Using diffusion of innovation theory to understand how technology is adopted in mathematics at a South African higher education institution.

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CHZSAB001

A Minor Dissertation

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE

DEGREE OF COURSEWORK MASTERS IN EDUCATIONAL TECHNOLOGY

UNIVERSITY OF CAPE TOWN

Faculty of Humanities

January 2016

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ABSTRACT

The issue of students enrolling who are ill prepared in mathematics for university studies has been an area of concern for some time in South Africa. Various universities tried different interventions to address this problem. One example is the establishment of a bridging programme at an institution of higher learning. Technology has been discussed as support that can be provided to students. This study therefore sought to understand the adoption of technology in the teaching of mathematics at an institution of higher education in South Africa.

Using Roger's diffusion of innovation theory, this study sought to understand how technology is adopted by mathematics teachers in the bridging programme. Whilst the results of the study show that some teachers have adopted technology at different scales to provide access, to supplement instruction and to encourage interaction, the results also show that some teachers are uncertain of the benefits that technology has to teaching and learning in the programme. The current talk and chalk method is seen as being essential as it is tried and tested.

The study also showed that teachers did not receive support from the institution resulting in them seeking assistance from outside of the university. The study recommends that higher education institutions should provide instructional design support to ensure that teachers are not overburdened with developing technology interventions where they have little or no expertise in.

Key words: **diffusion of innovation, mathematics teachers, higher education, South Africa**

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LIST OF ACRONYMS

ADP	Academic Development Programme
DoE	Department of Basic Education
DI	Diffusion of Innovation
ICT	Information Communication Technology
MSA	Monash South Africa

ACKNOWLEDGEMENTS

I would like to thank God Almighty who gave me this opportunity.

I wish to express my sincere gratitude to the following:

- My supportive supervisors, Dr. Cheryl Brown and Dr. Duncan Mhakure, for their expert advice, guidance, and prompt feedback throughout the duration of this study.
- Mr Agrippah Kandiero for the support and guidance provided throughout this journey.
- I would also like to thank all the MSA mathematics teachers who participated in the interviews and reviewed the interview questions.
- My wife Sibane and daughter Sandy for their understanding and support.
- To my father and mother for the encouragement and all the support including my brothers and sisters.
- I am also grateful to all those who gave their full collaboration and involvement in order for me to complete this research project. Without the support and guidance, I would not have been able to complete this research on time.

COMPULSORY DECLARATION

I, Sabelo Ransome Chizwina, hereby declare that the work contained in this dissertation is my own work and that it has not been submitted at any degree or examination at any other university. All sources have been acknowledged through referencing.

SR Chizwina **Date:** 01/02/16 **Signature**

Signed by candidate

Declaration by candidate for the degree of Master in the Faculty of Humanities

I, Sabelo Ransome Chizwina of Unit 34 Terrace Hill 2 Rugby Road Weltevreden Park 1709 do hereby declare that I empower the University of Cape Town to produce for the purpose of research either the whole or any portion of the contents of my dissertation entitled:

Using diffusion of innovation theory to understand how technology is adopted in mathematics at a South African higher education institution.

Chapter 1

Overview of the study

1. Introduction

This chapter presents the context and rationale of the study. This study focused on understanding how mathematics teachers adopt technology in their practice. In this study, the phrase mathematics teacher refers to teachers from higher education contexts who teach the module ZHC1010 at the site of the study.

1.1 Context and Rationale

Mathematics skills level remains a serious problem in South Africa (Ndlovu, 2011). The Department of Basic Education and Department of Higher Education (2010) stated that there were few students with good Mathematics and Physical Science results. Furthermore, the South African Development Indicators Report (Department of Performance Monitoring and Evaluation, 2010) stated that the country's performance in Mathematics and Science is poor when compared to other countries. The Department of Basic Education (2011) further reported that from a total of 300 000 pupils taking Mathematics in 2008, the number decreased by 25% by 2011. Ndlovu (2011) added to the debate stating that with a Mathematics pass rate of 29% in 2010, South Africa has few students completing high school with good enough Mathematics and Science pass rates to be admitted for further study in Science, Technology, Engineering and Mathematics (STEM) careers at vocational and university level. Amin (2012) stated that in South Africa the poor performance in tertiary education is a result of poor mathematics proficiencies (Amin, 2012). The poor mathematics skills are evident in the study by Wolmarans, Smit, Collier-Reed and Leather (2010: 274) whose report, based on the National Benchmark Tests Project (NBTP) revealed that 906 students enrolled in engineering at the University of Cape Town,

> "Only 7% achieved a mark at proficient level, 73% performed in the intermediate category and those at the bottom of this category needed an intervention programme. A further 20% of the students

> were found to have only very basic mathematical skills and
> required an extended programme to improve their skills". (Wolmarans et al., 2010: 274).

When putting Wolmarans et al. (2010) into context, the proficient level of these students is 66 – 100% and intermediate is 38 – 65%.

Monash South Africa (MSA) is a campus of Monash University, a public institution in Australia which is the site of this research. It has adopted an academic development programme (ADP) in an attempt to "bridge the gap" of under-prepared mathematics students entering the university system. The ADP was established in 2001 to offer an alternative pathway for access into undergraduate programmes (Cloete, 2014). The ADP follows "1 + 3-year model" (Cloete, 2014). In this model, students spend a year in a preparatory programme. These students would not have met the entry requirements into the formal undergraduate qualification.

