An investigation into the use of Visual Technology for the Autonomous Learning of Mathematics (VITALmaths) video clips through the medium of cell phones in the teaching of mathematics in selected South African Grade 9 classes: A case study

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ABSTRACT

This qualitative study examines the use of Visual Technology for the Autonomous Learning of mathematics (VITALmaths) video clips in three Grade 9 classrooms in the Eastern Cape, South Africa, two of which are in well-resourced ex-Model C schools and one in a semi-rural township school.

The rapid development of mobile technology, especially in Africa, has opened up previously unexplored avenues in economy, communication and education (Aker & Mbiti, 2010), with a number of mobile learning initiatives being launched in South Africa (Botha & Ford, 2007; Vosloo & Botha, 2009). The VITALmaths project was developed collaboratively between the University of Applied Sciences Northwestern Switzerland and Rhodes University in South Africa (Linneweber-Lammerskitten, Schäfer and Samson, 2010).

As the main platform for dissemination of the video clips is the cell phone, the study looked at the various aspects involved in the use of cell phones by learners in the classroom, as well as the incorporation of the clips into the teaching of three teachers. Consideration was given to whether or not the clips assisted the teachers in teaching, as well as whether or not they encouraged further exploration. The study was divided into six stages during which data was collected and analysed using an interpretive approach throughout. Data collection methods included semi-structured interviews, questionnaires, observation, journals and reflective essays.

The study revealed the participating teachers, having incorporated the clips into several lessons, found that these had a meaningful effect on their teaching practice, as well as on the engagement of the learners in the lessons. The majority of the learners involved in the study had access to cell phones, either their own or borrowed, and were able to download the video clips onto their phones from the website (www.ru.ac.za/vitalmaths). A number of learners found that the clips helped them find examples of specific mathematical concepts outside of the classroom, thus leading to further enquiry and exploration, while several learners downloaded and viewed additional clips.

Overall findings showed that the VITALmaths video clips could be incorporated into teaching with relative ease.

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My dad – for your love and encouragement, and your belief in me (not to mention the endless cups of coffee at all hours!) – I could not have done this without you!

DEDICATION

This thesis is dedicated to my best friend and sister-in-Christ

Jenny Kieck

"A friend is one that knows you as you are, understands where you have been,
accepts what you have become, and still, gently allows you to grow."

— William Shakespeare

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The aim of this study is to investigate the use of Visual Technology for the Autonomous Learning of Mathematics (VITALmaths) video clips in the teaching of mathematics in selected South African Grade 9 classrooms and takes the form of a case study.

This chapter will serve as an introduction to the study, looking firstly at the context and then the rationale for it, before considering the research goals. Finally, an brief overview of the thesis is provided.

1.2 Context of the study

According to Aljohani, Davis and Tiropanis (2011) the rapid growth in mobile and wireless communication technologies has influenced how people communicate with each other to such an extent that people are no longer limited in their interactions through geographic restrictions, and are able to download and manage endless varieties of data and information on mobile devices. In Sub-Saharan Africa, as indicated by Aker and Mbiti (2010), the development of mobile technology has tapped into previously unexplored potential by providing links between individuals, markets, services and information regardless of whether they live in urban or rural areas, or are rich or poor. In addition, such modern accoutrements as electricity, landlines and tarred roads are no longer a prerequisite for communication and, according to Lee, Levendis and Guitteirrez (2009), the relatively low cost of installing mobile services has brought significant economic development to the region.

BBC News (2011) reports that Africa's mobile market lies second to Asia, and is currently the world's fastest growing market, with around 650 million mobile subscribers, 86% of whom are prepaid customers and the remaining 14% having entered into contracts with the various mobile providers. Nielsen Southern Africa (2011) points out that some 29 million people in South Africa use cell phones as opposed to 5 million who have landlines (see figure 1), with between 82% and

85% of mobile users preferring prepaid subscriptions to contracts. South Africa currently occupies fifth place in the mobile data usage rankings, two places ahead of the United States .

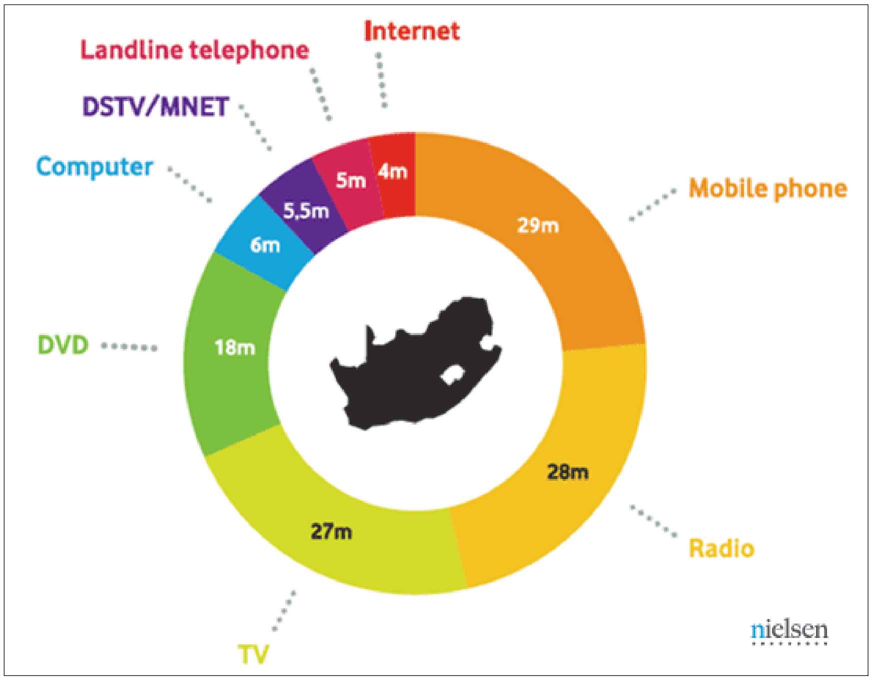

Figure 1: **Technological usage in South Africa (Nielsen Southern Africa, 2011)**

Kukulska-Hume and de los Arcos (2011) suggest that mobile phones are so much part of daily life that it is likely that they will be utilized for learning at some stage, albeit informally. Aljohani, et al., (2011) concur, stating that the prevalence of mobile technology has stimulated learning via these devices, and has led to the coining of the terms, "mobile learning or m-learning" (p. 81). Because "mobile technologies facilitate and encourage self-directed learning," (Kukulska-Hume and de los Arcos 2011, p. 76) ways should therefore be found to uncover these patterns of informal learning use and attempts made to incorporate them into formal learning by coupling them to learners' demands for mobile access.

Mobile learning, according to the UNESCO Institute for Information Technologies (ITTE) (2010) should be regarded as a collection of learning and teaching practices which have begun to emerge as a result of the diminishing effect of interaction between learners and teachers in traditional classrooms. Also, a much greater link between learning and life in general, and the workplace in particular, has emerged. Likewise, Naismith, Lonsdale, Vavoula and Sharples (2005) believe that the development of mobile technology will see a movement of learning, whether real or virtual, from the classroom into the everyday life of the learners and, in their opinion, efforts should be made to ensure the incorporation of mobile devices into educational practices. Prensky (2006) suggests that this is possible if learners' predilection for mobile technology, such as the cell phone and the computer, is incorporated into more traditional ways of learning.

In an m-learning project conducted by the Learning and Skills Development Agency in the United Kingdom, Italy and Sweden (Attewell, 2004) some 62% of participants were eager to participate in mobile learning, with 80% expressing a preference for mobile devices as learning medium. A number of advantages for participants who had become involved in m-learning were highlighted, such as improvements in self-esteem and self-confidence, longer periods of attention and focus, the engaging of reluctant participants in learning, the improvement in literacy and numeracy skills and the encouragement of both individual and collaborative learning experiences.

A variety of educational initiatives in m-learning in South Africa have been developed over the past decade or so, such as the Mobile Education (MobilED) project, Dr Math on MXit, M4Girls project and Imfundo Yami/Yethu (Botha & Ford, 2007; Vosloo & Botha, 2009). The Visual Technology for the Autonomous Learning of Mathematics (VITALmaths) project, in which I have become involved, is a programme consisting of a collection of short animated video clips hosted on a dedicated website (http://www.ru.ac.za/vitalmaths), developed collaboratively between researchers and students at the University of Applied Sciences Northwestern Switzerland and Rhodes University in South Africa (Linneweber-Lammerskitten, Schäfer and Samson, 2010). The video clips make use of animations using natural everyday objects before being edited and animated, and text added in a number of languages, including indigenous South African languages. The clips, approximately three minutes in length, are disseminated mainly via cell phone as large numbers of South Africans, particularly learners, have access to these (Vosloo & Botha, 2009; Nielsen Southern Africa, 2011).

Researchers have shown that animations, which Mayer and Moreno (2002) define as a "simulated motion picture depicting movement of drawn (or simulated) objects" (p. 88), have definite advantages over static pictures, depending on the amount of information relayed. This is particularly the case if they are simpler and include fundamental aspects of the learning, and if they omit irrelevant detail thus placing a lower cognitive load on the learner (Höffler & Leutner, 2007; Vogel-Walcutt, Gebrim and Nicholson, 2010). In addition, the period of retention of material is extended when animations as opposed to static pictures are viewed, and guidance is provided to reduce the chance of misconceptions arising (Anglin, 1987; Rieber, 1991). Durmus and Karakirik (2006) state that apart from including pictures, text, graphics and the like, animations may also consist of virtual manipulatives.

The development of mental images is often strengthened by the use of physical manipulatives, i.e. objects created to illustrate abstract mathematical ideas in a tangible way, and which may be assist learners in developing these abstract ideas as a result of their own concrete experiences (Attewell, 2005; Moyer, 2001). Modern technological growth, especially that of the Internet, has seen the development of virtual, digital and computer manipulatives (Moyer, Bolyard and Spikell, 2002), be they static, pictorial representations of physical manipulatives or interactive manipulatives where learners are able to manipulate the images using a computer mouse.

Prensky (2006) avers that integrating learners' digital knowledge and skills into the traditional classroom and 20th century curricula is important, as this could see more effective teaching on the part of the teachers. Wong (2003) agrees, and suggests that teachers bear in mind what he refers to as "the whole learner" (p. 3) in order to engage learners in mathematical ideas, using a variety of representations to facilitate their understanding. This is borne out in research carried out by Project Tomorrow (2009) where around 40% of respondents indicated a preference for digital learning, while UNESCO ITTE (2010) proposes harnessing learners' ubiquitous use of mobile phones to provide excellent education, thus removing the limitations placed thereon by the narrow view that learning only takes place in traditional physical settings like school buildings.

It is my belief that mobile phones are part of my own learners' lives and incorporating their phones into lessons may well encourage them to develop a liking and an understanding for mathematics. My research is therefore intended to feed back into the VITALmaths project, and to contribute in some small way to the growth of the project.

1.3 Rationale

From the time I purchased my first personal computer in the mid 1990's, I have found modern technology fascinating, and when mobile phones appeared on the market I eagerly invested in one. I have attempted to keep abreast with developments therein and have encouraged family, friends, colleagues and learners to embrace it. That, coupled with a love for mathematics, as well as a strong desire to find ways in which to improve my own teaching led me to the VITALmaths project, and I felt that this could prove beneficial to the learners whom I teach.

One of the problems that seems to have emerged from the aforementioned research is the disengagement of learners in the traditional classroom (Prensky, 2005) and ways need to be found to overcome this. Research has also shown that animations can both facilitate understanding and enhance teaching, if used in certain ways, which could assist learners in the development of abstract mathematical ideas based on their own concrete experience. That, coupled with the fact that a number of projects involving mobile technology have already been launched in South Africa, as well as prior research indicating the popularity and ubiquity of cell phone technology, seem to point to the possibility that the VITALmaths project could be of benefit to learners and teachers across the country.

The purpose of this study, therefore, has been to consider how the VITALmaths video clips may be incorporated into the teaching practice of two Grade 9 mathematics teachers, as well as that of my own teaching.

1.4 Research goals

The main goal of my research is to investigate the use of Visual Technology for the Autonomous Learning of Mathematics (VITALmaths) video clips through the medium of cell phones as an aid to teaching for selected Grade 9 mathematics teachers. In doing so I shall consider three questions:

- How have the VITALmaths video clips using cell phones been incorporated into teaching of mathematics?
- How do the video clips assist selected teachers in teaching? And

- How can the video clips encourage both the teachers and their learners to further explore mathematical ideas?

1.5 Overview of the study

1.5.1 Chapter 2

This chapter examines literature relevant to the study, starting with a look at the development and use of mobile technology in general, before moving on to the development and use thereof in education. Thereafter, first the use of animations and then that of physical and virtual manipulatives in teaching mathematics is considered. Finally, literature regarding mobile technology and animations is reviewed before the chapter is concluded.

1.5.2 Chapter 3

This chapter deals with the methodology of the study and describes the orientation and research methods used. It also explains the criteria used to select the participants and describes the research sites, as well as elaborating on the research design and techniques. Finally, a short exposé of the data analysis process is given, followed by a brief discussion around points of validity and the ethical aspects of the study.

1.5.3 Chapter 4

This chapter, the largest in the thesis, deals with the presentation, analysis and discussion of the data collected during the study. Divided according to the six phases of the research project, each phase is described and discussed in detail, before the chapter ends with a succinct consideration of the limitations of the study.

1.5.4 Chapter 5

In this final chapter of the thesis, a summary of the findings, together with an explanation of the significance of the study and its limitations, is presented. Thereafter, a number of suggestions for further research are made, before the chapter concludes with a personal reflection of my experiences.

As this study deals with mobile technology and animations and the use of both of these in education, the next chapter provides an in-depth review of the literature pertaining thereto.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The main thrust of my research is to investigate the use of Visual Technology for the Autonomous Learning of Mathematics (VITALmaths) video clips through the medium of the cell phone in the teaching and learning of mathematics in selected Grade 9 mathematics classrooms. For the purposes of this literature review I have therefore considered the nature of the VITALmaths project, and because the video clips are disseminated via mobile technology – in particular the cell phone – I have looked at research into and literature on the development and use of mobile technology. In addition, as the video clips make use of animation, I have also considered research and literature that refers to the strengths and weaknesses of animation in learning. Finally, I have reviewed literature that looks at the combining of animations and mobile technology in education.

2.2.1 Development and use of mobile technology in general

Naismith, et al., (2004) define mobile technologies as devices which are "personal and portable" (p. 2) such as mobile or cellular (cell) phones, personal digital assistants and notebook computers. The use and availability of mobile phones in Africa has risen sharply in the last few years (Banerjee & Ross, 2004; Scott, Batchelor, Ridley & Jorgensen, 2004; Botha & Ford, 2008; Andrianaivo & Kpodar, 2011). The main reason for this, according to Aker and Mbiti (2010), is that mobile technology has "effectively leapfrogged the landline in Africa" (p. 3), unlike in Europe and the United States, where the opposite holds true. This has allowed people without access to electricity, landlines, computers and the like to stay in contact with friends and relatives, and to tap into global resources such as the Internet and World Wide Web. They also point out that, in 1997, only 25% of the world's countries had mobile networks in place, but that by 2009 this had increased to 100%. According to statistics released by the International Telecommunications Union (Key Global Telecom Indicators for the World Telecommunication Service Sector, 2010) mobile cellular subscriptions in developing countries increased from

1 215-million, or 23 per 100 inhabitants, in 2005 to 3 695-million, or 70,1 per hundred inhabitants in 2010 (see figure 2). It is also estimated that penetration rates in Africa will have reached 41% by the end of 2010 (The world in 2010: ICT facts and figures, 2010).

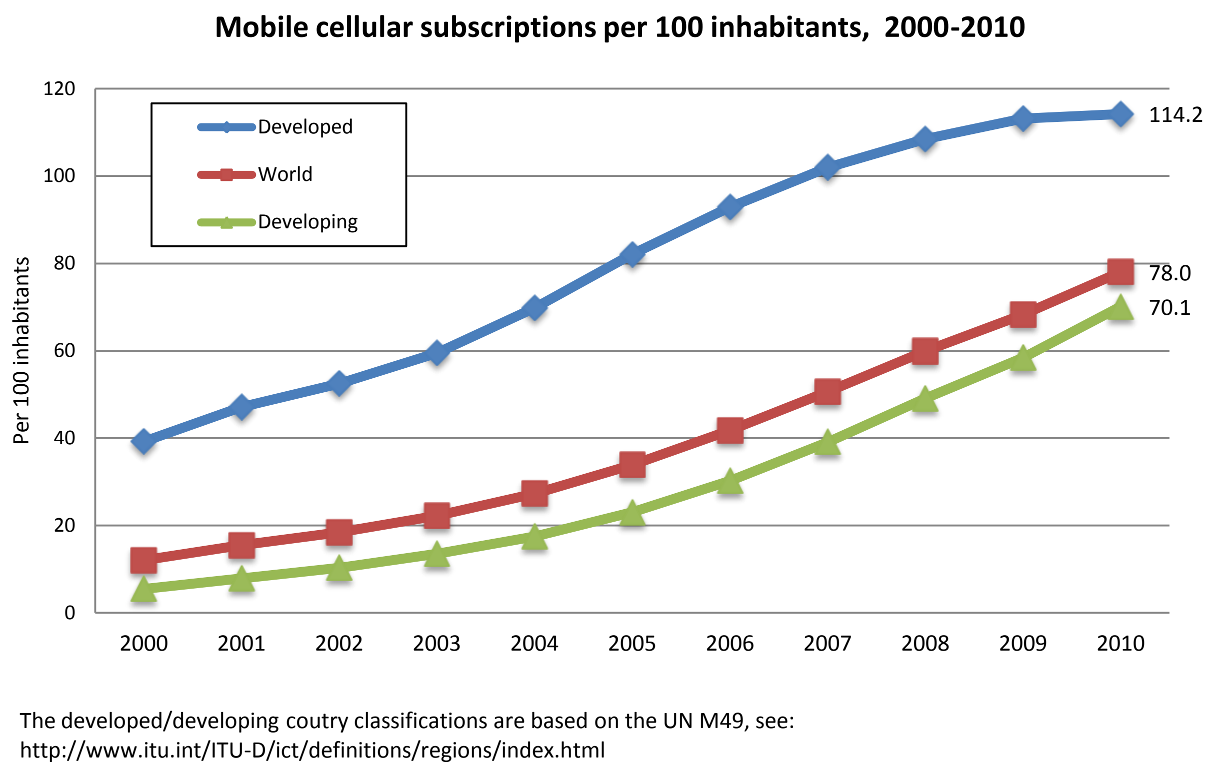

***Figure 2*: Mobile cellular subscriptions per 100 inhabitants, 2000-2010.**
Source: ITU World Telecommunication /ICT Indicators database (2011)

These global figures are consistent with annual reports released by some of South Africa's major cell phones companies. For example, as at 31 March 2009 Vodacom (2009) reported a customer base of 39.6 million users, which increased to 39.9 million users at the end of March 2010 (Vodacom 2010) with an additional 1.1 million data subscribers. Cell C (2010), for example, claimed a total of 6.9 million active users at the end of 2009, followed by a 12% increase to 8.2 million users by the end of 2010 (Cell C, 2011) with an increase of 17% in prepaid customers and a total of some 200 000 data subscribers, the latter as at the end of June, 2011.

