ______ is very ill
   b. ______ is healthy
   c. ______ is getting better.
   d. Write 3 different temperatures children may have when they are not feeling well. Write the 3 temperatures from lowest to highest.

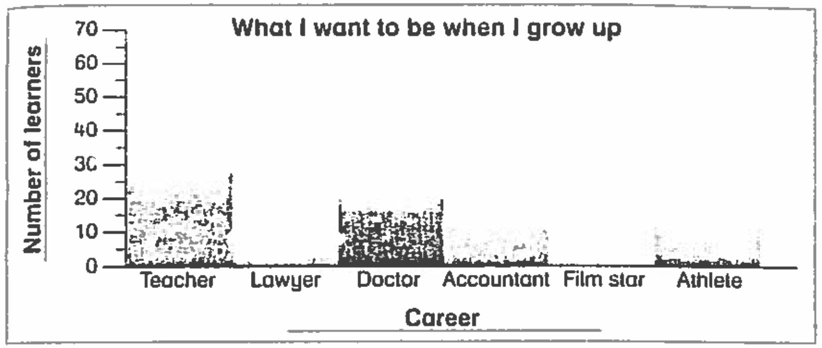
H2



E

Data Handling

1. Study the bar graph and answer the questions.



a. How many learners were surveyed?
b. Which career is most popular?
c. Which career is least popular?
d. What is the difference between the number of learners who want to be doctors and the number who want to be athletes?

H1

2. What unit of measurement would you use to measure the following? Say whether you would measure in: kilometres, metres, centimetres or millimetres.