In this type of approach (ADP) to learning, there are two "spaces" that students engage in. One is the more traditional face to face element which occurs on campus in lectures and tutorials, while the other is in a "technology space", usually online and requires a degree of self-direction. The "technology space" is mainly through the use of tools available in the Learning Management System (Moodle). In this space, teachers are able to use the learning management system to upload lecture slides, videos, set up quizzes, create discussion forums and announcements, provide links to resources and upload resources for students to use. The student plays a far more pivotal role as a responsible contributor to the learning taking place in the technology space. The integrated approach provides something of the best from both worlds of classroom learning and online learning environments.

As part of the academic promotions criteria, teachers are required to develop and adopt different ways of using the integrated learning approach in their teaching[1]. Currently, there is no documentation that shows how teachers are using technology in the integrated learning approach that the author is aware of. The documents submitted for the promotions criteria are confidential and are only available for the committee members to use. There is no reported research at MSA that shows what is being done in terms of using the "technology space" in the teaching of mathematics. There is need to understand how technology is adopted in the

[1] http://www.adm.monash.edu.au/human-resources/academic promotion/procedures/guidelines-committees-b-e.html

teaching of mathematics from the teacher's perspective. This is a problem where the teacher's perspective is unknown that is faced by many countries and is mentioned in a number of studies such as Wu, Lee, Chang, and Liang (2013) and Wachira and Keengwe (2011). A gap therefore exists in the existing literature with regards to understanding how technology is adopted in the teaching of mathematics which this study can contribute to. In response to this, this study seeks to understand how technology is adopted in the teaching of mathematics in the ADP.

This study sought to understand how technology was adopted in the teaching of mathematics at MSA. From the work of Cummins (1992) and Kaptelinin (1996) and other researchers, it is evident that the use of technology in teaching mathematics assists with, amongst other benefits, mediating, scaffolding and teaching of scientific concepts and mathematical concepts. The views of MSA mathematics teachers towards the use of technology were unknown and this study attempted to obtain those views. The aim of this study was also to add to research that addresses actual teacher accounts of technology utilisation in the use of ICT in teaching mathematics in the higher education sector in South Africa.

1.2 Theoretical framework

In order to understand how technology was used in the teaching of mathematics at Monash South Africa, a theoretical framework was used. The required theoretical framework had to be able to explain, predict and account for the factors that obstruct or enable the use of technology in the teaching of mathematics. The theory that was used in this study was Rogers' (2003) diffusion of innovations (DI) theory, which is a theory that examines how an innovation is taken up in society. Rogers' DI theory has been used in other studies with a mathematics focus (Cajilig, 2011; Hoerup, 2001). The DI theory has been shown in previous studies such as the one by Kamau (2014) to allow the researcher to study how an innovation is taken up in a society and to understand influences related to the implementation of technology.

1.3 Research Questions

This study used Rogers' DI theory to understand how technology was adopted in the teaching of mathematics at a South African higher education institution. The research questions that were used were:

(i) How did the attributes of an innovation affect adoption of technology in teaching mathematics?
(ii) How does the DI communication channel influence teachers' decisions to adopt technology?
(iii) In what ways does the social system influence adoption of technology?

1.4 Research Design

This study was undertaken in the participants' natural settings and the researcher collected data through interviewing participants. These are all characteristics of qualitative research. To address the research questions, a case study approach was used. A case study was appropriate for this research as it allowed for the incorporation of information from various participants as well as for detailing and understanding the similarities and differences of individual cases within their settings (Yin, 2009).

At MSA there were five mathematics teachers in the ADP who all teach the mathematics module ZHC1010. The module ZHC1010 was selected as it is the module that all students registered for Business, IT and Health Sciences stream all participate in. It has the largest number of staff and students. All the teachers were approached, and agreed to be participants for the study.

1.5 Limitations of the study

A qualitative observation is one type of collection procedure. Creswell (2014) defines observation as the process where the researcher could take different roles from a non-participant to a complete participant. In this study, observation was not used. The reason for this was that permission had to be obtained from all participants and not all participants

agreed to be observed. In addition, permission could not be obtained from the institution. This is one of the limitations of observations as the researcher may be seen as being intrusive.

In addition, the study sought to use document analysis. These documents were to be obtained from the teachers. However, the documents that were obtained from the teachers were class notes, lecture slides, unit guides, revision exercises and weekly schedules. Examples of the documents are attached as Appendix A. These documents were not useful as they did not show how technology was being used. The researcher requested for permission to view the Learning Management System page for the module from the unit co-ordinator for the module. This permission had to be sought from Senior Management. However, permission was not granted. As a result the researcher had to rely on what the teachers said.

1.6 Dissertation outline

- Chapter 1: This chapter serves as an introduction to the study.
- Chapter 2: This study describes the literature related to the adoption of technology in mathematics.
- Chapter 3: The research methodology is presented in this chapter.
- Chapter 4: The results and findings of the study are presented.
- Chapter 5: A discussion of the findings is presented in this chapter.
- Chapter 6: The conclusions and recommendations are presented in this chapter.

1.7 Conclusion

This chapter presented the context and rationale of the study, the theoretical framework, the research questions and the methodology that were used in this study. The next chapter reviewed the existing literature on the use of technology in the teaching of mathematics. It also examined how the diffusion of theory has been used in previous studies.