However, the figures as quoted by the abovementioned cell phone companies do not presuppose the ownership of handsets, as James and Versteeg (2007) point out. They found that the development of prepaid subscriptions allowed people, especially in developing countries with limited fixed-line telephonic coverage, to purchase their own SIM cards and airtime and then share handsets with family or other community members. Scott, et al., (2004) discovered that up to 80% of people in Africa used mobile phones, and that air time vouchers in low denominations fitted the pockets of the some 300-million low-income people who live on less than $1 a day and the so-called ultra-poor 120-million who live on less than $0,50 a day, providing them with a cheap form of communication. Donner (2009) agrees, stating that “mobile ownership is lower among the bottom billion” (p. 95), but that people often share both handsets and airtime, and by using other applications such as “please call me” messages, obtain maximum benefit from modern-day mobile technology. Andrianaivo and Kpodar (2011) concur with this as in their opinion many inhabitants of developing countries do not have a stable income and are unable to pay the necessary fixed costs linked to both post-paid contracts and fixed line telephony. According to the Global System for Mobile Communications Association (GSMA, 2008) only South Africa, Nigeria and Cote d’Ivoire have a significant number of contract users, while most of the rest of the 30 sub-Saharan countries included in their study rely almost entirely on pre-paid subscriptions.

According to Kefela (2010) this has opened up a wealth of entrepreneurial opportunities for communities across the world, such as Tanzania’s Simu ya Watu or People’s Phone community project, launched by Vodacom and which allows entrepreneurs to establish public calling centres with fixed cellular lines. This is a similar project to the Village Phone project launched by Grameen Bank in rural Bangladesh in 2006 (Village Phone, 2006) as an addition to its already successful provision of collateral-free loans to the poor. According to Kalil (2008), the mobile phone industry was responsible for the creation of some 3.5 million employment opportunities in sub-Saharan Africa alone, and that an increase of just 10 mobile phones per 100 people usually translates into a 1,2% growth in gross domestic product (GDP)..

Another project dependent on mobile phone technology is Vodafone’s M-PESA mobile money transferring system, developed, piloted and launched in 2006 in Kenya by African mobile provider, Safaricom (Hughes & Lonie, 2007). This system allowed people without a bank account or access to modern banking facilities to use their mobile phones in much the same way as a debit or credit card would be used. By 2007 M-PESA, which takes its name from “M” for mobile and “pesa”, the Swahili word for money, had attracted over 1,6-million users and was subsequently launched in February 2008 in Afghanistan and in Tanzania in April of that same year (Mobile Money Transfers to Launch in Tanzania, 2008; M-PESA: Changing lives in a changing world, 2010). In 2010 it was launched in South Africa as a joint venture between Vodacom and Nedbank (Vodacom and Nedbank launch M-PESA, 2010).

As Lee, et al., (2009) conclude, the effects of a single mobile phone, especially in sub-Saharan Africa and particularly where there is a dearth of land-lines, when linked to the relative low expense of installing mobile phone infrastructure, has already contributed significantly to the economic growth in that region, and will probably do so in years to come.

2.2.2 Development and use of mobile technology in education

According to Winters (2007), mobile learning was most commonly defined in early research as learning which made use of mobile devices such as mobile phones, iPods, personal media players and the like. However, before long researchers began to recognise the mobility of the learners as well, and thus the Educause Learning Initiative (2010) defines mobile learning as "any educational intervention delivered through mobile technology and accessed at a student's convenience from any location" (p. 2). Sharples, Taylor and Vavoula (2007) similarly suggest that mobile learning should be viewed as the gaining of knowledge through "conversations across multiple contexts amongst people and personal interactive technologies" (p. 4).

Prensky (2006) argues that the 21st century, also known as the digital age, has brought with it numerous changes, especially insofar as devices and the knowledge and skills needed to operate and gain optimum use from them are concerned. Learners have also changed, and according to him can be referred to as "digital natives". This means that they are completely at home using what he calls the digital language of such devices as computers, video games and the Internet. As a result, teachers and educational leaders born in so-called pre-digital times need to discover more effective ways of teaching today's learners in order to keep up with the rapid changes in both learners and technology. In his opinion, education should look at ways of taking advantage of modern technology's ability to adapt to learners' individual capabilities and skills, particularly as is the case in computer and video games. However, he also suggests that the cell phone, in conjunction with the computer, is an effective tool that should be used optimally in schools.

According to Colley and Stead (2003) mobile phones are the communication tool of choice of young people, especially those between the ages of 16 and 24. These are relatively inexpensive and easily upgradeable, and have become an essential part of youngsters' social and cultural lives. They also suggest that mobile phones could be used as a draw card to encourage learning. In addition, youngsters today have a longing to share information with others, a trait that could serve to encourage peer collaboration, especially in educational settings.

Wellings & Levine (2009) concur, suggesting that the fascination and keenness that children have for media and technology be taken and incorporated into the creation of challenging learning experiences which require active participation. In her findings regarding the world-wide use of mobile technology in education, Shuler (2009) reveals that learning can be enhanced by the use of mobile devices, especially in terms of situated learning where students are able to access information at the moment they need it, for example, during a field trip.

Shuler (2009) further states that mobile devices are ever-present in children's lives and mentions five attributes of mobile technology which could be harnessed to ameliorate education. These include its ability to provide "anywhere, anytime" learning (p. 17), to reach out to disadvantaged and insufficiently served children, to better interpersonal interaction in the 21st century, to adapt to modern learning environments and to individualise learning experiences. She also highlights a number of educational projects which make use of mobile technology, such as Project K-Nect and TechPALS in the United States, and further afield, projects such as MyArtSpace in Great Britain, the, the Three Rs in Singapore and the Mobile Education (MobilED) Project in South Africa.

Mobile technology has also been harnessed to assist in teacher development through in-service programmes, an example of which is the School Empowerment Programme (SEP), launched in Kenya in 2005 (Traxler & Dearden, 2005). One of the components of the SEP is a bulk short message service (sms) system which, according to Traxler and Leach (2006) is known as SEMA and takes its name from the Swahili verb, "to speak". SEMA allows the Kenyan Ministry of Education to disseminate information such as notices of meetings, documentation, reminders and other teacher support materials to teachers in that country and to collect data relating to schools, such as attendance, enrolment and the like, via sms.

A number of initiatives have been launched in South Africa, according to Botha and Ford (2007), to introduce computer technology in schools, particular in the so-called disadvantaged schools, but have not met with much success due to insurmountable difficulties such as, among others, a lack of infrastructure, high pupil-teacher ratios and insufficient computer skills among educators, to name but a few. For them, instead, the development of mobile technology across Africa provided the ideal platform for the launch of the Mobile Education (MobilED) project in 2006 through a partnership between the Meraka Institute of the Council for Scientific and Industrial Research (CSIR), University of Pretoria and Tshwane University of Technology in South Africa, and partners in Finland, Brazil and the United States of America. The main goal of the project was to "develop, expand and integrate mobile-phone tools, technologies and services into the areas of formal and informal teaching and learning environments" (Botha & Ford, 2008, p. 2) and to equip South African learners, in particular, to participate fully in the global information society through the acquisition of 21st century skills despite a lack of personal computers and ubiquitous internet access.

A MobilED pilot project (Botha & Ford, 2007), run at Irene Middle School in Tshwane, South Africa in 2006, revealed that the participants, mostly from very poor socio-economic backgrounds and who had never owned mobile phones before the start of the project, had a natural affinity for combining technology with their normal day-to-day lives. They were able, for example, to access lesson plans using the cell phones and the Internet with relative ease while the culture of sharing things in the community saw learners happily sharing handsets during the project. Botha and Ford (2007) also found that learners spent time looking up information related to other topics being studied at the time. A survey conducted by Kreutzer (2009) regarding cell phone usage and accessing of the Internet among a group of low-income youth in Cape Town showed similar results, where he found that despite limited access to handsets, around 80% of the group had direct access to the Internet on a daily basis. Learners were also spending around R20 ($3) per week on airtime, with many of them owning their own SIM cards and borrowing handsets from family members or friends.

The VITALmaths project, according to Linneweber-Lammerskitten, et al., (2010), was established through collaboration between Rhodes University and the University of Applied Sciences Northwestern Switzerland, and has seen the creation of a database of short animated video clips, no more than roughly 3 minutes in length and developed by students at these two institutions. The video clips serve to "unpack a variety of mathematical concepts" (*ibid,* p. 27) and are designed to stimulate mathematical inquiry and investigation by the viewers. The main platform for disseminating the VITALmaths clips in South Africa will be the cell phone as this form of mobile technology is easily accessible throughout the country. In addition, more and more people are using cell phones as computers, and already a number of programmes involving mobile technology for learning, such as *Imfundo Yami / Imfundo Yehtu*, *M4Girls*, *MOBI™* and *Dr Math on MXIT*, have been established.

Researchers such as Shuler (2009), Prensky (2006) and Botha and Ford (2008) believe that the use of cell phones and mobile technology can provide the learning environment with endless possibilities for enhancing education, but there are still a number of obstructions that need to be removed. One of these is the narrow view that mobile phones are only capable of making and receiving calls as evidenced by the General Secretary of National Union of Teachers in the United Kingdom who stated:

> "Mobile phones are not for use during the school day – particularly during lessons. It is not only the person phoning or being phoned whose education is being disrupted – it is the progress of the entire class." (Mobile phones: Child's play, 2002)

Sharples (2003) goes on to say that effective teachers keep control by ensuring that the classroom remains a "sealed environment" (p. 3) and carefully limiting external interference. Botha and Ford (2008) found that educators in schools where MobilED pilots were run were the biggest hindrance when it came to incorporating mobile phones as learning tools into the classroom, as they felt that these would be a nuisance and distract the learners. In a number of schools, cell phones and their use is banned from classrooms and inside school buildings. An extract from the Port Alfred High School code of conduct reads as follows:

> "1.8 No learner may use a cell phone inside the school. If a cell phone is in the possession of a learner, it should be switched off." (p.2)

American education boards seem to have similar feelings, as can be seen in the case of Price vs New York City Board of Education (New York State Law Reporting Bureau, 2008). Here the

Appellate Division of the Supreme Court in New York upheld a ban by the Board on the possession of cell phones by students while on school premises, dismissing the parents' appeal against the ban as enforced by a lower court. Lenhart, Ling, Campbell and Purcell (2010) discovered that 24% of learners attended schools where mobile phones were banned, 62% were permitted to have their phones at school, but were not allowed to have them in class and only 12% were allowed to have theirs at school without restrictions (see figure 3).

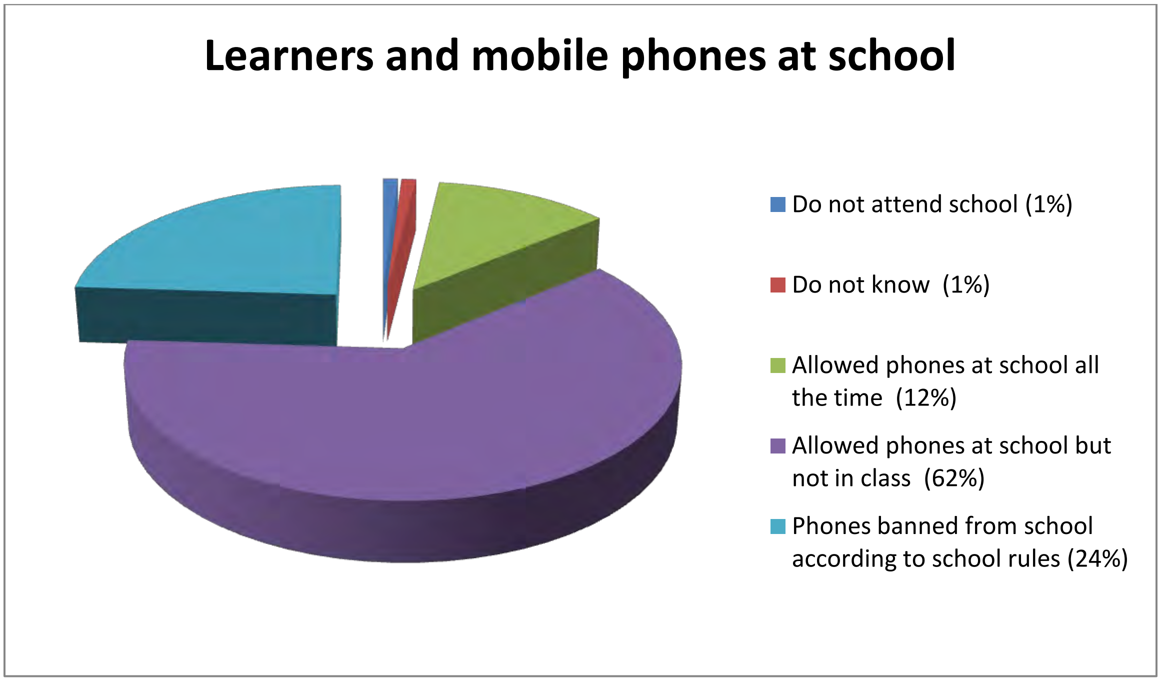

Figure 3 **Learners and mobile phones at school (**Adapted from Lenhart, et al., 2010, p. 82)

According to the national findings of Project Tomorrow's Speak Up 2009 (2010) although about 51% of teachers who participated in the study felt that the use of technology in the classroom provided motivation for students to learn, and around 58% believed that technology increased student engagement, some 76% believed that using mobile technology in the classroom would cause distraction. However, when students in Grades 6 to 12 were asked what they considered to be the main obstacles preventing the use of mobile technology in their schools, the number one answer was that they were not allowed to use their own Smartphones, cell phones or MP3 players at school.

In their Mobile and Ubiquitous Learning (MoULe) project Taibi, Gentile, Seta, Fulantelli, Arrigo, and Di Giuseppe (2009) found that teachers who were not particularly familiar with mobile technologies and technological devices were able to successfully participate in the project, provided they were given adequate training in developing and designing a flexible system which supported different types of mobile learning experiences. Moura and Carvalho (2009) discovered that student participants in a study they conducted considered themselves to be dependent on their mobile phones and they felt ill at ease if they were without their phones for any length of time. They were also reluctant to switch the phones off, preferring to keep them on "silent". Many of them had also not considered using their phones to support learning. The introduction of mobile technology as an educational tool in schools, therefore, requires that policies referring to what may be considered acceptable use thereof be put in place by the authorities in such schools (Botha and Ford, 2007), instead of maintaining outright bans thereon.

Van 't Hoof and McNeal (2010) believe that although mobile devices are common in society today, adults are still reluctant to allow their use, especially in educational settings, citing safety issues and the distractive effect as reasons. They suggest that mobile technology should be used to create a link between the structure and confines of the classroom and the community, and between formal and informal learning. To this end they have created the Geo-Historian project, run as an initiative by Kent State University in Kent, Ohio. This project enables learners from Kindergarten to Grade 12 (K-12) to produce digital resources around the study of history in their home-city, and therefore to "augment physical learning contexts with digital content" (*ibid,* p. 6).

Issroff, Scanlon and Jones (2007) state that, although many learners have a strong affinity for and drive to use mobile phones, there is a paucity of research on the reasons for this. However, they offer six ideas as a starting point for considering the motivational effect of mobile technology in the classroom, namely "control over goals, ownership, fun, communication, learning-in-context and continuity between contexts" (p. 21). However, Speak Up 2009 (Project Tormorrow, 2010) suggest that learners are well able to explain their attraction, and that they are fully aware that learning is not confined to a school classroom or bound by time. Also, they understand that using a variety of types of digital technology and resources will encourage learning productivity through engagement, and will enable and empower them to take their places in society with 21st century skills at their disposal.

According to Quillen (2010) a number of schools across America have started running pilot programmes, in which learners are allowed to use their mobile phones for educational purposes during the school day. Learners are allowed, for example, to connect to the schools' wireless networks to access information, or complete tasks. Discussions with teachers, administrators and parents revealed a growing acceptance for the use of mobile phones as educational tools, and learners also started seeing the potential in using mobile devices for learning. However, he cautions that professional development programmes also need to be put in place in order to assist teachers to use mobile technology effectively and with confidence in their teaching. Prensky (2009) also points out that embracing mobile technology must be done with an awareness of both its advantages and its potentially harmful effects, and thus developing wisdom in its application and use.

2.3.1 Use of animations in education

According to Mayer and Moreno (2002) animation is a "simulated motion picture depicting movement of drawn (or simulated) objects" (p. 88). In a study they conducted they found that some learners learnt better when exposed to pictorial representations while others preferred verbal representation. When pictures and words are combined into a single presentation, Mayer (2003) defines this as a *multimedia presentation*, and therefore where such a presentation is intended to promote learning, he refers to it as *multimedia instruction*. He asserts that, according to cognitive science research, three basic assumptions may be made regarding the way in which the human mind operates in multimedia, namely "the dual channel assumption, the limited capacity assumption and the active processing assumption" (p. 44), as clarified in Table 1 below.

Table 1 *Three assumptions about how the mind works in multimedia learning*

Assumption	*Definition*
Dual channel	Humans possess separate information processing channels for verbal and visual material
Limited capacity	There is only a limited amount of processing capacity available in the verbal and visual channels
Active processing	Learning requires substantial cognitive processing in the verbal and visual channels

(Source: Mayer, 2003)

Höffler and Leutner (2007) claim that during the last decade or so much debate has taken place in educational circles around the benefit of animations over static images in learning and teaching. The biggest influence in this field was Tversky, Morrison and Betrancourt (2002), who concluded from their research that studies claiming that animations were superior to static pictures in facilitating learning simply arrived at that conclusion because the former were advantaged by the additional information they were able to convey. As a result, Höffler and Leutner (2007) conducted a meta-analysis of 26 studies to decide if animation had any advantages over static pictures in terms of enhancing learning.

In their study they discovered that the results belied previous mainstream research, such as that conducted by Tversky, et al. (2002), and indicated that non-interactive animations clearly had a "rather substantial advantage" (Höffler & Leutner, 2007, p. 735) over static images. This was particularly valid when the movement used in the animations reflected the specific content that was being taught at the time, and therefore aided the learner in building a mental model of that content. However, these animations appeared to be even more helpful when they were representational and "the information to be learned relates to the motion, trajectory and change over time depicted by the animation" (Vogel-Walcutt, et al., 2010, p. 166). In addition, simpler, less detailed animations that showed only the fundamental aspects of the specific content seemed to have an advantage over more realistic and detailed animations, resulting in better cognition by the learners (Höffler & Leutner, 2007). This happened, according to Vogel-Walcutt, et al., (2010) mainly because of the lower cognitive load placed on the learner, and was advantageous because processing of information was done in the smaller working memory before being committed to larger long-term memory. Therefore, omitting irrelevant detail in animations reduced the amount of working memory used. In addition, while they found that learners who viewed static pictures were more adept at acquiring both procedural knowledge and conceptual understanding of a specific topic, they also found that those who viewed an animation of the same pictures showed a higher level of retention of their acquired procedural knowledge and conceptual understanding.

Ainsworth (2006) suggests that external representations support learning especially when the type of representation corresponds with the required learning of the situation. Anglin (1987) determined that retention of information lasted for up to 55 days when prose was supported by pictorial representations or illustrations. Rieber (1991) also found that learners being exposed to animations during the learning process retained the information for far longer provided enough guidance was provided to avoid the arising of misconceptions.