Chapter 2

Literature Review

2. Introduction

This chapter reviews the literature regarding the use of technology in the teaching of mathematics in higher education. Furthermore, the chapter describes various theoretical perspectives that have been used in understanding how technology has been used in the teaching of mathematics in higher education. Debates that have been raised by other researchers such as Chigona and Chigona (2013), Ertmer and Ottenbreit-Leftwich (2010) and Kamau (2014), in the field of using technology in the teaching of mathematics are also discussed. One of the major observations noted was that there was a dearth of literature with regards to the use of technology in mathematics in higher education in Africa and South Africa.

2.1 Technology in mathematics education

A review of the literature on the use of Information Communication Technology (ICT) in teaching mathematics is outlined in this section.

A number of studies indicate that the use of technology in teaching mathematics encourages a student centred teaching and learning environment (Becker & Ravitz, 1999; Engelbrecht & Harding, 2005). An example of the use of technology in learning is from the Economics and Business Studies field. In a study of undergraduate Australian students podcasts, were seen to improve student learning and assisted them to actively engage (Sutton-Brady, Scott, Taylor, Carabetta & Clark, 2009). In addition, Hay (2008) in a study performed in the United Kingdom further adds that a podcast can assist students with reading. A podcast can be used to provide supplementary material that will assist students. This is one way that technology could be used to assist students.

International studies report that ICT is seen as a tool to produce a meaningful view of mathematics. It is because it can be used as a thinking tool that facilitates mathematical

investigation and concept development and also increasing opportunities for students to engage with mathematics (Kaput & Shaffer, 2002). However, the literature from the United States also reveals that mathematics education has been criticised for the lack of adoption in implementing ICTs (Kaput, Hegedus & Lesh, 2007). This is clearly highlighted by Kaput *et al.* (2007) when they state that mathematics educators have a passive attitude towards technology and uncritically accept different products that they have no expertise in being able to facilitate suitable educational outcomes. This shows that the issue of teaching with technology might be neglected in teacher training programmes.

In South Africa, research studies on the use of technology in teaching mathematics have focused on the formal schooling sector (primary and high school). Examples of studies are Chigona and Chigona (2013), Hardman (2005) and Slay, Sieborger, and Hodgkinson-Williams (2008). Other studies that are related to the secondary schooling sector in South Africa include Verster's (2011) who created a social network for mathematical educators using the NING platform (see www.Mathematicsliteracy.ning.com). This network allows for file, photo and audio uploads, blogs, and a text chat to facilitate real-time discussions and online meetings. Another secondary school study from South Africa is Butgereit's (2011) who referred to "Dr Math", a text based chat service which was created using Mxit (a text based chat service which uses a cell phone). In Dr Math, pupils use their cell phones to ask questions and discuss their mathematics assignments. Other studies from South Africa's secondary schooling sector reported that technology is used merely to complement traditional teaching instructional methods instead of developing a student centred environment (Beldarrain, 2006). In other instances, despite the availability of technology in classrooms, many teachers do not use the technology as its affordances are unknown (Doering, Hughes & Huffman, 2003; Slay *et al*., 2008).

Within the higher education sector in South Africa, few studies have looked at adopting technology in teaching mathematics. Ndlovu, Wessels and De Villiers (2013) looked at the technology competence of pre-service teachers in the use of Sketchpad (a tool) in Geometry teaching and learning. Chikasha, Ntuli, Sundarjee and Chikasha (2014) examined the preparedness of South African pre-service teachers to teach with ICT. They used a quantitative approach to analyse the use of ICT in teaching at selected schools in Johannesburg, South Africa.

Internationally, the literature also reveals that teaching with technology can be a daunting task for most teachers due to a number of factors. Bowers and Doerr (2001) analysed United States teachers' views about technology. The major finding was that the use of technology "involves rethinking the format of activities and what counts as an acceptable explanation and solution" (Bowers & Doerr, 2001:126). The effect of this is that it can lead to teachers not using technology in their teaching of mathematics if they find rethinking the format of activities too difficult to comprehend.

In addition, Ertmer and Ottenbreit-Leftwich (2010) examined United States teachers' technology adoption. They found that if teachers have student centred beliefs, they are likely to modify their curriculum to incorporate technology in their practice regardless of barriers that could exist. The teachers' belief in the value of technology refers to whether the teacher sees technology as being able to promote student learning. Pina and Harris (1993) in a study to investigate how teachers can be aided to become at ease in using technology in the United States support Pina and Harris, as they state that if a teacher has a positive attitude towards technology the chance of the teacher to integrate technology is high. This study will seek to determine if MSA are also influenced by student centred beliefs.

2.2 Theoretical perspectives

Various theoretical perspectives have been used in studies undertaken to understand how technology has been adopted in higher education. The TPACK framework has been used to explain the relationships among content, pedagogy, and technology (Harris, Mishra & Koehler, 2009). Furthermore, activity theory argues that the construction of knowledge is based on the relationship between social and individual approaches as well as history and culture in the process (John-Steiner & Mahn, 2006). However, the activity theory has been criticised by Toomela (2008) for being individual activity focused, thus ignoring the cognition element of the individual. Another theory is the Technology Acceptance Model. (TAM) is based on the premise that the acceptance of ICTs can be anticipated based on user behavioural intention (BI), attitude towards use (A), and two other internal beliefs which are perceived usefulness (U) and perceived ease of use (E) (Davis, 1989). Dishaw and Strong (1999) criticised the TAM for its lack of task focus. The reason for this is that ICTs are task oriented. In this study, DI theory was the theory used. This section discusses the DI theory and why it is relevant in this study.