Schnotz & Rasch (2005), however, caution against assuming that all animations are beneficial at all times, arguing that in some cases animations prevent learners from carrying out the necessary cognitive processes needed for learning, especially when tasks are incorrectly facilitated. This is usually the case where learners with a higher level of prior knowledge and ability do not need the assistance of the animations but make use of them all the same. Yet, their study showed that, on the other hand, animations assisted those learners with limited abilities and who had a low level of prior knowledge, in forming the necessary mental models. Ainsworth and Van Labeke (2004) also point out that while animations usually have a positive effect on learners' motivation to learn, research has shown mixed results when considering animations as an aid to learners' "understanding of dynamic phenomena" (*ibid.,* p. 241). In their opinion animations are usually viewed as a prototype of dynamic representation, and they believe that there are three different ways of representing phenomena that change over time. These are what they refer to as "time-persistent representations" which "show a range of values over time"; "time-implicit" which "show a range of values but not the specific times they occur" and "time-singular" which "show only a single point in time" (*ibid.,* p. 241). They suggest that a combination of all three types of multiple representations is most effective in aiding understanding and retention in learners.

Yachi, Hoshi, Kitani and Akahori (2009) carried out a study where computer-based testing in mathematics was carried out with questions being posed using just animations without any text added and others using only text. They discovered that the subjects found it easier to understand the questions when faced with animations-only rather than text-only questions, and that they also considered the text-only questions to be more difficult.

While animations can include pictures, text, graphics and other physical and symbolic representations, they can also be virtual representations of "actual models of physical manipulatives" (Durmus & Karakirik, 2006, p. 121).

2.3.2 Physical and virtual manipulatives in education

According to Attewell (2005) development of mental images is enhanced through the use of physical manipulatives, which she defines as "objects or things that students are able to feel, touch, handle, move and, often, stack" (p. 20). Manipulatives are objects invented to illustrate abstract mathematical ideas in a clear and tangible way (Moyer, 2001) and are therefore tools that may be used to move students from their own concrete experience to the abstract levels of mathematics. This idea of so-called "hands-on learning" was mooted as far back as the late 18th century by Swiss educator, Johann Heinrich Pestalozzi, and later expanded by Friedrich Froebel, creator of the first ever kindergarten in 1837 in Germany. This idea was refined and then taken further by Maria Montessori (Resnick, Martin, Berg, Borovoy, Collela, Kramer, et al., 1998).

However, Moyer (2001) warns that using manipulatives is not as easy as it seems, and that teachers' own beliefs and attitudes play a huge role in determining the efficacy of using manipulatives. In addition she says that the internal pictures learners form of the mathematical ideas have to somehow be linked to the manipulatives, and often the thinking of the manufacturer when making the manipulatives is not at all clear to either the learners or the teachers. However, manipulatives can help learners with different learning styles and can also be used to show that there are a number of ways of solving mathematical problems (Fogt, 2008).

Durmus and Karakirik (2006) state that mathematicians have long used tools and manipulatives, including computers, in the development of mathematics as concepts and relationships that are represented visually are believed to enhance understanding. Computers and a multitude of software packages have been used with varying effect in mathematics classrooms the world over, for example, by providing instruction of content and the testing of the learning thereof, using programmes such as Koedinger and Anderson's (1997) experimental intelligent tutoring system, *Practical Algebra Tutor.* Programmes such as these, Durmus and Karakirik (2006) state, imply that computers could be used ultimately to replace teachers and textbooks. However, Norman (1993) argues that computers should be seen as "cognitive tools" that can be used as scaffolding, through which learners reflect on existing representations, modify them, add new representations and draw comparisons. In this way new knowledge is created and computers therefore are regarded as tools that encourage thinking.

With the development of technology, non-tangible manipulatives such as virtual, computer and digital manipulatives started to appear (Moyer, et al., 2002). These were either static manipulatives i.e. pictorial representations of concrete manipulatives, or interactive manipulatives, where students are able to manipulate images using a computer mouse.

Moyer, et al., (2002) define virtual manipulatives as “an interactive, Web-based visual representation of a dynamic object that presents opportunities for constructing mathematical knowledge.” Therefore, Durmus & Karakirik (2006) state, concepts and relationships that are represented visually enhance understanding. Learners become as involved with virtual manipulatives as with physical manipulatives. Because virtual manipulatives are more abstract and not "hands-on" they remove many of the constraints of physical manipulatives. One of the big advantages is that, because they are often web-based, learners can access them at home. It is important to ensure that virtual manipulatives are carefully chosen or designed to enhance and consolidate conceptual understanding. Resnick, et al., (1998) suggest that digital manipulatives should not be designed in such a way that they merely encourage learners to finish tasks more rapidly, but rather that these “engage them in new ways of thinking” (p. 282).

Durmus & Karakirik (2006) agree that there is a place for virtual manipulatives especially if they move learners from "learning with models” where learners find solutions using ready-made models to "learning to model” (p. 118) where reality is taken and used to construct a theory to express knowledge as an end product. These may be used to familiarise learners with mathematical representations that will help them to see the use of mathematics in solving everyday problems. In addition, virtual manipulatives could also be used to consolidate conceptual understanding, especially as they are available to learners via technology, such as computers, mobile phones, and the like.

2.4 Mobile technology and animations

The project that has inspired my research, the Visual Technology for the Autonomous Learning of Mathematics (VITALmaths) project, is currently being developed collaboratively by students and researchers at the University for Applied Sciences Northwestern Switzerland and Rhodes University in South Africa (Linneweber-Lammerskitten, et al., 2010). The project produces short animated video clips, using natural materials which are commonly found, to present and develop mathematical ideas. The text used in the clips is translated into numerous languages, including indigenous African languages.

In their research Linneweber-Lammerskitten, et al., (2010) considered various "theoretical and pedagogical issues relating to the use of video clips" (p. 28). In Switzerland, for example, mathematical competence includes such aspects as capacity to investigate and explore, as well as to develop and then test conjectures. In addition, the Swiss definition separates the ideas of competence and skills, with the former carrying with it the idea of something holistic. The current South African curriculum (South Africa, Department of Education [DOE] 2003) also has a similar idea in that it calls for learners to develop confidence to cope with mathematics, to appreciate the intrinsic attractiveness of mathematics, to become curious about the subject and to develop a love for it. The project intends thus to encourage learners to deal with mathematics outside of the rigours of strict instruction (Linneweber-Lammerskitten, et al, 2010).

The video clips, created specifically to encourage self-directed study of mathematics, are freely accessible via a dedicated website, http://www.ru.ac.za/vitalmaths (*ibid*.) and are available in various formats, such as MP3 and MP4. Due to the brevity of the clips, the download time is minimal, and they can be downloaded or streamed on a variety of devices, ranging from mobile phones to smartphones to personal computers. In addition, the videos are "self-explanatory – i.e. they require minimal instruction" (*ibid.,* p. 29), may be watched immediately and utilised for further exploration of mathematical ideas. The clips are also relatively straight-forward and viewers do not need to possess vast quantities of mathematical knowledge in order to make sense of the clips, nor do they need to perform complicated mental procedures.

According to Linneweber-Lammerskitten, et al., (2010) the design of the video clips is crucial, as this is what often determines to what extent interaction by the viewers will take place. The clips adhere to a number of design principles, as espoused by Herrington, Herrington and Mantei (2009), such as learners (and teachers) being able to learn anytime, anywhere and instantaneously, alone or in groups, without needing massive financial resources or technology beyond their own cell phones. Furthermore, the fact that the clips are made from natural materials means that they can easily be replicated, using materials readily available, the intention being to encourage the learners and teachers to carry out further explorations in a practical manner.

However, it is unfortunate, Prensky (2006) avers, that the syllabi and curricula of the 20th century and earlier hinder learners in terms of the skills and knowledge that they need to operate in the 21st century. However, by finding a way to compress these curricula and incorporate them into a 21st century curriculum would make that knowledge more relevant and accessible to the learners. Teachers need to find out how to integrate learners' digital knowledge and skills into their teaching. Leading classroom discussions, valuing the learners' input and seeking new ways in which to grab their attention in class could accomplish this. Teachers, in order to teach more effectively, therefore need to offer learners what the digital media offers them, i.e. a similar blend of "desirable goals, interesting choices, immediate and useful feedback, and opportunities to level up that engage kids in their favorite complex computer games" (*ibid.*, p. 9).

Wong (2003) espouses a similar view in saying that in order to engage learners in mathematics lessons teachers need to consider what he terms “the whole learner” (p. 3) and should therefore bear in mind that most learners carry mobile phones with them and are adept at using them, while a large number of learners are addicted to computer games. Lenhart, et al., (2010) found that 77% of teens had their mobile phones at school, regardless of the rule in that particular school, and 60% of those had them turned on during the school day, while 64 % admitted to either sending or receiving text messages during instructional time.

In addition, Wong (2003) states, symbolic representation is one of the most important aspects in mathematics teaching. In order to facilitate understanding by learners, teachers need to use a variety of representations ranging from words and diagrams to virtual manipulatives. This would also assist in engaging learners in the learning process. Thornton and Houser (2004) explain that research from the early 1980s onwards has revealed that video has been highly effective where it links teaching to problems which occur in real-life contexts, and when concepts and skills being taught have a definitive visual element. They conducted research among Japanese university students where 44 students studying English as a foreign language were sent 100-word vocabulary lists and where 31 students were encouraged to visit web pages which contained short, 15- second video clips and computer animations and explanations of the idioms, called Vidioms, in Japanese and English. Vocabulary lists were sent by email and web pages that could be accessed specifically by mobile phones were created. Some 71% of the first group of students indicated a preference for accessing these lists using their mobile phones rather than via a personal computer. Around 38% of the students who had studied the web pages found them helpful when studying, while 25% said they found the site fun, and 19% enjoyed specific animations. Results after testing indicated that learning definitely took place.

When asked what strategies teachers could use to help the respondents in learning mathematics, Project Tomorrow (2009) revealed that around 40 percent of the learners indicated a preferences for digital learning, with interactive simulations (37%), online or computer games (40%) and animations to enhance understanding of difficult questions (34%) appearing to be the most popular uses. In contrast to this, only around 12% of teacher respondents used digital simulations, 6% made use of virtual laboratories, and 17% included animations in their teaching. Toledo (2007) found that only 10% of teachers included in her study included mobile devices to enhance their teaching, which seems to tie in with teacher attitudes towards cell-phones as evidenced by Joan Ganz Cooney Center and Common Sense Media (2008) where research indicated that some 85% of teachers viewed cell-phones as distracting in class, and 64% believed these did not belong in schools. Sharples (2006) suggests that a tension has developed between the teacher in the classroom, bound by the education system to a curriculum that is non-negotiable in a sealed environment, i.e. the classroom, and the learner, who has become thoroughly conversant with the informal world of social networking. This tension needs to be resolved before learners' ubiquitous use of mobile technology can be harnessed to provide excellent education, thus providing a clear collaborative link between learning, life and work, and removing the limitations imposed on education through the traditional view that learning can only take place in specific physical settings such as classrooms or university lecture halls (UNESCO IITE, 2010).

As mentioned earlier, Quillen (2010) states that a number of public schools in the United States of America have begun piloting projects which have seen learners being allowed to bring their mobile phones to school. These devices are now being viewed as educational tools instead of as disruptive influences and policies governing responsible use by learners have been drawn up. These policies reflect the idea that it is not the technology itself that causes abuse thereof, but rather the behaviour of the learner-owners, and that this may be dealt with in terms of general codes of conduct in schools. Preston (2011) also suggests that if teachers become amenable to incorporating mobile phones into their teaching, and advance the viewpoint to their learners that the phones are to be used as mobile learning devices and not for nefarious purposes, incidents of abuse will become less prevalent with time.

2.5 Conclusion

The ubiquitous use of cell phones, especially in developing countries throughout the world, for such varied uses as banking, making calls, sending messages and the like, to my mind seems to indicate that there is a place for projects such as the VITALmaths project. The rapid rise in cell phone usage in South Africa, as well as the various educational projects launched in recent years in South Africa where material may be accessed by learners using their cell phones or they may request help via sms, also shows that mobile technology has started being incorporated into teaching and learning in this country.

In addition, Linneweber-Lammerskitten, et al., (2010) surmise that the combination of the video clips and modern cell phone technology will prove advantageous to a broad spectrum of teachers and learners across the entire country, especially in deep rural areas where little or no mathematical resources are available. Feedback from those using these clips will assist in refining the design principles used in creating them, and ongoing research will tie into both the growth and development of the project, and the ever-continuing academic discussion into mathematics education.

Having carefully considered literature pertaining to both the advantages and disadvantages of the use of both mobile technology and animations, conducting this case study, albeit on such a small scale, should give some sort of indication as to the possibility of incorporating the VITALmaths video clips into education as a resource for both teachers and learners.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter I shall outline and briefly discuss the procedures followed while conducting my research by considering such aspects as orientation, methodology, participants, research design, techniques, analysis, validity and ethics. In doing so, a clearer picture should emerge of my interest in the VITALmaths project.

3.2 Orientation

Newby (2010) states that interpretivism in the social sciences means that the world is only comprehensible from the point of view of others by considering how they live, and what they say and do. He also mentions that an interpretive approach requires the close examination of data to reveal meanings which at first glance may not be apparent. Willis, Thompson and Sadera (1999) argue that there are no absolute truths in human behaviour and that "realities are local, transitory, and contextually based" (p. 35). This idea is supported by Newby (2010) who avers that people can hold opposing views based on perfectly valid yet differing truths, and as a result "interpretivism underpins the qualitative approach to research" (p. 656).

According to Cresswell (2003), research which involves interaction or collaboration between researcher and participants, and in which the researcher acknowledges that his or her values and biases play a role, can be described as qualitative research. Newby (2010), in turn, defines qualitative research as research where the main intention is to discover the reasons why people behave the way they do. In this study I introduced the selected teachers to the VITALmaths project before encouraging them to utilise the clips in certain lessons. I also observed said lessons to explore what role the video clips played. Semi-structured interviews both pre- and post-observation enabled me to gain perspective on each teacher's thoughts and actions, while journals kept by the teachers provided further insight. As my interaction with the teachers was to take place from a position where I believe that the VITALmaths project has much potential for success, my research would therefore take the form of a qualitative investigation that lies within an interpretive paradigm.

3.3 Methodology

Cohen, Manion and Morrison (2005) define a case study as an instance that may be used to show what would be most likely to happen in a generalised context, and that it may be used to investigate and report on events and relationships as they unfold i.e. to show exactly what occurs in a specific context. Creswell (2003) concurs, and further clarifies this by mentioning that it usually involves investigating an individual event limited by time and place, and the collection of comprehensive data through a variety of methods. According to Newby (2010) one of the key features of a case study is this: "Put an interpretation on what has been found out, identify critical events, times, stages and key people in achieving success or capturing failure" (p. 619).

This research project took the form of a case study involving myself and two other teachers in two specific schools over a three month period. Data was collected in my case through observation via video recordings and through my own journal, and from the other teachers by means of interviews, questionnaires, journals and observation. The main unit of analysis is the teachers' experiences in using the VITALmaths video clips in their mathematics lessons. This includes their actions in using the video clips in selected lessons as well as their own thoughts and feelings thereof. I also analysed the experiences of the learners themselves in this regard.

3.4 Participants

3.4.1 Selection criteria

Babbie and Mouton (2001) point out that sampling in qualitative research is often deliberate, usually bearing specific criteria in mind. Choosing specific cases which are best suited to the needs of the researcher is defined by Cohen, et al. (2005) as purposeful sampling. Therefore, because I am a Grade 9 mathematics teacher, and am fully conversant with the content taught at this level, the participants in this study included both myself and two Grade 9 mathematics teachers who owned cell phones which have the capacity to download the video clips and who currently teach in two combined schools in the area in which I live. I also made use of the clips in my own classroom in order to gain a better understanding of how they may be used in a classroom setting.

3.4.2 Research sites

The first school in the study, referred to as School A, is a multi-racial, multicultural Section 21 school, also known as an ex-Model C school, and which is classified as a Quintile 5 school. This means that the Department of Basic Education (DBE) paid the salaries of 32 teachers out of a staff complement of 40 in 2011 and, according to the Government Gazette (2010) an annual per pupil financial allocation of R156 per learner. The school is therefore responsible for raising funds through school fees to cover the rest of the operating costs of the school, and has an enrolment of some 780 learners from pre-school level through to Grade 12. This school has performed well academically, constantly delivering a Grade 12 pass rate of 98% to 100%, while it also performed far higher than the national averages in the Annual National Assessments (ANAs) for Grades 3, 6 and 9. The school is considered a dual-medium school, where one class per grade up to Grade 9 is taught in both English and Afrikaans, while in the other classes in each of those grades the Language of Learning and Teaching (LoLT) is English. From Grades 10 through to 12 classes are taught in both languages, which are also offered as Home Language and First Additional Languages. The majority of learners choose English as their Home Language, regardless of which language is their mother tongue.

For my second research site I had originally planned to use a secondary school in a rural township. However, this school was situated some distance from school A, and time constraints coupled with an inability to synchronize timetables between the teacher concerned and myself meant choosing another research site closer to home. The replacement for the second school in my research, however, is situated in a rural township area in which the majority of inhabitants belong to the so-called “Coloured” group. A Quintile 4 school, its teachers are all employed by the DBE, who also pays a financial allocation of R453 per learner (South Africa. Government Gazette, 2010). Enrolment stands at 790 learners from Grade R to Grade 9, all of whom are either Coloured or Black. The school performed poorly in the ANAs, delivering scores below the national averages. The LoLT is Afrikaans, and all learners are required to take Afrikaans at a Home Language level up to Grade 9, irrespective of the language spoken at home.

Both teachers selected are males and are considered to be fully qualified teachers. Teacher A has taught at School A since January 2007, and has a B. Sc degree and a PGCE. This is his first teaching post, and he currently teaches mathematics from Grade 7 through to Grade 10. Teacher B has taught at School B since 1989 and has a teacher's diploma, as well as a B. Ed degree. He teaches mathematics from Grade 6 through to Grade 9. While I am female, the other teachers selected are males and are considered to be fully qualified teachers, as am I. Teacher A has taught at School A since January 2007, and has a B. Sc degree and a PGCE. This is his first teaching post, and he currently teaches mathematics from Grade 7 through to Grade 10. Teacher B has taught at School B since 1989 and has a teacher's diploma, as well as a B. Ed degree. He teaches mathematics from Grade 6 through to Grade 9. I have a B.Ed (Hons) degree and have taught at the same school for the past 15 years.

3.5 Research design and techniques

Stake (1995) notes that a case study involves:

> …placing an interpreter in the field to observe the workings of a case, one who records objectively what is happening but simultaneously examines its meaning and redirects observation to refine or substantiate those meanings (p. 9).

In order to provide a clear picture in terms of my research regarding the role of VITALmaths video clips I divided the study into a number of phases, which are briefly explained below.

Phase 1 consisted of an introductory workshop with the selected Grade 9 mathematics teachers during which I explained the VITALmaths project to them. We viewed some of the video clips and discussed how the content and concepts of the clips could be replicated by the learners using ordinary everyday materials. Part of the discussion was devoted to brainstorming how the clips could be used as part of the teaching process. The workshop was not recorded but I made detailed notes and completed the analysis of this phase virtually directly after the completion thereof.

Phase 2 consisted of semi-structured interviews which, according to Newby (2010), should be structured in such a way that they include questions to be used as an introduction to the interview, and provide guidance as to how the interview should proceed in terms of information required. These were conducted with each participating teacher and included questions regarding their teaching style, how they go about teaching mathematical content, what kinds of teaching resources are available to them, their feelings about using modern technology in the classroom and how they envisaged incorporating the VITALmaths video clips into their lesson. They were also requested to keep a journal in the form of a "fill-in" blank template (see annexure A) detailing their use of the video clips and their own observations regarding the use thereof in the classroom.