The DI theory was used in this study because it is useful in understanding (1) the technology and how its attributes influence mathematics teachers to adopt technology; (2) the innovativeness and technological needs of the different mathematics teachers (the early adopters and late adopters); (3) the communication channels used by a teacher to share or seek information with regards to technology; and (4) the social system in which the teachers operate in and how it influences technology adoption (Kamau, 2014).

Diffusion is described as a "process in which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 1995:5). Rogers added that adoption or rejection of new ideas leads to a social change – a "process by which alteration and functioning occur in a social system" (Rogers, 2003:6).

According to Rogers, diffusion is influenced by four elements: (1) innovation – "an idea, practice or object that is perceived to be new by an individual or other unit of adoption" (Rogers, 2003:12). This study did not focus on an idea, practice or object. The aim of this study was to identify the ideas, practice or objects that the mathematics teachers were using in their teaching. (2) Communication channels – Rogers stated that communication is "the process by which participants create and share information with one another in order to reach a mutual agreement (Rogers, 2003:18). The process of communication involves i) innovation, ii) an individual or a unit that has prior experience or knowledge with regards to the innovation, iii) another individual or a unit who has not experience or knowledge of the innovation, and iv) a communication channel which could be for example mass media which connects two individuals. This study sought to examine the communication channel of the teachers as there was a need to understand how the teachers were obtaining the information with regards to technology. (3) Time – the time an individual moves from the knowledge acquisition stage to the adoption or rejection of an innovation. In this study time was not examined. The reason for this was that, as Rogers' (2003) suggested, different methods to collect data to measure time more accurately should be used. The methods suggested include field experiments and longitudinal panel studies. In this study there was a time constraint to undertake a longitudinal panel study and field experiments would require the co-operation of teachers who had denied permission to be observed and (4) a social system defined as a "set of interrelated units that are engaged in joint problem solving to accomplish a common goal" (Rogers 2003:23). This social system can be individuals, groups, or organizations. In this

study the social system was examined to determine if there was a collaborative culture, institutional support or expertise in the system.

According to Ellsworth (2000), the DI theory consists of four variables that determine the rate of adoption of innovations. These are:

1. *Attributes of the innovation*

Relative advantage is described as the degree to which an innovation is alleged to be better than the current idea or practice (Lee, 2004). Examples of relative advantage include economic profit, less discomfort, social esteem and proximity of reward.

Compatibility is the degree to which an innovation is perceived. For an innovation to be accepted, it needs to be consistent with the individual's existing values, beliefs, past experiences and needs (Ellsworth, 2000; Lee, 2004).

Complexity is the degree to which users perceive the use of an innovation (Ellsworth, 2000).

Trialability refers to the degree, to which a user can alter or implement an innovation on a limited scale in terms of size (Ellsworth, 2000).

Observability is the degree to which results of an innovation are noticeable to others in the social system or communication channel.

2. *Time*

Rogers highlights that time is involved in three ways during the diffusion of innovation process. These are:

a) Rogers also added the five stages of the innovation-decision process. These are the knowledge, persuasion, decision, implementation and confirmation (Anderson & Driskill, 2012). These stages are discussed below:

Knowledge stage: The innovation process begins with the knowledge stage in which the individual is introduced to the innovation and begins to understand its functionality.

The persuasion stage:

> "includes liking the innovation, discussion about the innovation with others, acceptance of the message about the innovation, formation of a positive image of the message and innovation, and support for innovative behaviour from the social system" (Anderson & Driskill, 2012:59).

b) Rogers (1995) further categorized adopters based on their innovativeness. These categories include:

- Innovators are individuals who are categorized as being venturesome.
- Early adopters are individuals who are categorized as having esteem within the social system due to their adoption of an innovation.
- Late majority are individuals who are categorized as being sceptical about an innovation.
- Laggards are individuals who are categorized as being traditional who resist change that is being brought about by the innovation.

c) The rate of adoption which can be described as the rate at which an innovation is taken up by individuals within a specific social system (Kamau, 2014). To measure the rate of adoption, a longitudinal study would be required. This study will not focus on the time attribute as this requires observation over a period of time.

3. *Communication channel*

The communication channel refers to the means by which messages are transmitted from one individual to another. This could be either by mass media or interpersonal communication. Rogers (2003) introduced the concepts of homophily and heterophily with regards to communication. Homophily is described as "the degree to which two or more individuals who interact are similar in certain attributes, such as beliefs, education, socioeconomic status and the like" (Rogers, 2003:19). Heterophily is described as the degree in which individuals possess different attributes. Rogers further argued that DI does not occur between individuals with similar ICT skills. The reason for this is because there is no information exchange that occurs. This study sought to examine if mathematics teachers are either homophily or heterophily as this determines if teachers can learn from one another.

4. *Social System*

Rogers defined a social system "as a set of interrelated units that are engaged in joint problem solving to accomplish a common goal" (Rogers, 2003:23). The units include individuals, groups and organizations. An important element on the social system is the extent of change agents' promotion efforts. According to Rogers (2003:238), "change agents would not be needed in the DI if there were no social or technical chasms between the change agency and the client system". This shows that the role of a change agent is to facilitate communication of relevant information about an innovation.

2.3 DI Theory Studies in Higher Education

Most of the literature drawing on DI theory has focused on high school teachers in the United States (Bussey, Dormody & Vanleeuwen, 2000; Cajilig, 2011; Colandrea, 2012; Sarama & Clements, 2015). Other studies that have used the theory in higher education include Shea, Pickett and Li (2005) who examined how it could be used to analyze online teaching in American colleges. This section reports on some of the studies that have been undertaken in higher education that have used Rogers' DI theory. The focus of the studies is not necessarily mathematics as studies in this discipline are few.