Cohen, et al., (2005) suggest that interviews recorded using a video camera are considered to be beneficial to researchers than those not filmed as it is possible for the researcher to pick up on such details as non-verbal communication. I therefore recorded the interviews in this manner. These were then transcribed verbatim, and the transcriptions returned to the teachers to allow them to check them. The videotapes and transcripts have remained in my possession.

During **Phase 3** each learner from each class received a questionnaire (see annexure B) covering areas such as cell phone availability and usage, as well as their views regarding mathematics. These were collected prior to classroom observations which were carried out to see how the VITALmaths video clips had been incorporated into specific lessons. These lessons were recorded using a video camera in order to assist with analysis of how the particular teacher had used the clips and to what extent this had encouraged both the teacher and the learners to further explore the mathematical content of the clips. In addition, learners were requested to write a short reflective essay at the end of the study detailing their experiences during the study. The classroom observations, which were partly informed by the use of the Flanders' Interactional Analysis Category System (FIACS) observation schedule (see annexure C), formed **Phase 4** of the research project. This system, first mooted by Flanders (1961) and implemented at the University of Minnesota, looks at the interaction between teachers and learners during lessons and, although it started out as a research instrument, was used to improve teaching practice. Because one of the difficulties in observation lies in deciding what, in particular, should be observed, I felt that the FIACS would help me in finding out what was happening during the lessons involving the VITALmaths video clips, and also in the analysis of my own practice. During Phases 3 and 4 I incorporated one of the video clips into my own teaching, using recorded close circuit television (CCTV) footage to analyse my own teaching practice and the reactions of the learners, based on the observation schedule previously mentioned.

Phase 5 consisted of the collection and analysis of the teacher journals in order to gain a clear picture of the teachers' use of the VITALmaths video clips. This formed an important part of the triangulation process which, according to Newby (2010), desires to substantiate results through two or more separate sources. During this phase I also analysed the learners' essays in terms of their experience of the video clips and compared this to the teachers' experiences.

Phase 6 comprised follow-up semi-structured interviews with each of the teachers to ascertain their impressions regarding the incorporation of the clips. These interviews also sought to gain a deeper understanding of the teachers' views in terms of use the clips, as well as consideration of their opinions. They were, once again, recorded, transcribed and returned to the teachers for verification.

3.6 Data analysis process

According to Newby (2010) qualitative research is a rather intricate process as data can be collected using a variety of research tools and needs to be organized in such a way that interpretation is made possible. He suggests employing the broad outline as illustrated in figure 3 below:

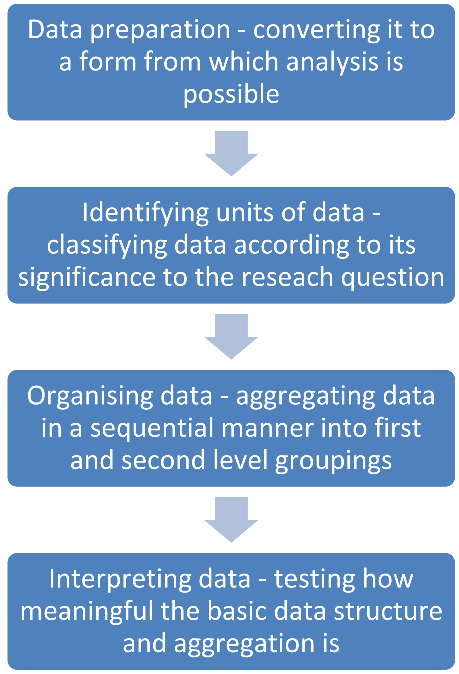

Figure 4 **The data analysis process**
(Adapted from Newby, 2010, p 459-460**)**

As I had divided my research into phases, I analysed data as it was gathered. The workshop in Phase 1 offered insight into the types of questions included in the semi-structured interviews used in Phase 2 of the study, while Phase 2 informed Phase 3, and so on. Data analysis also involves eliciting meaning from the data which has been collected by searching for patterns and relationships, as well as illustrating wider implications it may have (*ibid*). Therefore, the most important part of **Phase 1**, to my mind, was the teachers' ideas on how they could utilize the VITALmaths video clips in their teaching. My analysis in this phase focused on their selection of video clips, which I would later tie in to the selected lessons I observed during **Phase 4** of my research.

In **Phase 2** I analysed the semi-structured interviews, seeing if there was any correlation between the teachers' views on the teaching of mathematics and their actual teaching practice, particularly as pertaining to the lessons involving the video clips. In addition, I looked at their views regarding modern technology and mobile phones, to see if these attitudes would have any bearing on their teaching practice in the classroom, and I also considered the challenges that they face on a daily basis.

Information gathered from the questionnaires referred to in **Phase 3** served merely as a guide to determine whether or not learners would be able to access the clips themselves, either in class or at home, and also looked at their views regarding mathematics in general. However, I analysed their views of mathematics in more detail to see where possible weaknesses might lie and to see whether these would tie up in any way with the video clips used in the lessons selected by the teachers.

Observation in terms of the selected lessons in **Phase 4** was conducted using an observation schedule (Annexure C) based in part on Flanders' Interactional Analysis System (See & Lim, 2006) and lessons were then analysed in terms of teacher-pupil interaction and in terms of the role the videos played in the actual lessons. Here I considered aspects such as when and how each video clip was incorporated into each lesson, what additional resources such as natural materials were included, if any, and how the learners reacted to the use of the video clips. I also analysed how the video clips used tied in to the Grade 9 curriculum by looking at the Revised National Curriculum Statement (2002) and comparing the two. I also drew on my own experiences in using the video clips in my Grade 9 classroom as part of this analysis.

The analysis in **Phase 5** including looking at how the teachers' journals of their experiences reflected their attitudes towards teaching mathematics and using cell phones as analysed in Phases 1 and 2, and how these may or may not have changed. I also used my own journal kept during this time, looking for similarities and differences between my experiences and theirs. In addition I analysed the learners' essays to see how they had experienced the utilization of the video clips.

In **Phase 6** I had followed up certain questions regarding my observations and the teachers' journals, so here my analysis looked at a comparison between the earlier semi-structured interviews and the ones conducted in this phase. Again I considered such aspects as changes in teacher attitude and experience, and how this would affect future inclusion of the VITALmaths video clips in their teaching practice.

During this process of analysis I have included discussions regarding my findings, as my research seemed better suited to this method, rather than separating these two aspects.

3.7 Validity

For research to be valid, notes Newby (2010) it must comply with the following three basic principles:

- It needs to be illustrative of the specific issue being investigated i.e. data obtained must be meaningful;
- Evidence gathered to support the argument offered needs to be as comprehensive as possible; and
- The research and data collection processes, and the results presented needs to be transparent in order to allow the research to be judged fairly by others. This includes mentioning problems encountered during the process.

I have endeavoured throughout my research to apply these three principles, and where I have encountered problems I have mentioned them. In addition, all interviews were transcribed and handed back to the teachers concerned for checking, and both teachers were able to view the videotapes made in their classes, although both declined. I have also placed all videotapes and transcripts in safekeeping, should they be required at a later stage for confirmation.

3.8 Ethics

According to Cohen, et al., (2005) prior to the conducting of research, issues such as confidentiality, anonymity and informed consent need to be addressed. Permission, in writing, was obtained from the headmasters of the two schools concerned (see annexures C and D), and consultation with the teachers, who would be participating in this study, took place. They were assured that confidentiality and anonymity would be maintained throughout the study, and that this would also hold fast for the analysis and writing up of research. Recordings of interviews would remain in the possession of the researcher and shall not be made available to anyone not directly connected to the research project itself. In addition, I obtained the consent of both the pupils and their parents or guardians by sending a letter to each with an attached reply slip (see annexure F), explaining the nature of the project and assuring them of confidentiality and anonymity and that, as was the case with the participating teachers, recordings would not be made available to anyone not directly involved in the project itself. I received a hundred percent return rate from School A, while 95% of the learners in School B returned their permission slips.

3.9 Conclusion

In this chapter I have considered a number of aspects pertaining to my research, and elucidated each to a greater or lesser degree. I believe that by being transparent about the processes involved in conducting this case study, and explaining such, my research might contribute to the VITALmaths project in particular, and educational research in general.

CHAPTER 4

ANALYSIS AND DISCUSSION

4.1 Introduction

In this chapter I shall focus on the analysis of the data I collected during my research into the use of VITALmaths video clips in teaching mathematics, and present a discussion on my findings. As I conducted my research in phases, I have retained a similar framework in this chapter.

Prior to conducting my research I obtained permission from the principals of the relevant schools (annexure F), both of whom were happy to acquiesce to my request. In addition, I visited all three classes of Grade 9 learners to explain the project to them and to give them the letter and reply slip to be signed by their parents or guardians (see annexure G). Iobtained permission from the all parents of the learners in school A to participate in the project, while there was a 95% return rate of permission slips from learners in school B. I was therefore able to exclude, from the project, those learners whose parents did not respond.

4.2 Phase 1: Teacher Workshop

This phase consisted of a workshop during which I outlined the VITALmaths project to the two participating teachers, showing them how to download the video clips onto their cell phones before considering which video clips they would prefer to use in their teaching. This process necessitated careful consideration of the content of the video clips as all three of us considered it not to be in the learners' best interest if we used clips which did not reflect material relevant to Grade 9.

Teacher A is fortunate in that his classroom is equipped with an interactive whiteboard incorporating data projector and computer with internet access, so he felt that this would probably be a better way to allow the learners to view the clips and engage with them.

Teacher B was content with the idea of downloading the video clips onto his phone, and allowing his learners to do the same on their phones, but expressed some concerns regarding the availability of cell phones among his learners, and also that the screen size of the cell phones might make the clips harder to view. I decided to address these fears during the semi-structured interview I was to conduct with him in Phase 2 of my research.

In terms of the actual video clips to be used, we eventually decided to make use of two video clips, both of which tied in well with the Grade 9 curriculum statement (South Africa. DOE, 2002).

The first video to be used would be *Rectangular Products* (http://www.ru.ac.za/vitalmaths/) as this video deals with basic skills such as multiplying two digit numbers using rectangles to represent the products. Teacher A felt that, apart from encouraging learners to do calculations without resorting to calculators, this clip would also help his learners with calculating area of shapes, especially if one incorporated shaded areas into the rectangles. Teacher B, on the other hand, saw the possibility of using the video clip as an extension to the teaching of algebra, mentioning one of the Grade 9 Assessment Standards which states that learners need to be able to use "the distributive law and manipulative skills developed in Grade 8 to find the product of two binomials" and "factorise algebraic expressions (limited to common factors and difference of squares)." (South Africa. DOE, 2002, p. 79) I, in turn, felt that one of the possibilities would be to use this clip to see if it could help learners develop an understanding of factorisation, as opposed to multiplication alone.

As the curriculum statement clearly states that learners must be able to "use transformations, congruence and similarity to investigate, describe and justify (alone and/or as a member of a group or team) properties of geometric figures and solids" (South Africa. Department of Education [DOE], 2002, p. 83), the second video clip we decided to use was *Hubcap Geometry*. Teacher B commented that, in his opinion, this clip could be fun for the learners as they would be able to find examples of such transformations in the vicinity of the school.

It was interesting to note during this workshop that the two teachers are fully conversant with the Revised National Curriculum Statement (South Africa. [DOE], 2002) and the assessment standards for Grade 9, as neither of them needed to refer to said Statement or to their textbooks.

During this workshop, which I did not videotape, I made detailed notes, highlighting certain questions to ask the two teachers during the interviews which followed in Phase 2. I was careful not to prescribe to them how they should use the video clips in their lessons, as part of my research goal was to consider when or how they could incorporate the video clips into their teaching practice; and colouring this with my own beliefs would minimise the importance thereof.

4.3 Phase 2: Semi-structured interviews

This phase of my research consisted of a semi-structured interview with each of the teachers concerned. These interviews were recorded and transcribed, with Teacher A's interview conducted in English as that is his mother tongue, while Teacher B's interview was conducted in his home language, Afrikaans. I have highlighted certain questions I addressed to both teachers and their answers, and where the latter have been taken directly from the transcripts, I have coded them as 'A' for Teacher and 'B' for Teacher B.

Question 1: What are your feelings toward the possibility of using cell phone technology as an educational tool, and allowing your learners to use their phones during mathematics lessons / *Hoe voel u oor die moontlike gebruik van selfoontegnologie as 'n opvoedkundige bron, en toe te laat dat u leerlinge tydens wiskunde lesse hul selfone gebruik?*

Both teachers seemed to believe that cell phones do have potential in this regard, and have used their phones regularly to access sites such as Google, or to download email. However, each school has strict rules pertaining to the use of cell phones at school. School A allows learners to have their cell phones with them, but insists that these be switched off during class time and prohibits the use thereof within the school buildings. Learners who break these rules usually have their phones confiscated and stored in the school strong-room until the first Monday following the infringement. School B tends to discourage learners from bringing cell phones to school with them and also does not allow the use of phones in class. Infringers are usually given detention as punishment.

Teacher A said he would allow the learners to download the video clips from the VITALmaths website, but expressed concern that learners would ignore the clips and would visit social networking applications like MXIT or Facebook instead of doing the work or paying attention to the lesson. He said he would feel far happier if he were allowed to use the interactive whiteboard to show the videos, and incorporate them into his lesson via that medium, as he had a reputation for being strict on learners who break the rules. As I could identify with this from my own experience as a teacher, I could see no reason why he should not follow this route, and that is precisely what he subsequently did.

Teacher B was worried about the lack of cell phones among his learners and was not sure how to overcome this potential problem. I suggested he wait until he had handed out the questionnaires from Phase 3 to the learners and collected them, and we then consider how many learners had access to cell phones and take it from there. Kreutzer (2009) had discovered in a survey among low-income youth in Cape Town that the majority of them had access to cell phones, SIM cards and air-time, so I was interested to see what the outcome would be in this school. He seemed rather keen on the use of cell phones by the learners, stating that this might encourage them to enjoy the lessons and "…*dalk vir 'n verandering aandag te gee aan wat ek in hul koppe probeer kry. Mens staan en verduidelik en verduidelik, en dan gaan die kinders huis toe en as hulle die volgende dag terugkom, dan is die huiswerk deur sommige kinders nie gedoen nie, want hulle het kwansuis 'nie verstaan wat om te doen nie'. Of ek word soms beskuldig dat ek die werk nie ordentlik verduidelik het … "Meneer het my heeltemal deurmekaargemaak met Meneer se verduidelikings" is een van hul klagtes* (…pay attention, for once, to what I am trying to get into their heads. I stand and explain over and over, and the children go home and when they return the next day, some children's homework is not done, because they apparently 'did not understand what to do.' Or they sometimes accuse me of not explaining the work properly… 'Sir, your explanations muddled me up completely' is one of their complaints)" (B, lines 34 to 37).

He also felt that the learners might view the use of cell phones in class as something to be proud of but, like Teacher A, was concerned that they might not restrict themselves to viewing only the video clips during class – "*Mevrou weet mos hoe is vandag se kinders – altyd besig met MXIT en Faceboek en sulke dinge* (Ma'am, you know what today's children are like – always busy on MXIT and Facebook and things like that)" (B, line 71). I must admit that I had the same concern, but felt that I would rather wait and see what happened in my own lessons, and would tell my learners beforehand that I expected them to be fully involved in the video clips and not to go onto MXIT or visit Facebook during class time.

Another misgiving expressed by Teacher B was the fact that these clips had not yet been translated into Afrikaans, but were only available in English and isiXhosa. However, he said that this could perhaps work in his favour to a certain degree, especially with the Xhosa speakers in his class who already find it difficult to speak, read and understand Afrikaans, and that he would translate verbally for the Afrikaans-speaking learners where necessary.

Both teachers also wondered whether the learners might not find it difficult to view the video clips on their cell phones as the screens are rather small. I suggested that we wait and see if any of the learners raise this matter as, interestingly enough, Prensky (2003) was quick to state the following when it comes to the screen size of cell phones:

> (Y)ou may be thinking "it won't work – the screen is too small." You are wrong. As you may have noticed, today's "Digital Natives" do just fine with the Game Boy, thank you, without complaining – and there are 150 million of those devices around the world. Having grown up with this size, they think it's the way screens are, and should be. (p. 4)

Question 2: What are your beliefs in terms of teaching mathematics and what methods do you use to teach / *Wat glo jy ten opsigte van wiskunde-onderwys en watter metodes gebruik jy tydens onderrig?*

What intrigued me somewhat were the differing opinions of the two teachers when it came to teaching mathematics. Teacher A firmly believes in combining teacher explanations with allowing learners to discover mathematics in an exploratory fashion, and letting them construct their own learning through investigations and the like. As he says: "Learners should be allowed to carry out self-exploration and in this way link concepts to each other. I like to build on one concept that is well understood by the learners, for example the area and perimeter of squares and rectangles, and use that to lead to the area and circumference of the circle" (A, line 24). He also thinks that learners need to move away from seeing mathematics in isolation from everything else. "They should start associating mathematics concepts with everyday experiences. It is important to use contextual questions and then to break them up in parts and work through them" (A, lines 30 & 31).

Examples of teaching strategies he has employed in the past include, for example, using the game of battleships to help learners come to grips with ordered pairs and Cartesian planes. He also believes that, in mathematics, there needs to be a "constant reinforcement of terms and concepts to ensure learners understand the work" (A, lines 33-35).

Teacher B does not spend much time allowing his learners to explore, citing lack of resources as one of the biggest hurdles to overcome. "*As ek projekte of ondersoeke vir die kinders wil gee, moet ek sorg dat hulle alles neerskryf want ons het nie genoeg papier vir fotostate nie. Baie van hulle het ook nie geld vir extra papier en karton om projekte mooi te maak nie, en daar is nie altyd tyd om dorp toe te gaan om in die (Dorps-)Biblioteek navorsing te doen nie* (When I give the children projects and investigations to do, I have to ensure that they write everything down as we do not have enough paper to make photocopies for them. Many of them also do not have money to buy extra paper and cardboard to beautify their projects, and they do not always have enough time to go to town to do research in the (Town) Library)" (B, lines 21 – 25).

He also tends to explain the work and then give homework, and appears to be a disciplinarian who does not tolerate misbehaviour. *"As ek les gee moet die kinders stilbly en luister en hulle gedra, want daar moet orde in die klaskamer wees. Maar ek gee ook kans vir vrae as hulle nie mooi verstaan nie* (Children should be quiet and listen and behave when I am teaching, as there has to be order in the classroom. However, I allow them to ask questions if they don't understand,)" (B, lines 30 to 31).