Al-Qirim' (2011) study evaluated the effectiveness of the Interactive White Board Technology in teaching in the Faculty of Information Technology in the United Arab Emirates (UAE). The study used Rogers' five attributes of an innovation characteristics to evaluate the white board technology. The results revealed that there were compability and complexity issues as most of the users were not experienced with regards to using the features of the Interactive White Board Technology. The study concluded that Rogers' compability and complexity characteristics can be used in determining the effectiveness of technology adoption. This study however, does not show the effect of communication channel and social system. The study only looks at the individual and not on the influence of collegues in the same institution or other institituions. There is a need to investigate communication channel and social system. This study not only looks at the attributes of the innovation, but on the social system as there is need to investigate how other people influence a teacher's decision to adopt technology.

Rogers and Wallace (2011) undertook a study of preservice teachers in the United States to determine if there was a significant relationship between the level of anxiety, innovatiness, and the level of technology intergration in pre-service teachers. The results of the study found that there was a relationship between computer anxiety, innovativeness and technology intergration. The results also found that there was little or no significant differences between certification level and innovativeness and there were no gender differences on innovativeness or anxiety. The study concluded that Rogers' theory was extremely significant in predicting technology adoption. The study by Rogers and Wallace is useful in that it introduces the influences of anxiety, innovatiness and level of intergration. It could have examined if attitudes and beliefs had an influence on the adoption of technology. This study examined the level of technology integration and also explore if attitudes, collaboration and institutional support have an influence on technological adoption. This was not looked at in the study by Rogers and Wallace (2011).

Pundak, Dvir and Valley (2014) investigated the difficulties involved by lecturers in Israel to intergrate online courses in academic colleges. The study used Rogers' stages of innovation: knowledge, persuasion, decision, implementation and confirmation. The research questionnaire used in the study investigated "the lecturers attitudes concerning principle and practice of the online courses at the persuasion stage" (Pundak *et al*., 2014:224). The results revealed that a small group of lecturers who could be regarded as innovators could be found. The study concluded that the role of innovators as suggested by Rogers' theory should be used to pilot a technology innovation and that there is a need to use the Rogers' series of stages to identify any difficulties and be open for solutions from participants. This study demonstrates the need to adopt technology using a formal process. This process should include the stages of knowledge, persuasion, decision, implementation and confirmation. The study also shows the importance of Rogers' theory when intergration technology into teaching and learning. The study by Pundak *et al*., (2014) is based on the premise that the lecturers have already accepted online courses. It does not look at attributes of the innovation, coomunication channel and social system. Lecturers operate in a social system. There is need to find out if teachers in this study have a social support system. This study incorporates the social system as there is need to find out if mathematics teachers have support or they adopt technology without any form of support.

The issue of social support has been found to be useful by Delialioglu and Yildirim (2007) in a study to examine the utilization of ICT in basic education in Turkey. The results indicate that a lack of strong leadership and inadequate cooperation among teachers affected implementation of technology. Thus, this study examines the social system as it can influence adoption as revealed by the study by Delialioglu and Yildirim (2007).

Kamau (2014) applied the DI theory to investigate technology training for secondary mathematics teachers in Kenya. The results of the study found a lack of resources, lack of training and little or no motivation on the part of teachers. The study found the DI theory to be useful when anaylsing a diffusion of innovation over a time period. This study was undertaken to review how an innovation has been deployed and was already in use. This study differs from Kamau (2014) as in this study there is a need to determine if there has been a diffusion of technology. As mentioned earlier, there is no documentation that shows that technology has been adopted by teachers in the site of this present study.

According to Rogers' theory, any diffusion process is influenced by four elements which are (1) innovation, (2) communication channel, (3) time and (4) a social system (Kamau 2014). However, an analysis of the literature reveals that most researchers focus on an element of the DI theory.

Ntemana and Olatokun (2012) analysed university lecturers' attitudes towards information and communication technologies in Lesotho using perceived attributes of an innovation – relative advantage, complexity, compability, trialability and observability. They chose to focus on the perceived attributes using the rationale that the five key elements that affect the individual and the large collective with regards to an innovation. The study found that the DI theory is valuable as a framework for studies with an adoption diffusion scope.

Celik, Sahin and Aydin (2014) developed a mobile learning adoption in Turkey for preservice teachers. The scale was based on Rogers' DI theory. The scale developed focused on stages in the innovation decision process, attributes of innovations and adopter categories. It did not include the elements of the social system and the communication channel which this study sought to understand. The study found that Rogers' theory was a useful framework to investigate the adoption of innovations that are used for teaching purposes.

Anderson and Driskill (2012) used Rogers' theory to investigate United States college agriculture lecturers attitudes toward the intergration of technology in mathematics teaching. The study used the sub – elements from the time element which were the categories of innovators and the innovation decision process. The study found that Rogers' theory was useful in identifying attitudes towards intergration.

Another study that used the attributes of an innovation was conducted by Samarawickrema and Stacey (2007) using Australian Universities. The study sought to determine factors related to the adoption of a learning management system in a large multi-campus urban Australian university using the DI attributes. The study found that relative advantage was the most important attribute of the innovation. Compatibility was the next important attribute. The results of the study showed that participants' social systems had an effect on adoption. If the social system required that they adopt, the innovation would be adopted. This is due to the tool being compatible with their values and their social networks and thus they were comfortable with adoption. Trialability, observability, and complexity were found to have minimum effect. This study will seek to determine which attributes have a greater influence on adoption at MSA.