Question 3: What are some of the challenges you face in teaching mathematics / *Watter soort uitdagings staar jou ten opsigte van wiskunde-onderrig in die gesig?*

Teacher B highlighted one problem he faces on a daily basis – that of the Language of Learning and Teaching (LoLT). "*Onse kinders word in Afrikaans geleer, maar baie van hulle kom uit die township (sic) en praat Xhosa by die huis. Hulle Engels is maar bra power en hul Afrikaans bestaan amper nie eers nie, en ek sukkel partykeer so met die Afrikaans en Engels en Xhosa deurmekaar sodat hulle kan verstaan, maar dit gaan nie altyd te lekker nie. Baie van die swart ouers kan nie die fooie in die Model C skole bekostig nie, maar hulle wil ook nie hê hulle kinders moet township-skole bywoon nie, so hulle stuur dan hulle kinders na ons toe, wat ook nie so goed werk nie want hulle het nie in Afrikaans geleer nie* (Our learners are taught in Afrikaans, but many of them come from the township and speak Xhosa at home. Their English is rather poor and their Afrikaans almost non-existent, and I battle along in a mixture of English, Afrikaans and Xhosa to try and help them understand, but that is not always a success. Many of the black parents cannot afford the fees at Model C schools, so they send their children to us. This also does not work so well, because they have not been taught in Afrikaans) (B, lines 33 to 40).

Teacher A was in agreement: "The language barrier is a huge problem sometimes, especially with the Xhosa kids who do not understand English too well. Also, I have found that some of the Afrikaans-speaking learners also battle as there is a lot of English spoken in the classroom" (A, lines 39 to 41).

Another basic problem, according to Teacher A is the poor understanding some learners have of basics mathematical concepts, often "because they are passed on from grade to grade without mastering the necessary skills along the way, and a lot of time has to be spent on those learners who need remedial teaching" (A, lines 41 & 42). In addition, parents are reluctant to provide learners with basic mathematical resources like a calculator, maths sets, rulers, pencils, or learners tend to leave these items at home. "It makes teaching extremely difficult at times, because seven or eight people might on a certain day have left their stuff at home, which means constant borrowing from each other – very irritating, not to mention the attendant noise factor*"* (A, lines 42 to 44).

Question 4: If you could change anything about teaching mathematics, what would it be and why / *As jy enigiets betreffende wiskunde-onderrig kon verander, wat sou jy verander en hoekom?*

Teacher A would like to see streaming of learners into separate classes at school A according to mathematical ability. "At the moment there is no streaming, so you can end up with one child who gets 90% and one child who is scraping along with 10%. Then you have to spend time on remedial teaching on the 10 percenter, while they sits and gets bored. A lack of basic skills and knowledge compounds everything." (A, lines 45 to 47). He also mentioned the differing speeds with which learners grasped concepts, and said that this sometimes had a negative effect on learners. "The ratio of time spent on explaining concepts to learners understanding them is not constant for all learners, and brighter kids sometimes start playing up because they can't understand why some learners can't see what is very clear to them" (A, lines 48 to 50).

The number of pupils also has an effect on teaching and learning in the classroom, with Teacher A saying that, ideally, he would like to have about 24 learners in a class at any given time. "I have found classes of 32 or more are really hard to handle, as there is too little time to help everyone who has a problem" (A, line 51). Teacher B also mentioned class sizes: *"Ons het min onderwysers vir die aantal kinders hier. Ek het op die oomblik 37 en 42 kinders in mytwee wiskunde-klasse, en ek sukkel om almal op dieselfde vlak te hou. As een kind iets mis, dan val alles uitmekaar* (We have too few teachers for the number of children here. At the moment I have 37 and 42 children in my two mathematics classes, and it's a struggle to keep them all on the same level. If one child misses something, then it all falls apart)" (B, lines 46 to 49).

Both teachers feel that a lot more could be done to improve mathematics teaching and learning by the Department of Basic Education. "I would love," said Teacher A, "to take the guys who sit in their ivory towers and plan our teaching for us and put them into a Grade 9 classroom for a day or two – and then maybe they will plan things that we can actually implement in our classes, instead of the pie-in-the-sky plans they come up with," (A, lines 53 to 55). Teacher B was equally vociferous, reminding me how in 2010, just ten days before the Grade 9s were due to write the external June examinations the subject adviser had arrived at a moderation session with a new work schedule/pace setter for Grade 9, which had been changed from the one in 2009. None of the schools had been given the new schedule, with the result that learners in all the surrounding schools ended up at a disadvantage as work which should have been covered in the second half of the year, according to the 2009 schedule, had been moved to the third term in 2010 and appeared in the exam paper. "*Hierdie probleem kon maklik met die geringste moeite vermy geword het – ons kon self die goed by die Distrikskantoor loop haal het.* (This problem could have been avoided easily – we could have collected the stuff from the District Office ourselves)," he added (B, lines 52 to 53).

4.4 Phase 3: Learner Questionnaires

In Phase 3 each learner in each of the three selected Grade 9 classes was handed a questionnaire which needed to be completed before the teachers started using the video clips. I analysed the questionnaires before sharing some of the information, such as the availability of phones, with the teachers concerned.

A total of 87 learners participated in the VITALmaths project, split into three classes of 28 (my class), 24 learners (Teacher A's class) and 35 (Teacher B's class) respectively. Two of the learners in Teacher B's classroom did not return slips, so they were sent off to another venue with work to do. The reasons for not returning the permission slips were not clear, but the learners were excluded simply to avoid repercussions of any sort. Teachers A and B both teach two classes of Grade 9 learners, but decided to do the project in only one class each.

The questionnaire was divided into two parts, with the first part asking questions regarding ownership and use of cell-phones and the second part relating to learners' feelings about mathematics itself. Of the 89 learners, only 18 did not own their own cell-phones, and of these only 3 did not have access to a cell phone through a parent or friend (see figure 5 below).

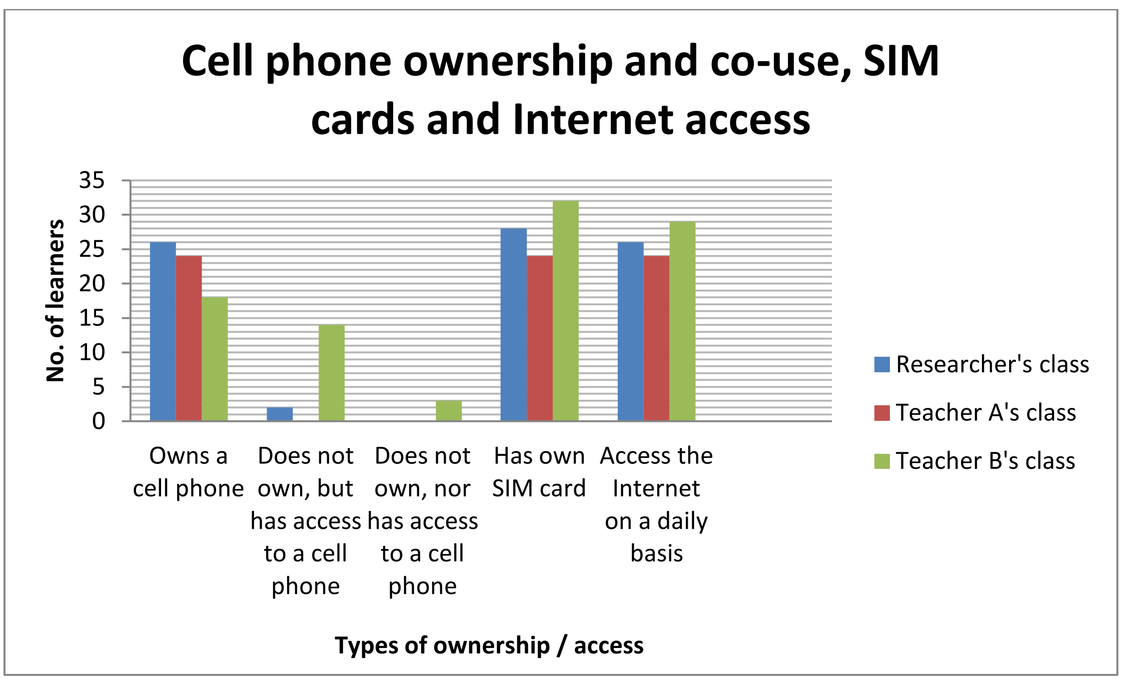

***Figure 5:* Ownership of and access to cell phones**

As Teacher B had expressed concern regarding access of his learners to cell phones, I was able to allay his fears by lending him three personal media players (PMPs) onto which the video clips had already been downloaded, so that the three learners without cell phones could watch the video clips and also participate in the lessons. The statistics as shown in figure 3 correlate with statistics from Kreutzer's (2009) research among learners from low income families, where he found that more than 80% of the respondents accessed the Internet on a daily basis, as do 85% of the learners participating in the VITALmaths project. Interestingly enough, if one looks at cell phone ownership and co-use in School B where, as in Kreutzer's (2009) study, most of the learners are from families of low socio-economic means, my questionnaires revealed close similarities to his project in that 83% of the learners either owned or co-used cell phones, while in Kreutzer's (2009) study this figure stood at 77%.

Most of the learners make use of prepaid airtime, spending an average of around R15 per week, while only 3 of the 87 learners have cell phones which are on contracts paid for by their parents. Some 52% of the respondents in my study subscribe to MTN, 27% to Cell C and 23% to Vodacom. Nokia handsets are the most popular (41%), closely followed by Samsung (33%), and only a few owning Blackberry Curve, Sony Ericsson and LG handsets (see figure 6 below).

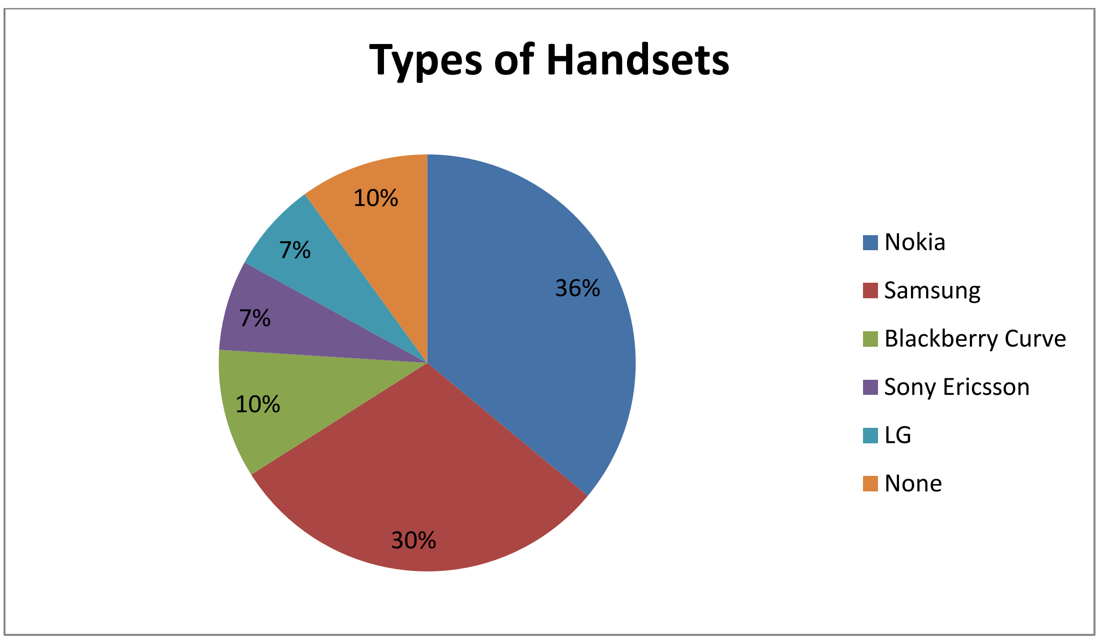

***Figure 6*: Types of handsets**

The learners were also asked to list what they used their cell phones for on a regular basis. The majority (85%) accessed the internet to chat to their friends via MXIT, while 37% downloaded music or videos. Around 30% used their cell phones to visit social networking sites such as

Facebook and 15% to play games (see figure 7). Non-internet uses (see figure 8) include making calls (56%), listening to music (44%), sending smses (30%) and taking photos (14%).

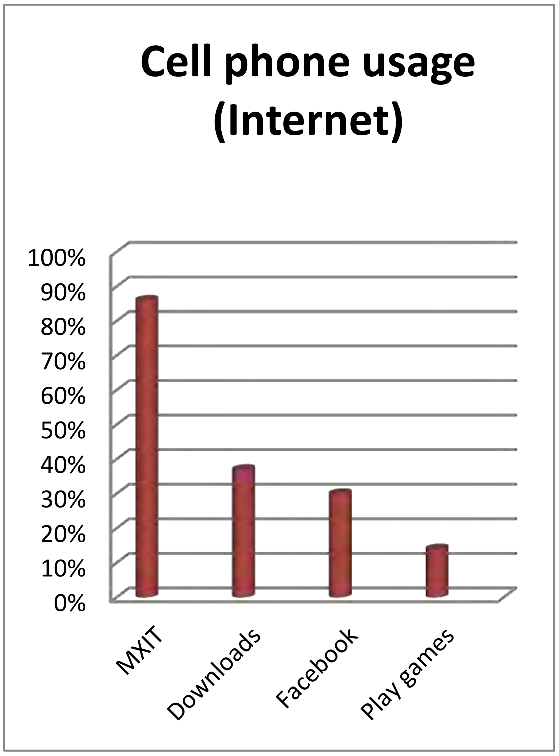

Figure 7: **Cell phone usage (Internet)**

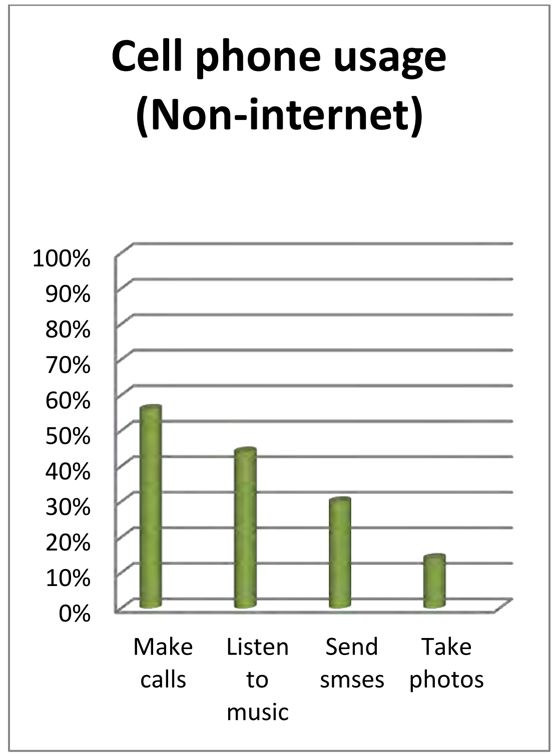

Figure 8: **Cell phone usage (non-internet)**

Looking at part 2 of the questionnaire provided some insight into the learners' feelings towards mathematics as a subject, with 61% of the respondents stating they liked mathematics a lot, 22% stating that they liked mathematics and 18% saying they did not like mathematics at all. Only 26% of respondents felt that they were good at mathematics, while 48% said that they were average and 27% said they were bad at mathematics. Some 42% liked algebra, 26% enjoyed geometry, 12% liked doing mental mathematics, 11% thought mathematical operations were fun, 6% decimals and 3% fractions. Areas of difficulty highlighted included algebra (54%), geometry (31%), exponents (12%) and equations (1%), while 1% of the respondents stated that they found everything too difficult

4.5 Phase 4: Classroom Observation

4.5.1 Researcher's class

Early on in the VITALmaths research project I decided that it would be a good idea if I carried out the same research in my own Grade 9 mathematics class, and decided to include myself and my own experiences in the case study as a third participant. I was interested and motivated to see how the VITALmaths video clips could be used in my own teaching, and decided it could be interesting to compare my experiences with those of the participating teachers. Fortunately the school at which I teach has closed-circuit television (CCTV) cameras in the classrooms, and I requested that the footage of the relevant lessons be downloaded to negate the need for someone to come in and film the lessons. In addition, the learners have become so used to having the CCTV cameras in the class that they were not likely to "play up" for the camera by showing h on the one hand or becoming extremely reticent and withdrawn on the other. I was then able to watch these recordings and analyse my own lessons.

I started off the lesson off by explaining to the learners where to find the relevant video clips on the internet, and letting them download the two video clips I and the other two teachers had decided to use as part of the project. I suggested they not look at the video clips until everyone had finished downloading them. Several learners experienced problems in downloading the clips, receiving messages like "file too large" and "format not supported". For once, however, a spirit of cooperation reigned in the classroom, with learners helping each other where necessary. Several learners sent the video clips to others who did not have airtime via bluetooth (a wireless method of transmitting data between portable devices such as cell phones and computers up to approximately 10m apart at a speed of up to 1 megabit per second, using radio waves in the 2.54 GHz frequency band – Haarsten, 1998). Two learners were unable to download the video clips at all, and they ended up watching the videos with two of their friends.

Once the video clips had been downloaded, I wrote on the blackboard and asked the learners how they would calculate the answer if they were not allowed to use calculators. The majority of learners seemed to think long multiplication would be the easiest route to follow i.e.

One learner objected, saying that this was incorrect, as one should split the numbers up into tens and units, and then multiply them, i.e.

This elicited quite a heated discussion as the rest of the class tried to point out why this learner's reasoning was incorrect, but he was unable to see why they were right and he was wrong. I then put a stop to this argument by suggesting we look at the video clip, *Rectangular products*, (http://www.ru.ac.za/vitalmaths). The learner who had come up with the wrong answer of 648 studied the video carefully and then clearly realized where his mistake was as, after a moment or two, asked if he could show everyone what he had done versus what he should have done. I found his explanation interesting, as he wrote the following on the board, explaining as he went along (see figure 8):

X ✓

"When I split up the numbers, I just multiplied the tens by each other and then the units by each other, and added them together. What I should have done after that was to cross-multiply as well, like this, and I would have ended up with 600 +180 + 160 + 48, which equals 988!"

***Figure 8*: Learner correction of mistake**

There were a few other learners who did not seem to agree with the rest, preferring to check the answers on their calculators. However, I told them to wait while I handed out squared paper. I asked all the learners to watch the video clip again, if necessary, and then to copy what they had seen in it onto the squared paper. Once they had done so I suggested they count the blocks in each of the smaller rectangles within the bigger rectangle to check whether or not everyone else was right and if the answer was, in fact, 988.

One of the learners experienced a great deal of difficulty so, while I helped him figure out how to draw the rectangles, I suggested the rest of the class find out if the same method could be used for three digit numbers, such as . While they were busy I had to help another learner who could not see that Eventually I made her physically count the blocks in that specific rectangle of the ones she had sketched, in rows of 20, before she finally saw her mistake.

Most of the learners split the three digit numbers into and, as a result, experienced some difficulty in calculating the correct answer. Then one of them suggested splitting the numbers into hundreds, tens and units and before long a number of learners were working the answer out on paper while others worked on graph paper, carefully counting blocks and drawing precise rectangles before working out the answer.