On the other hand, Kamau (2014) applied the DI theory to investigate technology training for secondary mathematics teachers in Kenya. The study used all four elements of Rogers' theory. The results of the study found that Rogers' DI theory was useful in understanding the technological innovations in the training programs, the innovation-decision processes for teachers and the stages involved, technological needs of different adopter categories, communication channels used to share information related to technology and the organizational unit of the social system and how it influences technology adoption (Kamau, 2014). The study by Kamau was investigating the effects of training. The teachers had already been trained on how to use technology in the teaching of mathematics. This study sought to understand if training has an influence on adoption.

Apart from the study by Kamau (2014), most of the studies focused on attributes of the innovation. These studies did not investigate the communication channel, time and social system. Analysing the attributes of an innovation allows the researcher to determine which elements are the most significant. According to Dillion and Morris (1996:6):

> "innovations that offer advantages, compatibility with existing practices and beliefs, low complexity, potential trialability and observability have a more widespread and rapid rate of integration".

The limitations of using the attributes of the innovation are that the focus is only on the individual teacher it does not look at the context that the teacher works in. Thus, this study does not only look at the attributes of the innovation but on the environment that the mathematics teachers operated in. For example, there was a need to look if the environment supports collaboration or team support. This is not found in most studies reported above. Support is seen as crucial in technology adoption. Tong and Trinidad (2005) undertook a study in Hong Kong to identify the conditions and constraints of sustainable innovative pedagogical practices using technology. The study concluded that if there is no support for teachers, they become frustrated resulting in their unwillingness to use technology.

2.4 Criticism of the DI theory

Stephenson (2003) describes Rogers' theory as being pro-innovation biased. He states that using Rogers' theory has an implication that an innovation should be dispersed and adopted by everyone in the social system. This statement is based on the categories of adopters which are innovators vs laggards. To overcome the pro-innovation, Rogers suggested that :

1. An innovation (tool) should be investigated while the diffusion is still underway. MSA adopted its blended learning policy in 2011 and most academic staff member are in the process of blending their courses (Cloete, 2014). Thus, adoption is still underway at the site of the study.
2. Studies must understand why an innovation was accepted, rejected or re-invented by individuals (Rogers, 2003). This study focused on the reasons why mathematics teachers accepted, rejected or re-invented technology. Questions in the interviews were created that focused on the reasons why teachers accepted, rejected or re-invented technology.

Another criticism of Rogers' theory is how the issue of time is measured in an innovation-decision process. Rogers' (2003) suggested that researchers should use questionnaires to ask adopters about their communication channels used during adoption. In addition, researchers should gather data at different intervals when the innovation is being diffused. In this study

the rate of adoption is not part of the study. This is because this study is not focused on investigating how a particular innovation has been adopted over a period of time.

2.5 Reasons for selecting Rogers' DI Theory

The previous sections identified various theories and also presented studies where Rogers' theory was used to study the DI in teaching and learning. This section provides justifications on why Rogers' (2003) DI theory is used in this study.

There is little research that has been undertaken using Rogers' DI theory in the teaching of mathematics in higher education worldwide. Much of the research focused on primary and secondary schools. The focus has been to identify barriers to the use of technology and to identify factors related to technology use. Most of this research focused on early adopters or change agents.

Rogers' DI theory has been applied to research that focused on investigating how technology is used in an educational context. The study by Kamau (2014), even though it was targeted to the secondary school teachers, found that Rogers' DI theory was useful in understanding (1) the innovation and how its attributes influence individuals, (2) the communication channels used to share and disseminate information (3) and the social system and how it influences the adoption of technology (Kamau, 2014). These elements are useful in understanding how technology is being adopted within a context such as where this study was undertaken.

To overcome the issue of pro-innovation bias, Rogers (2003) suggested that a research problem should be examined while the innovation is still being implemented in order to identify the challenges that can be evident during the early stages of diffusion. This study therefore sought to understand the factors that influence adoption in the early stages of technology adoption in the teaching of mathematics. Most of the technology that is being used in teaching is relatively new. Examples of such technology include iPads, interactive whiteboards, learning management systems, and online videos such as Khan Academy. In addition, to address the issue of individual blame bias and to be consistent with Rogers (2003) suggestions, mathematics teachers will be examined as units of study as opposed to studying the university system.

In this study the perspectives of all the mathematics teachers at the site of the study were considered to establish the factors that influence the adoption of technology. Furthermore, the issue of the social context was addressed using a qualitative research method. One of the main characteristics of qualitative research is "that the researcher attempts to understand people in terms of their own definition of the world" (Mouton, 2001:194). This means that the focus is on an insider-perspective (Mouton, 2011). The advantage of using a qualitative approach is that it enables the researcher to understand how technology is adopted by the mathematics teachers, from the subjective perspective of the individuals involved because the "intricacies, richness and diversity of their lives can only be captured by describing what goes on a day to day basis" (Mouton, 2011:194). Lastly, the rate of adoption was not discussed in this study. This is because to measure the rate of adoption requires that one relies on respondents to give precise information. This requires accurate information which may not be available and also difficult to verify.

2.6 Debates on effective use of technology as a tool for teaching and learning mathematics in higher education

With regards to the use of technology in teaching mathematics in higher education, Oates (2011:709) in a study in New Zealand to determine the integration of technology in undergraduate mathematics stated that "the effective intergration of technology into the teaching of mathematics remains one of the critical challenges facing contemporary tertiary mathematics". Barzel (2007) undertook a study in Germany to investigate whether classroom-arrangements and integrating the technology were an impediment to technology adoption. The results found two challenges faced by mathematics teachers which are new teaching methods and intergrating computers. This section examines how technology has been adopted in the teaching of mathematics in higher education. It will also look at arguments against the use of technology in mathematics.

Lokar (2010:155) was of the view that technology in the Slovenian context should be:

> "determined by considering what is most appropriate for the students, the subject and the learning objectives and then select the most appropriate technology to use, such as, "….an online discussion, a multimedia simulation, or a workplace experience".

This shows that technology should not be the main consideration, but the educational goal should supercede their choice of technology.

In addition, Chickering and Ehrmann (as cited in Gil-Pérez, Vilches Fernández, Cachapuz, Praia, Valdés & Salinas, 2005) identified seven factors that are critical when using technology in teaching. These are communicate high expectations, give quick feedback, encourage contacts between students and faculty, especially those students who are willing to speak in classroom setting, use active learning techniques, develop reciprocity and cooperation among students allowing for peer learning, emphasize time on tasks and respect diverse talents and ways of learning.

Risser (2011) using the United States context identified three arguments with regards to why technology should not be used in the teaching of mathematics. The first argument refers to whether technology should change the way people teach mathematics. Some of the issues raised in this argument is that the early incorporation of technology in teaching would lead to the neglect of basic skills such as manipulation problems and pencil-and-paper computation algorithms obsolete. The second argument was whether technology changed the way students develop mathematically. Quinn as cited by Risser (2011:99) speculated that " how students are required to enter computations into a calculator may be somewhat to blame for creating some mathematical misunderstanding". Risser (2011:99) added that evidence from other "disciplines indicate that relying on technology does change how individuals think and process information". From this, it is clear that there are researchers who fear that technology has a negative effect on the development of a student's understanding (Risser, 2011). The third argument looked at the implications of using the technology. One of the arguments raised is that the time spent teaching students how to use technology to solve mathematics is time not spent teaching mathematics. Technology is seen as a distraction from the issue of teaching mathematics. These arguments, while they are valid, have not been subjected to empirical research. They are based on views from teachers.

With regards to how technology should assist in the teaching of mathematics, Bergqvist's (2013) study in Sweden sought to investigate how mathematical content was presented in the podcasts, and how then it influenced students to enjoy mathematics. The study identified problem solving ability, reasoning ability, representation ability, connection ability and communication ability as being the role of technology in mathematics (Bergqvist, 2013). A

problem solving ability refers to dealing with a task for which the solution is not obvious to the solver, and the problem solving ability is then the ability to handle problem solving (Bergqvist, 2013). The reasoning ability is to reason mathematically (Lithner et al. as cited in Bergqvist, 2013); representation ability is the ability to handle substitutes of mathematical entities; connection ability is the ability to connect mathematical entities and communication ability is the ability to communicate one's capacity to participate in a process where information is exchanged between individuals.

2.7 Factors to be considered in technology adoption studies

This section presents some of the factors that should be considered in technology adoption studies.

Henderson and Dancy (2007) identfied two characteristics that affect technology adoption. Their study which was undertaken in the United States using college lecturers identified the instructor (individual) characteristics and the instructional context (situational characteristics). They concluded that in order to understand the adoption of technology, it is important to consider multiple individual and situational charactersitcs. Rogers' (2003) elements of the diffusion of innovation process provides researchers with these chatacteristics to investigate. By using the attributes of the innovation, time, communication channel and social system the researcher is able to the individual and instructional context.

One of the major changes lecturers face is the issue of cultural barriers. Brill and Galloway (2007) undertook a study using lecturers at a United States university to investigate college lecturers' use of and attitudes towards classroom-based teaching technologies. The results reported that large cultural barriers serve to work against innovations. One of the major barriers is that lecturers emphasise on their research productivity for tenure and promotion and thus neglect innovations in teaching. Brill and Galloway (2007) thus advocate for a cultural shift that acknowledges and rewards efforts in teaching.

In addition, Hartsell, Herron, Fang and Rathod (2009) undertook a study in the United States that focused on the effectiveness of professional development in teaching mathematics and technology applications. The study concluded that technology workshops improved teachers technology skills as well as their confidence in teaching mathematics using technology. This

supports Rogers' theory as one of the intergration attributes proposed was that of social support. Social support is seen as being key to the adoption of technology. This support varies from face-to-face to workshop environments.

One of the challeges faced by lecturers in the adoption of technology is a lack of training. Henderson, Dancy and Niewiadomska-Bugaj (2012) examined physics lecturers at universities in the United States to understand how they adopt technology. The study recommeded that faculties should engage in discussions about teaching. These discussions should involve scaffolding to ensure that these discussions address core issues related to different teaching methods and alternatives to traditional teaching and learning (Henderson *et al*., 2012).

Jarvis, Lavicza and Buteau (2014) examined two Canadian universities mathemactics departments sustained use of technology in the teaching of mathematics. The results proposed the following to be present in the successful implementation of technology in mathematics:

> "a key proponent in a position of influence or power; a strong and shared incentive for change; strategic hiring practices; an administration which supports creative pedagogical reform and well-considered risk-taking and a continous and determined revisiting of the original program vision" (Jarvis *et al*., 2014:138).

These are the factors which should be considered if technology is to be used in the teaching of mathematics. These factors provide the researcher with suggestions for questions when examining the social system for the study.