During the next lesson I encouraged the learners to watch the same video once more to refresh their memories and then I wrote on the board. Immediately approximately two-thirds of the class groaned and made comments like, "Oh, no – not algebra, please," and "I hate using **FOIL**" (referring to a method of multiplying binomials by finding the sum of the products of the **F**irst, then the **O**uter, then the **I**nner and finally the **L**ast terms together – Simmons, 2011). However, a learner asked if she could come up to the board and show the class that it was actually very easy if the method used in the video clip was followed. She rapidly drew the necessary rectangles on the board and filled in the equation and the answer as shown in figure 9 below:

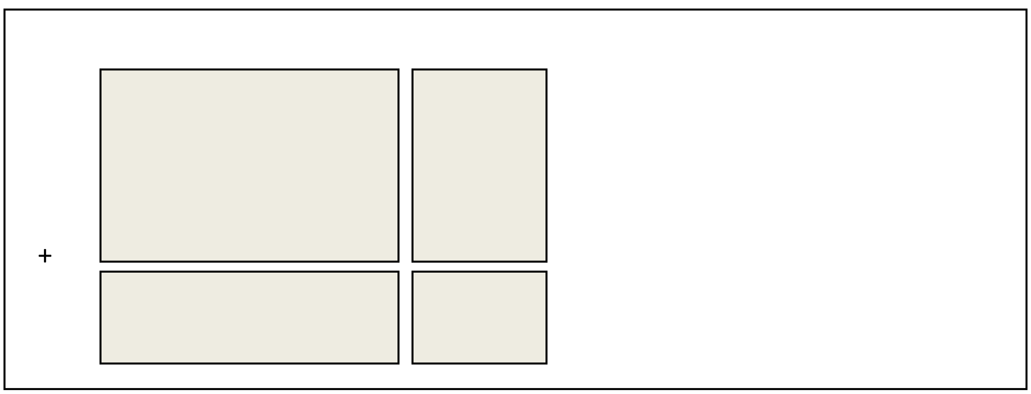

***Figure 9*: Using the *Rectangular Products* video clip to multiply binomials**

The rest of the class took a few moments to absorb what she had done, and they seemed to start getting the idea. I wrote a number of pairs of binomials on the board and suggested they try multiplying them, using whatever method they found easiest. I noticed that several of the stronger learners were quite happy working out the answers without using rectangles, but a number of learners who seem to freeze up when faced with anything vaguely algebraic were engrossed in trying this new method. I noticed two learners at the back of the classroom who were studying their cell phones and, afraid that they might be doing other things like chatting on MXIT, I went across to check up on them. However, they were merely watching the video clip again, as one explained, "..*om seker te maak, Juffrou, dat ons dit reg doen en nie verkeerd nie* (to make sure, ma'am, that we are doing it correctly and not incorrectly)! I cannot say with confidence that all learners were watching the videos and not chatting on MXIT on their phones at some point during the lessons, but it would appear from their behaviour in general that they were mostly paying attention to the video clips.

Towards the end of the lesson I asked various learners to give the answers to the multiplication of the pairs of binomials I had given them earlier. I was pleased when several of the learners who I knew had yet to arrive at the correct answers for these types of question had actually done so. Their delight was also evident, and what was even more surprising was the request from the class to give them some more questions for homework!

One of the intentions behind the VITALmaths video clips is to encourage further exploration of mathematical ideas by teachers and learners. While I was going through some of the work my learners had done during the previous lessons, I came across the following successful attempt by a learner to multiply two four-digit numbers with each other using the method shown in the *Rectangular Products* video clip (see figure 10 below). She explained that she had first multiplied two three-digit numbers together, and then decided to try the same method with two four-digit numbers. She commented that it was actually relatively easy to use this method without resorting to the help of a calculator, although she had used one to check the answer afterwards.

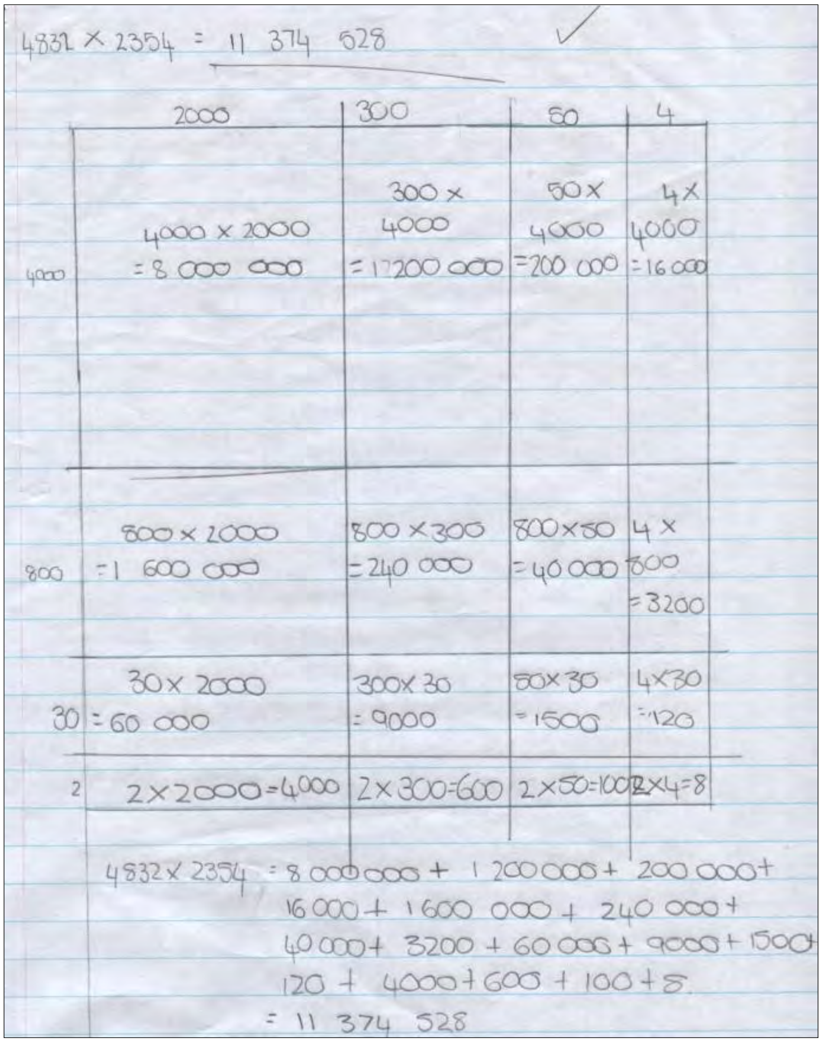

Figure 10: **Learner's application of *Rectangular products*' method when multiplying two four-digit numbers together**

According to Larrivee (2000) "self-reflection involves developing the ability to look at what is happening,withholding judgment, while simultaneously recognizing that the meaning we attribute to it is no more than our interpretation filtered through our cumulative experience" (p. 298). However, she posits that because one's own values often become a lens through which to observe what is happening in the classroom, it is not easy to take an objective stance when reflecting on one's teaching, as "critical inquiry involves the conscious consideration of the moral and ethical implications and consequences of classroom practices on students" (p. 294).

Bearing this in mind, I therefore attempted to critically analyse and reflect on my own teaching during the two lessons, using the Flanders' Interactional Analysis Category System (FIACS) observation schedule (see annexure C) adapted from a matrix drawn up by See and Lim (2006). The results of my observations appear in Table 2 below:

Table 2 FIACS Observation results: Researcher

<table>
<tr><th></th><th></th><th>Behaviour observed</th><th>Frequency</th></tr>
<tr><td rowspan="7">Teacher Talk</td><td rowspan="4">Indirect influence</td><td>Teacher accepts feelings</td><td>4</td></tr>
<tr><td>Teacher praises or encourages</td><td>13</td></tr>
<tr><td>Teacher accepts or uses ideas</td><td>6</td></tr>
<tr><td>Teacher asks questions</td><td>5</td></tr>
<tr><td rowspan="3">Direct influence</td><td>Teacher lectures</td><td>1</td></tr>
<tr><td>Teacher gives direction</td><td>3</td></tr>
<tr><td>Teacher criticizes or justifies authority</td><td>2</td></tr>
<tr><td colspan="2" rowspan="2">Learner talk</td><td>Learner responds verbally to teacher</td><td>5</td></tr>
<tr><td>Learner initiates talk with teacher</td><td>6</td></tr>
<tr><td colspan="2">Silence</td><td>Learner remains silent, confused</td><td>1</td></tr>
</table>

(Adapted from See and Lim, 2006)

I discovered that I tend, more often than not, to influence the learners indirectly by praising and encouraging their actions and behaviour, by accepting or using their ideas to build on the concepts under consideration and by asking questions about content and procedure. Direct influences on the learners such as lecturing, giving directions and criticising appeared less often, while learner-initiated talk and learner response to questions occurred with approximately the same frequency. The learners were only silent while watching the videos, and there appeared to be little confusion where it was not possible to understand what I was saying to the learners. It would seem to me that when using the video clips in class it might be to the learners' advantage to try and influence the children indirectly rather than directly in order to allow them to use the video clips to enhance their learning.

The video clip was used approximately 10 minutes after the start of the lesson, and learners were not restricted thereafter to viewing the clip at any specific time during that lesson or the next. I felt that this would perhaps encourage them to view the clips outside of school hours which, in turn, might lead to further exploration on their part. It will be interesting to see when I analyse their essays in Phase 5 whether or not this did, in fact, happen.

Because of time constraints I did not use the *Hubcap Geometry* video as part of my own teaching analysis for this project, preferring to point learners towards it when we revised transformational geometry towards the end of the last term of the year.

It struck me at some stage that the learners seemed to exhibit an almost conspiratorial air whenever they came into my class, and when asking them why this was so, received the answer that they felt most important because cell phones may not be used in class, or anywhere in the school buildings, but in the maths class they are allowed to break the rule with impunity – something they really appreciated!

4.5.2 Teacher A

The lessons of Teacher A which I observed for the VITALmaths project differed somewhat to mine, although it seems we share the same beliefs – we both tend to lean more towards constructivist teaching principles rather than behaviourist principles. We both believe, too, that learners need to understand one concept well before trying to build knowledge on top of that concept.

Teacher A started his lesson by showing the learners how to download the video clip, *Rectangular Products,* by opening the website http://ru.ac.za/vitalmaths/ on the interactive whiteboard. This made it much easier for the learners, as they merely needed to copy what Teacher A was doing. He pointed out that they needed to download the video clip onto their cell phones using the format for *Mobile* in English, while he downloaded the *PC* version from the website. He also directed them to download the video clip, *Hubcap Geometry*, while he did the same. As had happened in my class, some learners experienced difficulties in downloading the video clips, but most of these problems were overcome through the use of bluetooth. Teacher A then suggested they all watch the entire *Rectangular Products* video clip on the interactive whiteboard before continuing with his lesson.

He then proceeded to ask questions about what they had noticed happening in the video clip, asking individual learners for their response. There was a noticeable order in the classroom, with learners replying when addressed directly, and others putting their hands up to respond. He then handed out squared paper and suggested they choose any two two-digit numbers and, using the system shown in the video clip, work out the answers. While they were working, he moved around the classroom, encouraging learners to view the video clip again (he had "looped" the video clip so that it repeated continuously on the interactive whiteboard) when he noticed that they were experiencing difficulty.

He then sketched a shaded rectangle on the blackboard (see figure 11) and asked the learners to calculate the area of the shaded rectangle, using the same method shown in the video clip:

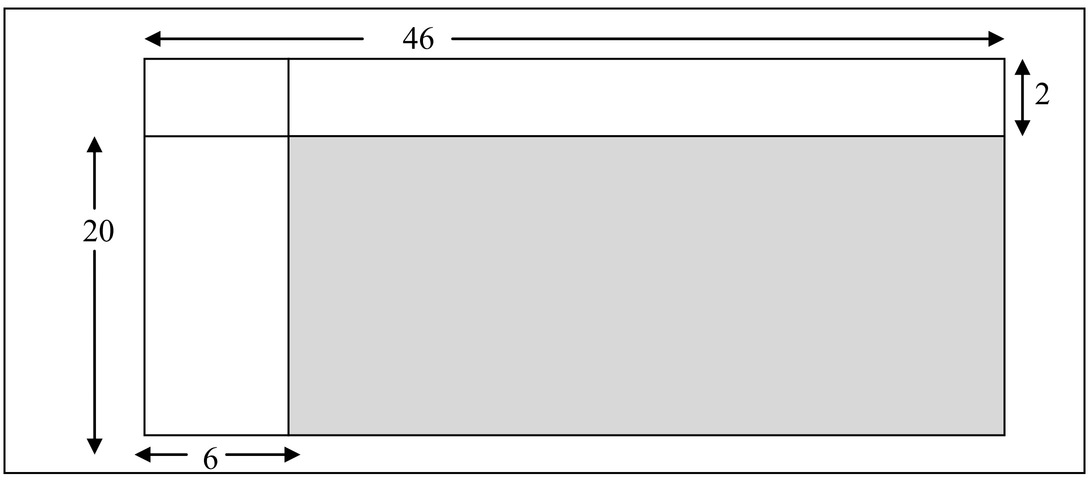

Figure 11 **Rectangle sketched by Teacher A during lesson**

The learners set to work, although one or two of them looked rather puzzled until he suggested they take another look at the video clip before they attempt the question. One learner kept muttering to himself, "I don't get it, I just don't get it." Teacher A then asked another learner to help him, and with what seemed like great patience, the second learner explained to the first learner until he managed to produce a sketch and a calculation. It was not clear whether the first learner really experienced problems in terms of understanding, or if he just did not feel like thinking for himself, although Teacher A suggested that it might well be the latter! When the bell rang the learners were told to complete the calculation of the shaded area for homework if they had not already done so.

At the beginning of the next lesson Teacher A spent a few minutes recapping the previous lesson, before calling up a learner to come up and demonstrate how she had calculated her answer, telling her she could write over his sketch. She did the following (see Figure 12):

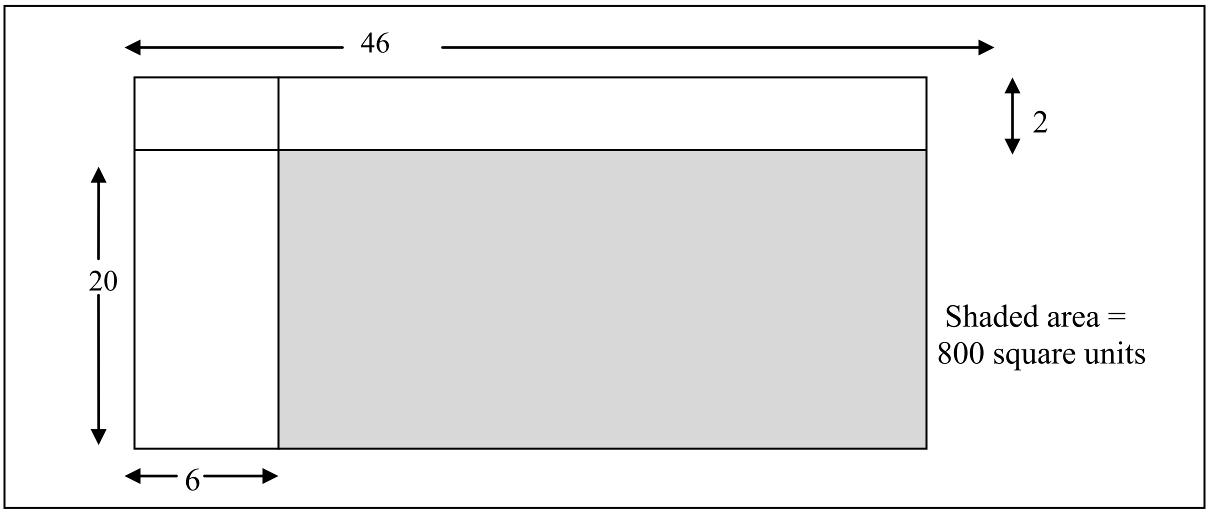

***Figure 12*: Learner's calculations**

Another learner put her hand up and said, "Sir, that's too long. All you have to do is just calculate the shaded area by saying that 40 x 20 equals 800 – you don't have to calculate all the other areas as well."

Teacher A then asked the learners if anyone could calculate the area of the non-shaded parts of the rectangle. "That's easy," replied one. "You just add 12 + 80 + 120 and you get 212 square units!" There was murmured assent from the rest of the class but a learner raised her hand and said, "There's an even easier way. Just take minus and you come up with the same answer – just one calculation, instead of three or four!"

Teacher A gave out a classwork exercise dealing with calculation of shaded areas of various shapes, and moved around checking on what learners were doing. He suggested they refer back to various formulae in their text books where necessary, and combine that with what they had learned with the help of the video clip in order to complete the exercise.

My observations of Teacher A's interaction with the learners in his class and *vice versa*, according to the FIACS observation schedule, resulted in the following results table:

Table 3 FIACS Observation results: Teacher A

<table>
<tr><th></th><th></th><th>Behaviour observed</th><th>Frequency</th></tr>
<tr><td rowspan="7">Teacher Talk</td><td rowspan="4">Indirect influence</td><td>Teacher accepts feelings</td><td>1</td></tr>
<tr><td>Teacher praises or encourages</td><td>2</td></tr>
<tr><td>Teacher accepts or uses ideas</td><td>2</td></tr>
<tr><td>Teacher asks questions</td><td>11</td></tr>
<tr><td rowspan="3">Direct influence</td><td>Teacher lectures</td><td>0</td></tr>
<tr><td>Teacher gives direction</td><td>4</td></tr>
<tr><td>Teacher criticizes or justifies authority</td><td>1</td></tr>
<tr><td colspan="2" rowspan="2">Learner talk</td><td>Learner responds verbally to teacher</td><td>9</td></tr>
<tr><td>Learner initiates talk with teacher</td><td>4</td></tr>
<tr><td colspan="2">Silence</td><td>Learner remains silent, confused</td><td>1</td></tr>
</table>

(Adapted from See and Lim, 2006)

It was interesting to note the link between Teacher A's beliefs in allowing learners to explore concepts and construct their own meaning, as espoused during the semi-structured interview prior to the observation lesson, and his practice in the classroom. This is especially noticeable in terms of the frequency of questions asked regarding either content or procedure and the number of times learners responded to him, offering answers to his questions, as well as the total lack of "lecturing" on his part. However, learners only occasionally initiated talk with the teacher, working in silence for most of the time and hardly talking to each other. One reason for this could be that Teacher A's learners hold him in high esteem and their respect is evident in their behaviour – the other reason could have been my presence together with a video camera. I noted later in his journal that Teacher A mentioned that the reason for this behaviour was the latter, and not the former! On the only occasion where silence on the part of the learner indicated confusion, he quickly drew in a peer to help, which seemed to solve the problem.

Unfortunately Teacher A was unable to present a lesson on the second video clip, *Hubcap Geometry*, within the time-frame of the research as he had to take family responsibility leave for the birth of his son, and a few days thereafter the mid-year exams started. That being said I was still able to analyse his teacher's journal and his learners' reflective essays (Phase 5) as well as conduct a follow-up interview with him (Phase 6).

4.5.2 Teacher B

In the case of Teacher B I was able to observe and videotape three of his lessons, two dealing with the first video clip, *Rectangular Products*, and one with the second, *Hubcap Geometry*. I also visited his class prior to the observation lessons to collect the learners' permission slips and questionnaires. I analysed the latter to determine whether or not cell phone handset access was a problem, but found that there were only three learners who did not have any access at all, and as mentioned previously, I lent him three personal media players (PMPs) I had sourced from my family with the video clips already downloaded on them.

Teacher B started the first observation lesson by explaining to the learners how to go about downloading the two video clips from the dedicated website, http://ru.ac.za/vitalmaths/. He also suggested to the Xhosa-speaking learners that they download the isiXhosa version if they preferred, and explained to the Afrikaans-speakers that he would translate the English text into Afrikaans if necessary. While the learners were doing this he walked around the classroom, checking on them and helping where necessary. When a couple of learners could not download the video clips, I stepped out of my role as observer and helped them use bluetooth to send them to each other and, in one case, to move a SIM card to another phone, downloaded the clips onto it and then return it, whereupon the learner was able to view the video clips. One learner had a cell phone that just would not download the video clips, despite us trying various methods, so she then joined up with another learner who was using a PMP, after which I returned to filming the lesson.

As the learners downloaded the video clips they were instructed to watch the first video clip, *Rectangular Products*, very carefully. There was quite a buzz in the classroom at first as learners downloaded and watched the video clip. After a while, Teacher B called the class to order and started questioning them about what they had seen. Answers flew thick and fast as the learners seemed somewhat excited at this rather different way of doing mathematics, and Teacher B had to step in to quieten them several times. He also apologised once or twice to me for the noise, but I reassured him that I was not there to criticise his teaching or his learners, but rather to observe both.

The problem caused by the lack of resources in this class was soon evident when it came to copying the method used in the video clips onto paper by the learners. Teacher A and I were able to photocopy squared paper for our learners, a privilege not afforded to Teacher B, and his learners had to draw their own squared paper in their workbooks. This took quite a long time as only some learners had rulers and pencils or pens and passed them to each other once they had finished. Several learners drew their squared paper freehand, which was also not ideal. However, everyone seemed to be enjoying themselves, and Teacher B moved around from desk to desk, checking on and helping learners where necessary.

Once they had drawn a page of squared paper, Teacher B divided them into groups and gave each group a different set of two-digit numbers to multiply, using numbers between 10 and 20 so that learners would be able to fit their rectangles onto the hand-drawn squared paper. He also instructed them to count the squares while drawing the rectangles, and then to obtain the answers by finding the area of each of the four rectangles in squares. He also told the learners that they needed to work out their question on another page in order to check that they had the correct answers. As the bell had rung, signalling the end of the lesson, it was decided that I would return to observe his class the next day when he would continue the lesson.

When I arrived for the next lesson Teacher B had the learners hard at work drawing sets of four rectangles in their workbooks, dispensing with the squared paper altogether. Once each learner had completed three sets of four rectangles he recapped the previous day's lesson briefly, going over what they had done by asking each group for their homework answers and checking that they were correct. He then asked them all to view the video clip again to refresh their memories.

Some learners had not been able to bring borrowed handsets with them, but the others shared with them so nobody was left out.

Teacher B then told the learners to write across the top of one of the sets of 4 rectangles, and down the side. He then gave everyone 5 minutes to work out the answers using the same method as the previous day, and told them to raise their hands as soon as they had done so. As soon as the hands went up, he would move to each desk and check the learner's answer and either praise them or tell them to try again. After a couple of minutes he told everyone to stop what they were doing and pay attention as he had picked up a mistake that a number of learners were making. He then drew a set of rectangles on the board and added in the equations (see figure 13):

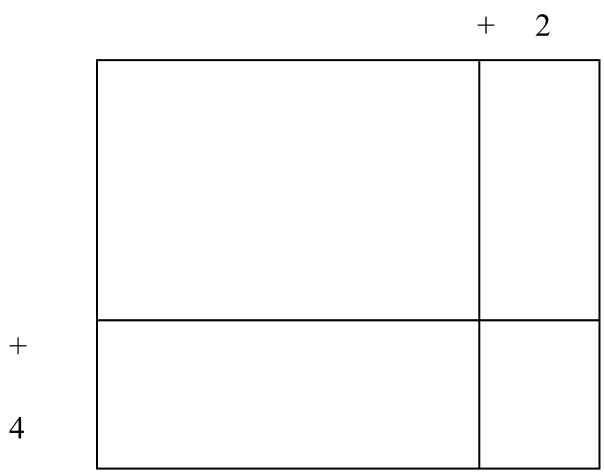

Figure 13 **Teacher B's sketch done on the blackboard**

He then asked one particular learner what was and she answered, " , *meneer* (sir)". Several of her classmates told her she was wrong, but Teacher B quietened them and asked the learner if she were aware that the answer was actually . When she, and a couple of others who had made the same mistake, looked rather blank and clearly puzzled, he said, "*Kom ons vervang gou die letter met 'n getal soos 4* (let's replace the letter with a number like 4). He then wrote the following on the blackboard: , followed by "*Kan julle nou sien hoekom* ? (Can you see now why ?). He then went on to give them a number of binomials to multiply, and moved around the classroom constantly to monitor what the learners were doing and if they were on the right track. When the bell went for the end of the lesson he dismissed them, telling them they would continue the next day.

The third lesson I observed took place a few days later. Teacher B had already started teaching using the second video clip, *Hubcap Geometry,* the previous day, and this lesson was thus a continuation of that lesson, and Teacher B explained to me how he had gone about incorporating the video clip, into his lesson. After viewing the video clip at the start of the lesson, his learners had been sent outside into the school grounds and its immediate surrounds to find examples of rotational and reflectional symmetry, and to sketch the examples into their workbooks. They then returned to class before sharing their drawings with their peers and indicating whether they contained reflectional or rotational symmetry.

I moved around the class to film some of the sketches, and noticed that, while some learners had merely copied the hubcaps from the teachers' motor vehicles, others had gone to some trouble to find more unusual examples. Two learners had walked across to a nearby house that had an old-fashioned front door decorated with yellow stained glass panels and including a rotational pattern of blue diamond shapes as may be seen from the sketch in figure 14 below:

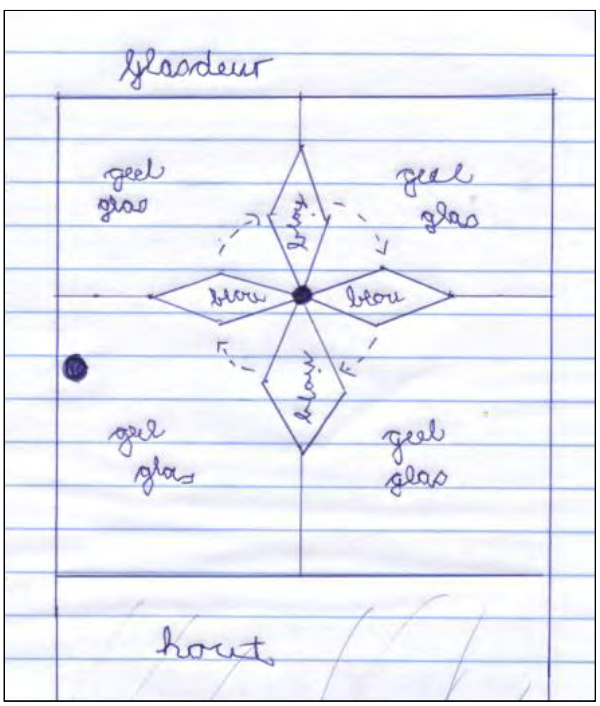

***Figure 14*: Scanned copy of a drawing of the top section of a stained glass door showing rotational symmetry, sketched by a learner from School B and taken from her workbook**

One of the two learners very proudly pointed out that the stained glass section of the door also held reflective symmetry: "*Sien juffrou, as mens 'n lyn in die middel van bo na onder trek, dan is die linkerkantste helfte'n spieëlbeeld van die regterkantste helfte, en dieselfde gebeur as mens 'n reguit lyn dwars deur die middel van links na regs trek. Slim, né!* (Look, ma'am, if you draw a line straight down the middle from top to bottom, the left hand side is a mirror image of the right hand side, and the same happens if you draw a line through the middle from left to right. Clever, hey!)"

Teacher B then asked the learners to write out the letters of the alphabet using capital letters in their workbook and tasked them with finding out which letters contained reflectional symmetry. He also instructed them to indicate the lines of symmetry with dotted lines, and to complete the task for homework. Once again I was reminded of the advantages of teaching in a well-resourced school, where one can save time by merely printing out the letters of the alphabet from a computer and photocopy enough copies for the learners to use.

Analysing Teacher B's interactions with his learners, and their interactions with him over the three periods I spent observing his class delivered the following results as summarised in table 4 below:

Table 4 FIACS Observation results: Teacher B

		Behaviour observed	Frequency
Teacher Talk	**Indirect influence**	Teacher accepts feelings	9
		Teacher praises or encourages	19
		Teacher accepts or uses ideas	10
		Teacher asks questions	24
	Direct influence	Teacher lectures	8
		Teacher gives direction	17
		Teacher criticizes or justifies authority	9
Student talk		Learner responds verbally to teacher	18
		Learner initiates talk with teacher	14
Silence		Learner remains silent, confused	5

(Adapted from See & Lim, 2006)

On the whole, the learners seemed to enjoy the lessons presented by the teacher, and it was interesting to note that, despite the fact that Teacher B said in his earlier interview that learners should remain quiet and well-behaved during his lessons although they would be allowed time to ask questions, he did not enforce this as much as I had expected. There was a fair amount of chatter and noise from learners during the lessons, although they were reprimanded on a number of occasions during each of the lessons I observed. Unlike Teacher A's class, they appeared to play up for the camera in the opposite fashion, showing off at times rather than being on their best behaviour.

Teacher B sappeared to welcome learner interaction, regardless of whether it is as a result of his questions, or initiated by the learners themselves. Although it is rather difficult to control a class of 35 learners and keep them occupied during the lesson, Teacher B's issuing of instructions during the lessons appeared to keep the class on track and, to a large extent, focused on the job at hand. In addition, his praise and encouragement towards the learners seemed to be fairly effective, and the learners were eager to show off their sketches done as part of lesson 3 to the camera.

In lessons 1 and 2, Teacher B used the video clip at the beginning of each lesson, while in lesson 3 he had used the video clip during a lesson prior to my arrival. He did not, however, place restrictions on viewing the video clips, but was happy to allow the learners to view them as and when needed.

4.6 Phase 5: Teacher journals and learner essays

For Phase 5 I collected the teachers' journals and the learners' reflective essays and used both to try and gain a clearer understanding of both the teachers' and the learners' experiences during Phase 4 of the VITALmaths project. Teacher A's journal contained only a few entries regarding his experience, as he had taught only one lesson, but Teacher B's was more detailed, and included some interesting comments.

4.6.1 Analysis of teacher journals

Teacher A detailed his experience from the week before observation took place and, although short, his comments contained a fair amount of insight. He mentioned in his journal that he thought the cell phone maths idea was a very good one, especially as he believed that learners have the ability to cope with modern technology, and that it was something they deal with on a daily basis in today's world. He did, however, mention that he thought that the collection of VITALmaths video clips should perhaps be expanded to include work aimed at the higher grades. As he wrote, "If there were video clips available to explain Grade 10 work, then learners could watch the explanation at home on computer or cell phone, and not come back to class having not tackled their homework at all."

He put a fair amount of thought into planning how to incorporate the video clips into his lesson, stating that he would, in all likelihood, get the learners to download the video clips at the start of the lesson so that they could view them later, and then let them use squared paper to copy what they saw. "Go on to doing other numbers, then to calculating shaded areas – leave out algebra," read the rest of his planning.

After his lesson he commented that it had gone off far better than expected, “Good thing the class was being video’d (*sic*) – for once the class behaved!” He also mentioned that perhaps it was a good thing if ways could be found to incorporate cell phone technology into teaching practice. “Perhaps this kind of thing could lead to the blurring of lines between ‘in school’ and ‘out of school’ and maybe we could get kids to view subjects like maths as something that is enjoyable, and not just to be endured for 45 mins every day,” he mused. “Could really make a difference!”

Teacher B’s journal contained a lot more in terms of planning and reflection than Teacher A’s, as he had planned and taught a total of four lessons. His planning was straightforward, and merely reflected what he intended doing and when. After each of the lessons, however, he reflected quite thoroughly, and mentioned what worked well and what did not work well. For example, one of his fears, shared by me and Teacher A, was that the learners would ignore the VITALmaths video clips and instead go on MXIT and chat. However, he noted, “*Kinders het my verbaas met entoesiasme vir video’s* (*sic*) *– was heeltemal opgewonde en het oor en oor daarna gekyk. Was verniet bang!* (Children surprised me with their enthusiasm for the video’s (*sic*) – were very excited and watched them again and again. Fears were unfounded!). He went on to say, as had Teacher A, that there might well be a place for cell phone technology in the classroom, “*Dalk kan ons die kinders oorreed dat Wiskunde nie so ‘n slegte vak is nie – veral as hulle sommer op hul fone kan saamkyk en werk* (perhaps we could persuade learners that mathematics is not such a bad subject – especially if they are able to follow on and work using their phones).

Another point he raised was the visual aspect of the video clips, “*Hou daarvan hoe die video’s* (*sic*) *eintlik uit prente bestaan – dink dit maak sulke dinge soos transformasie-meetkunde veral makliker om te verstaan. Moeilik om so iets in woorde te beskryf, maar wie sou nou kon raai ‘n doodgewone wieldop en ‘n paar lyne kan vir ‘n kind so ‘n moeilike idee so rotasie uitbeeld. En dan kan hy nogal sy eie voorbeelde op straat gaan soek – en kry!* (Love the way that the video’s (*sic*) are made up of pictures – think it makes such things as transformation geometry a lot easier to understand. Difficult to describe something like that in words, but who would have guessed that an ordinary hubcap and a couple of lines could illustrate a difficult idea like rotation to a child. And then he is even able to go and hunt for – and find – his own examples out in the street!)

Something that bothered him, though, is the lack of resources available in School B. "*As ek maar net sulke goed soos blokkiespapier en die letters van die alfabet en ander voorbeelde van transformasie-meetkunde kon fotostateer pleks dat die kinders dit self moet teken – sou baie tyd in die klas spaar* (If only I were able to photocopy such things as squared paper and the letters of the alphabet and other examples of transformation geometry instead of making the children draw them themselves – would save a lot of time in class.)

His closing comment at the end of his journal said it all: "*Ai, maar dit was nou vir jou 'n lekker ervaring – wens ek kon meer sulke goeters met my kinders doen* (Man, that was a really lovely experience – wish I could do more things like that with my children!)

4.6.2 Analysis of learners' reflective essays

Generally the learners' essays seemed to reflect their enjoyment of the VITALmaths project, especially the use of the "forbidden" cell phones during class. This could be seen in comments like: "The best thing is that we used our phones," and "It was cool we could use our phones – it made us feel like doing maths, as well as " Using cell phones in class was the best part of it!" and "Using my cell phone makes me pay more attention." However, one of the girls mentioned that "cell phone maths is the funniest thing I have learnt this year," which is not perhaps the intention behind the video clips. One learner made it very clear why he and his friends enjoyed the project: "It is in our comfort zone – as teenagers we are always on our cell phones and to use cell phones in the classroom will actually make us work harder….we will use any excuse to use our cell phones." Another learner agreed with him: "It does feel nice to use our cell phones in class because it makes us feel more comfortable and it feels modern, which makes us proud to have access to these things nowadays when people twenty years back didn't have access to cell phones."

As mentioned earlier, learners found it relatively easy to download the video clips or to bluetooth them to each other, and I was quite surprised at the spirit of cooperation that came to the fore in all three classes. Those learners who had airtime were quite happy to bluetooth the video clips to others, while some allowed their peers to use their SIM cards in their handsets to download the clips. When learners were unsure of how to go about downloading the clips, there seemed to be two or three others offering assistance: *"Ek het gesukkel in die begin want my foon* *wou nie so lekker werk nie, maar toe help Meneer my en ek het my SIM-kaart in my pêl se foon gesit en die videos gedownload* (*sic*) *en toe kon ek ook kyk* (In the beginning I struggled but then Sir helped me and I put my SIM card in a pal's phone and downloaded the videos and then I could also watch)."

Learners also found the videos fun to watch and easy to understand, with one young learner stating that: "It's not the type of video that puts you to sleep – it's fast and gets to the point quite quickly." However, his friend suggested that the videos could be made "livelier and more fun if they add some funky music to them," while another learner commented that "the explanations are easy and simple, and we can understand it (mathematics) better." One learner summed it up by stating: "I think if you do not understand something it is easier to watch a video than to learn from books," while another added: "When I don't understand something I can just quickly watch the video on my phone instead of having a lot of books on my table."

One learner suggested the videos could prove invaluable because "sometimes the teacher explains stuff that's like Greek to me and in that case I couldn't understand and I was like "say what?" to myself. Then I looked at the video again and I actually understood it and what the teacher said made sense!" Another advantage, in some of the learners' opinions, included the fact that the video clips could be accessed anywhere and anytime, and that they would be able to go over the clips at home, should they forget what had been taught in class. "I found I could access the videos on my phone at home, and remind myself of what we had learnt, and then I was able to do my homework properly," said one learner, while another highlighted how the video clips had resolved one of her greatest fears: "I am sometimes very scared to ask the teacher if I don't understand and the other people sometimes laugh at me and say I am dumb. But the videos mean I can look at the concept again and again until I figure out what is going on, and then I can do my work and not get in trouble."

In my own class one of the weaker learners who spent more time finding reasons for why he had not done his work than actually trying his work offered this piece of insight: "VITALmaths helped me a lot more than the teacher just explaining. It was hard at first but I paid more attention and the videos helped me because it (sic) has pictures in it and I understand things much better when it has pictures." This aspect also worked to another learner's advantage: "*Die* *prentjies in die videos is wat my beter laat verstaan as wanneer die meneer sommer net op die swartbord skryf* (The pictures in the videos are what made me understand maths better than just the teacher writing on the blackboard)" while someone else pointed out that "*prentjies verduidelik goeters beter as woorde* (pictures explain stuff better than words.)"

Earlier I had wondered whether or not the learners would go home and look at the video clips on their own, and not just watch them in class because of my instructions to them. I received my answer via a number of essays: " You can use the videos day and night and even at home, like when I was bored, I went on to the website and downloaded other videos to look at. That was interesting and quite fun," and "*Dis lekker om enige tyd die videos te kan kyk – dit het my nou die dag gehelp met my huiswerk toe ek by die huis was en nie vir Meneer kon vra om my te help nie* (it's nice to be able to view the cideos at any time – it helped me with my homework at home the other day when I was unable to ask Sir for help.)"

Towards the end of the project I came across two comments made by learners which lead me to believe that the VITALmaths cell phone project has already started proving its worth, that it has a place in education and that it has helped me make a difference in some learners' lives. One learner had this to say: "It is really nice using a cell phone anywhere anytime to do mathematics for fun. I never liked mathematics until Ms Hyde showed us an easy way with the videos and now I practise my mathematics every day because I never knew there was such an easy way to understand mathematics. I bet Albert Einstein is sorry he never knew about VITALmaths!" Another explained thus: "I used to tell myself I am not bright enough to understand maths but all because of Ms Hyde's idea of the videos and encouraging us to always do our best I stood up, told myself I could do it and, well, I did it! I've always failed at maths, but this year for the first time in like forever I got 49% for a test – and that was like magic!!!"

4.7 Phase 6: Follow-up interviews

During the follow-up interviews I spent time finding out what the teachers had thought of the project and if they would ever make use of the videos again.

Question 1: What are your impressions of using the VITALmaths video clips in some of your lessons / *Wat is jou indrukke oor die gebruik van die VITALmaths video-opnames in sommige van jou lesse?*

Teacher A had enjoyed the experience and found it rather interesting. "What I liked was the way the kids became involved in watching the videos themselves – and how they viewed them again while doing their homework," he said, adding that he was rather surprised that, during the second lesson, he had not had to reprimand anyone for not doing their homework, which was a first for him!

Teacher B also found that he had learnt a lot along with his learners. *"Ek moet sê ek was nie juis ingenome met die hele idee van 'n video wat uit animasie bestaan as leermiddel nie, maar ek was verbaas hoeveel prêt die kinders daarmee gehad het* (I must say was not really taken with the whole idea of an animated video as a teaching aid, but I was surprised at how much fun the children had with them)," he explained. *"Ek kon my nie indink hoe so iets sou werk nie, maar tog het dit, en ek het self geleer om wiskunde van 'n ander kant te benader* (I could not imagine how thise would work, but it did, and I also learnt to approach mathematics from a different angle)".

Question 2: What effect, if any, did the use of the video clips have on your own teaching practice / *Watter effek, indien enige, het die gebruik van die video-opnames op jou onderwyspraktyk gehad?*

Both teachers were in agreement that the video clips had had an effect on their teaching practice, with Teacher B mentioning that he had learnt that it was not always necessary to stand in front of a class and lecture them about mathematics. *"Dit is so lekker om toe te laat dat hulle self ondersoek instel na iets, en dat hulle teen hul eie pas kon beweeg* (It was lovely to allow them to investigate something for a change, and to let them move at their own speed)." He also found that the learners enjoyed the added investigations and suggested that these could serve as an assessment task as well: "*Mens sukkel soms om lekker ondersoeke te vind, en die videos gee nogal idees* (One has to contend with the difficulties in locating good investigations, and the videos do provide ideas)."

Teacher A said that in his opinion the interactive whiteboard had made a huge difference: 'I can easily put the video clips on the board, and let the learners work on the maths, instead of always trying to explain and make sure they understand everything. Then it's much easier to try and help those learners who really struggle."

Question 3: Do you think cell phones and cell phone technology could have a place in today's classrooms / *Dink jy daar is 'n plek vir selfoontegnologie en selfone in die vandag se klaskamers?*

Teacher A chuckled when asked this question, "I am already a convert – you do not have to try and persuade me any more. I really think it could be a very worthwhile venture, and am happy to incorporate the VITALmaths video clips into more and more lessons." Likewise, Teacher B expressed hope in terms of the project: *"Gee net kans – my kinders sal julle nog verbaas een dag met hul goeie uitslae – en dit moontlik te danke aan 'n paar selfoonvideos* (Just wait and see, one day our children will surprise you with their good results – made possible through a couple of cell phone videos)."

4.8 Critical reflection on limitations during the project

While it could appear from first glance that this project was relatively easy to implement and research, a number of problems surfaced at various times. These are summarised briefly here below:

- Arranging suitable times to conduct both the Phase 2 and Phase 6 interviews were hampered by the teachers' extramural activities, as well as my own load;
- Likewise, arranging suitable times for observing and filming both participating teachers' lessons was difficult due to having to take time out of my own teaching time, necessitating finding substitute teachers to stand in for the various lessons;
- Certainly in my own class I was not able to prevent the learners from either accessing MXIT from their phones during lessons or anything else, despite my belief to the contrary, as evidenced by learners in their reflective essays – "*alhoewel ons kroek en op MXIT gaan terwyl ons dit doen* (although we cheat and go on MXIT while we are doing it) and "using cell phones was the best part of it all because we even lied to Ms Hyde telling her we busy (*sic*) with VITALmaths on our phones but we're doing our own things";

- Opposition was picked up from colleagues who appear to believe that introducing the use of cell phones in class was going against the school's code of conduct and thus encouraging learners to break the rules. This was also highlighted when a learner had his cell phone confiscated by the invigilating teacher during a mathematics test when, according to him, he had left his calculator at home and had decided to used the calculator application on his cell phone instead.

However, problems such as these should perhaps be viewed as challenges rather than difficulties, and ways need to be found to overcome them and any others which may arise in future research.

4.9 Conclusion

When I first set out to conduct my research into the role of the VITALmaths video clips in certain Grade 9 classrooms, I had intended merely to show the teachers where to find the videos and get them to use them in their lessons. However, both teachers surprised me with their enthusiasm for and belief in the project, and their willingness to do their best with implementing the project in their lessons, despite some initial misgivings.

I also found that in my own classroom the learners enjoyed using the VITALmaths video clips and that, for some of them, mathematics was no longer a subject to be feared and disliked. In addition, learners were able to access the video clips away from the classroom and use them to help them with homework, while those learners who were scared of asking the teacher to explain a concept again for fear of appearing foolish to their peers, had a resource which could help them gain understanding.

While there are still many challenges in terms of, for example, the use of cell phones in school, it would appear that the VITALmaths video clips can be used by Grade 9 teachers and learners in their classrooms, and that they can lead to further explorations of mathematical ideas.

CHAPTER 5

CONCLUSION

5.1 Introduction

This chapter serves as a conclusion to my research into the use of the VITALmaths project video clips, and offers a summary of the findings thereof, as well as highlighting its significance. It also discusses the limitations and ethical considerations of the study, as well as suggesting further research that may be carried out. Finally, as I feel that I have gained much valuable experience as a novice researcher, I conclude with some personal reflections on this experience.

5.2 Summary of findings

During the teacher workshop conducted as phase 1 of the study I found that the teachers were both enthusiastic about the use of the video clips, and agreed to use two specific clips closely allied to the Grade 9 syllabus (South Africa. DOE, 2002) namely *Rectangular Products*, which looks at using rectangles to represent the products of two two-digit numbers, and *Hubcap Geometry*, which explores the reflection and rotational geometry found in motor vehicle hubcaps. Both teachers had very clear, yet differing ideas on how to incorporate the clips into their teaching in terms of what the clips would be used for, with Teacher A preferring, for instance, to use the first clip to lead to an investigation of the calculation of shaded areas, while Teacher B saw the possibility of using it when multiplying binomials. They both appeared to be completely *au fait* with the Grade 9 curriculum and assessment standards.

The semi-structured interviews conducted during phase 2 of the study revealed that while both teachers saw the potential of using cell phones in mathematics lessons, they had reservations regarding the control of what the learners did while using their cell phones. While Teacher A preferred using the interactive whiteboard in his classroom for the viewing of the video clips, encouraging his learners to use their cell phones outside of lessons, Teacher B felt that learners might become more enthusiastic about mathematics lessons when being allowed to use their phones.

Both teachers hold fundamentally differing beliefs in terms of teaching mathematics, with Teacher A favouring investigation and exploration, and Teacher B preferring to teach a concept and then give homework exercises, while still allowing learners to ask questions. They also face similar challenges in teaching, such as problems with learners not coping with the LoLT in the classroom, large class sizes and a poor grasp of basic mathematical concepts evidenced by some learners.

Analysis of the learner questionnaires revealed that only a quarter of the respondents felt they were good at mathematics, while around half rated themselves as average and the rest as bad at the subject. In terms of cell phone access, only three out of the 87 respondents did not have any access, while 18 borrowed phones from family members or friends. The majority makes use of prepaid airtime, and the most popular internet usage is to access MXIT.

Learners from all three classes (mine included) were enthusiastic about using their cell phones, and most were able to download the clips with relative ease. I certainly found it fairly easy to include the *Rectangular Products* clip in a mathematics lesson, while the other teachers also appeared to have little difficulty in doing the same. However, some differences emerged in the actual use of the clips, firstly in terms of the point at which the clip was used, and secondly, what concept the clip was used to underscore.

Teacher A introduced the clip almost at the beginning of his lesson, as did Teacher B, while I allowed my learners to download the clip and only view it some ten minutes into the lesson. Teacher A used the clip to encourage his learners to explore the calculation of shaded areas of rectangles, while my learners and those in Teacher B's class looked at using the clip in the multiplication of binomials. Teacher B's use of the second clip, *Hubcap Geometry*, saw him send his learners out of the classroom to find examples of reflection and rotational geometry.

Using the *Rectangular Products* video clip certainly seemed to engage the learners more in my own lessons, and it appeared to help certain learners grasp the fundamental concept of the multiplication of binomials. Teacher A felt that his learners appeared to benefit from the use of the clips, and suggested that perhaps finding ways to incorporate more clips into lessons could prove beneficial to him in terms of teaching practice as well as to his learners. Teacher B felt that the visual aspects of the clips was important, as this seemed to simplify the explanation of rather difficult concepts, and appeared to allow learners to grasp concepts more thoroughly than through explanations alone.

These benefits also received mention in the learners' reflective essays, as several of them pointed out that the clips had helped them in understanding concepts that they had found difficult, and a number of them felt that using more video clips in mathematics lessons could help them find the subject more interesting and easier to understand. In addition, some learners pointed out that having access to the video clips outside of the classroom meant that if there was something they did not understand, they would be able to view the specific clip again which could then help them in completing homework or studying for tests.

I also found, upon interviewing the two teachers at the end of the study, that the use of the clips in their classrooms had had some effect on both their own teaching practice, especially in Teacher B's case, where he revealed that he had learnt a different method of teaching, as opposed to merely lecturing his learners. Teacher A had also found that the clips added a new dimension to his teaching, particularly with the use of the interactive whiteboard during his lessons.

Finally, both teachers agreed that cell phones and mobile technology, in their opinion, could have a meaningful place in today's classroom.

5.3 Significance of the study

The VITALmaths project is unique in the South African education scene as it deals with animated video clips in mathematics education, and this study was one of the first carried out in the Grahamstown district of the Eastern Cape.

The study attempted to look at how the video clips using cell phones could be incorporated into the teaching of mathematics and if they could assist teachers in teaching, as well as if they encouraged both the teachers and the learners to further explore mathematical ideas. While a number of mobile learning projects have been launched in South Africa, not much research appears to have been done in terms of using mobile technology in mathematics classrooms in particular. According to the ideals of the VITALmaths project, research is needed to feed back into it in order to enhance the development thereof, and it is hoped that this study, albeit in a small way, will do just that.

5.4 Limitations of the study

One of the biggest limitations of this study is that it was conducted on a very small scale, looking at the incorporation of the VITALmaths video clips into the teaching of three Grade 9 teachers, and participation by 87 learners in three Grade 9 classes. In addition, due to time constraints, the study was carried out over a three month period, and only considered the incorporation of two video clips into some six lessons in total. It would therefore be unwise to generalize these findings as pertaining to all Grade 9 learners and teachers in all schools across the Eastern Cape.

Another limitation to this study included the difficulties experienced in coordinating observation lessons as I am a full time teacher with a full teaching load, as are both the teachers included in the study, and we are all involved in extra-mural activities at our respective schools. As a result, I was only able to observe a total of five lessons, having to miss a sixth lesson which had been planned and which could have added to my research. Instead, for that lesson I had to rely on information recorded by the teacher in his journal, and by the learners in their reflective essays, thus missing out a chance to observe and videotape the lesson.

A third limitation was the fact that one of the two teachers could only use one clip over two lessons in his Grade 9 class, as he had to take family responsibility leave for the birth of his son, and was therefore unable to complete the planned number of lessons.

5.5 Suggestions for further research

As this study was conducted on a very small scale, there are opportunities to expand this research in number of ways:

- Include a larger number of teachers and schools, as well as more grades, rather than just Grade 9 by linking of video clips through the content and context thereof to the Curriculum Statement of the various grades ;
- The possibility of including more than just two video clips, as was done in this study, and thus gaining a broader understanding of the potential use of these; and

- A deeper consideration of how the video clips lead to autonomy in both teachers and learners from the point of further exploration of mathematical ideas beyond the confines of both curriculum and classroom.

5.6 Personal reflections

Prior to conducting this research, I had only conducted one small historical research project as part of the requirements of the research methodology component of my B. Ed (Honours) degree at Rhodes, where I looked at the history of the school at which I teach. I therefore consider myself to be very much a novice researcher.

However, this study has opened my eyes to the wonderful world of research, and the excitement that this can bring in terms of discovery, not only of what other people have found during their own research, but also of my own thinking and beliefs. The hours spent poring over different texts, searching for links between other researchers' work and my own, has resulted in development in such mundane, yet diverse areas as reading speed and patience, while writing up of the thesis has taught me a tremendous amount about areas of my own life that can be improved, such as my notoriously bad time management skills.

That being said, I think that this study has awakened in me a desire to attempt to do the following:

- Remain involved in research at university level;
- To find ways to assist with the improving teaching and learning of mathematics in classrooms in South Africa; and
- To remain an advocate of the use of mobile technology in education.

Looking back over the past two years, I have discovered things about myself of which I feel proud, and things which desperately need improvement, and I have also discovered what the support of people can mean when one is attempting to do something which, at times, feels far beyond one's reach, as I felt when I first embarked on this study.

5.8 Conclusion

This chapter has served as a conclusion to my research project, offering a summary of my findings, as well as a short discussion regarding the significance of the study and its limitations. Consideration was also given to further possible avenues of research, before ending with a personal reflection of my experiences during this time.

ANNEXURE A

Teacher Journal

Teacher's Name:____

Date:____________________ **Lesson**:____________________

Planning:

Reflections:

ANNEXURE B

VITALmaths Questionnaire: Learner participants

Please read and answer the following questions:

1. Name: ____
2. Do you own a cell phone? ____
3. If you answered **YES** to question 2 what make and model ? ________________________

OR

   If you answered **NO**, do you have access to a cell phone? ___________________________

   If so, what make and model? ____

4. Do you have your own SIM card? ____
5. Which network do you use? ____
6. Is your phone on contract or do you use prepaid airtime?____________________________
7. What do you use your phone for? (be specific):___________________________________

   ____

8. Can you access the Internet via your cell phone? __________________________________
9. How good do you think you are at doing Maths? __________________________________
10. Do you enjoy doing Maths? ____
11. Is there anything you like about Maths? _______________________________________

    ____

12. Is there anything you dislike about Maths? _____________________________________

    ____

13. What do you find difficult when doing Maths?___________________________________

    ____

ANNEXURE C

Flanders' Interactional Analysis Category System (FIACS) Observation Schedule

<table>
<tr><th></th><th></th><th>Behaviour observed</th><th>Frequency</th></tr>
<tr><td rowspan="7">Teacher Talk</td><td rowspan="4">Indirect influence</td><td>Teacher accepts feelings</td><td></td></tr>
<tr><td>Teacher praises or encourages</td><td></td></tr>
<tr><td>Teacher accepts or uses ideas</td><td></td></tr>
<tr><td>Teacher asks questions</td><td></td></tr>
<tr><td rowspan="3">Direct influence</td><td>Teacher lectures</td><td></td></tr>
<tr><td>Teacher gives direction</td><td></td></tr>
<tr><td>Teacher criticizes or justifies authority</td><td></td></tr>
<tr><td colspan="2" rowspan="2">Learner talk</td><td>Learner responds verbally to teacher</td><td></td></tr>
<tr><td>Learner initiates talk with teacher</td><td></td></tr>
<tr><td colspan="2">Silence</td><td>Learner remains silent, confused</td><td></td></tr>
</table>

(Adapted from See and Lim, 2006)

ANNEXURE D

Letter of permission: Principals of participating schools

P O Box 67
PORT ALFRED
6170
16 February 2011

The Headmaster

Dear sir

Re: VITALmaths Research Project: Rhodes University

As you are no doubt aware, I am currently in the process of completing my Master's Degree in Mathematics Education and intend conducting research into the use of abovementioned project in three schools in the Ndlambe area.

The VITALmaths project is a collaborative research and development project between Rhodes University and the University of Applied Sciences Northwestern Switzerland (FHNW) and all information regarding this project is available by accessing the project's website at http://www.ru.ac.za /vitalmaths.

The project involves incorporating video clips disseminated via cell phone as a teacher resource and to determine how these may assist with the teaching of mathematics. I should also like to investigate to what extent these clips encourage both learners and teachers to further explore the mathematical ideas presented therein.

I therefore would humbly request your permission to use your school as one of my research sites. As the video clips I intend using are aligned with the Grade 9 Revised National Curriculum Statement, this will not take away valuable teaching time from the teachers concerned, and therefore should not provide any disruption. In addition, it will require learners in each class to download the clips and then view them on their own cell phones during four lessons in the second term. Learners will then be able to access further clips on their own outside of school.

I am fully aware that the usage of cell phones in class time is forbidden by school rules. Should you feel unable to grant permission because of this, I am able to bring in cell phones from Rhodes which have been preloaded with the clips and which do not operate using SIM cards, therefore the learners would not be able to log on to the internet at all. However, this is not without attendant logistical problems

In terms of ethics, confidentiality and anonymity shall at all times be maintained throughout the study, and this will hold fast for the analysis and writing up of research. I shall also obtain the permission of parents and/or guardians of all learners who participate in the study, prior to commencing my research.

Should you require any additional information, feel free to contact either me or my supervisor, Professor Marc Schäfer at tel. 046 603 7278 or via email at m.schafer@ru.ac.za.

I await your favourable reply.

Yours faithfully

Janet Hyde (Ms)

Cell no. 082 471 8292

ANNEXURE E

Letter: Permission from parents / guardians

P O Box 67
Port Alfred
6170
18 March 2011

Dear parents/ guardians

Re: **M Ed research project**

I am currently undertaking research in order to complete a Master's degree in Mathematics Education through Rhodes University. I am also involved in the VITALmaths cell phone mathematics project, which is being run as a joint collaboration project through Rhodes University and the University of Applied Sciences, Northwest Switzerland, an explanation of which is attached to this letter.

My research involves using short video clips which are downloaded onto the learners' cell phones in a total of six periods. This will involve the learners bringing their phones to school to use in the mathematics periods under the direct supervision of myself or their mathematics teachers. In addition I would like to videotape several of the lessons to assist me in analyzing what happens during the lessons.

Once I have completed my research in the classroom the results will form part of my thesis which will be handed in towards the end of the year. Learners in the classes will remain anonymous as no names will be mentioned in the thesis. All videotapes and transcripts shall be used only for research purposes and will not be viewed by anyone not directly involved in the project.

I should be pleased if you would grant permission for your child to participate in this research. Should you not wish your child to participate, he/she will not be disadvantaged in any way. Please sign and return the attached reply slip to me by Tuesday 22 March 2011.

You are welcome to contact me for any additional information.

Kind regards

Janet Hyde
Cell no. 082 471 8292

ANNEXURE F

Information sheet: VITALmaths Research Project

VITALmaths is a multilingual collaborative research and development project between the University of Applied Sciences Northwestern Switzerland (FHNW) and Rhodes University in South Africa. The **VITAL**maths project produces short video clips specifically designed for the autonomous learning of Mathematics. These intellectually and visually appealing video clips are short (typically 1-3 minutes long) and specifically make use of natural materials to animate and develop a variety of mathematical concepts and processes. These video clips can be used in the preparation of lessons, for personal conceptualisation of mathematical concepts, and as motivational, exploratory and explanatory tools. The emphasis of **VITAL**maths is for teachers and students to use the video clips as autonomously and independently as they wish. Feedback from users will be utilised to continuously refine the design principles of the video clips through a cyclical feedback process. The video clips can be freely downloaded in two formats. The MP4 format is suitable for PCs, iPods and iPhones, while the 3G2 format is designed specifically for use on mobile phones.

Integral to the **VITAL**maths project is a research agenda which seeks to investigate the efficacy and implementation of this growing databank of video clips. If you would like to learn more about **VITAL**maths, have suggestions for further video clips, or would like to share your experiences with using these video clips, we would greatly value your comments and feedback.

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Prof. Marc Schafer: m.schafer@ru.ac.za
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Tel: +27-46-603-8111 • Fax: +27-46-622-5049

Website: http://www.ru.ac.za/vitalmaths/

ANNEXURE G

VITALmaths Research Project: Reply slip

I ____(parent/guardian name)

hereby grant permission for my child ____(child's name)

to participate in the VITALmaths research being conducted by Janet Hyde.

Signed this _______________ day of MARCH, 2011.

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