2.8 Summary of Literature Review

The literature review has highlighted a number of theories and frameworks that can be used in understanding how technology is being adopted. What is evident is that no one theory can be described as being sufficent for developing a framework for analysing the adoption of technology. The reason for this is the contexts differ and also the aim of the study differs. A framework cannot be effective for all studies.

There is a dearth of studies in higher education in particular with using technology in teaching mathematics. Ntemana and Olatokun (2012) add to this when they state that there is

little literature about ICT diffusion research in developing countries especially in Africa. Futhermore, the studies have focused on potraying the usefulness of the innovation in teaching and learning and providing accounts of successful early adopters. Very few studies focus on the diffusion of the innovation . Most of the studies that have been carried out have focused on the innovation and not on the experiences of the late adopters, non adopters or failures of innovations. Studies that seek to understand the factors for resolution in not using an innovation are also few especially in the African context. Henderson *et al*. (2012) also add that there are vey few studies being undertaken to find out how and why instructors make their ICTs choices.

The adoption of technology involves social interaction. It therefore follows a constructivist approach. There is need for continous communication amongst all the individuals in the social system. Formal and informal settings need to be constructed and maitained during the diffusion of the innovation as well as after the diffusion has taken place. However, the literature does not report on studies that have actually examined the communication that has taken place during the diffusion of the innovation or when examining the attributes of an innovation.

Most of the studies analysed seek to potray ICTs as useful in the teaching of mathematics. This shows that there exists a pro-innovation bais that was reported by Rogers (2003). There is a dearth of the accounts of the teachers that use the technology in the teaching of mathematics in as far as their experience is concerned and the decision making process they follow in selecting a tool in particular in the higher education context. This study therefore, seeks to add to the research on understanding the adoption of technology from the perspective of the teacher.

Rogers' theory analyses the diffusion of an innovation, looking at attributes of an innovation, the participants social system in which it is diffused, the type of innovation decision that should be made, the types of communication channels used, and any promotional efforts used by change agents (Rogers, 2003). The literature reviews that most researchers are concerned with are the attributes of the innovation. Most of the studies focus on examining how the attributes affect adoption. The reason for this could be that Rogers theory seeks to understand how an innovation is diffused over a period of time. However, as the literature review shows the theory provides attributes that can be analysed in an individuals social system to identify how an innovation is adopted.

With regards to mathematics, the literature does not provide a pedagogy that teachers could use in their teaching. Suggestions on the type of tasks, material that can be used or activities that can be implemented are provided. The absence of a framework for intergration technology in the pedagogy is an area where research is required. However, there is need to consider the social and cultural context in developing the framework. This will provide the teachers with best practices on how to intergrate technology in their practice.

Further research on the adoption of technology in mathematics in higher education is required. Examples of the areas where the research can focus on is the arguments of the teachers who do not support the adoption of technology in the teaching of mathematics. This will enable emperical evidence to be available to counter or support the arguments that are being made with regards to the adoption of technology in teaching

2.9 Conclusion

This chapter presented the theoretical framework used in this study. It also reviewed the literature from previous studies that addressed the issue of adoption of technology in a higher education context. The next chapter discusses the research methodology adopted by the study.

Chapter 3

Research Methodology

3. Introduction

The purpose of this study was to understand how technology was being adopted in the teaching of mathematics in a higher education institution in South Africa. This chapter includes a description of the: research design, participants and sample selection, data collection procedures, data analysis procedures, reliability and validity and ethical considerations.

3.1 Research design

This section presents the research design that was followed in this study.

3.1.1 Research design

Research design focuses on the outline, plan or strategy that was used to answer to research the questions (Johnson & Christensen, 2004). Furthermore, Mouton (2001) described a research design as a plan or a blueprint that shows how a researcher will undertake the study. Mouton (2001) concluded that a research design is used to provide answers to the type of research used by the researcher and explains the reasons for the research approach used.

3.1.2 Research approach

Creswell (2014) described a research approach as the plans and procedures for research. This includes the methods of data collection, analysis and interpretation. Creswell (2014) further added that the research approach is selected based on the research problem, the researcher's prior experiences and the intended audience for the study.

As the aim of the study was to gain an in-depth understanding of the situation regarding the adoption of technology and the meaning associated with technology, the study adopted a qualitative approach. Qualitative research has been described as an approach adopted for

exploring and understanding the meaning individuals or groups assign to a social or human phenomenon within their context (Creswell, 2014). In order to understand the situation and the meaning associated, research needs to be undertaken in the context where the problem exists in this case at MSA. Maxwell (2013) supported the use of the qualitative research method when the researcher attempts to view the phenomena under study in its natural setting. This enables the researcher to understand the context within which the participants act and the influences that the context has on the participants actions (Maxwell, 2013). To understand how technology is adopted, there is a need to undertake the research in the participants' natural settings. The researcher collected data through interviewing participants and inductive data analysis was used. These are all characteristics of qualitative research. Hence, this study will be a qualitative inquiry.

One of the characteristics of qualitative research is "that the researcher attempts to understand people in terms of their own definition of the world" (Mouton, 2001:194). This means that the focus is on an insider-perspective (Mouton, 2001). The advantage of using a qualitative approach is that it enables the researcher to understand how technology is adopted by the mathematics teachers, from the subjective perspective of the individuals involved because the complexities, richness and diversity of their lives can only be captured by describing what goes on in their everyday teaching lives (Mouton, 2001). Quantitative approach would not have been appropriate for this study. Drew, Hardman and Hosp (2008) describe quantitative research approach as dealing with the collection of data in the form of numbers. In this approach, the occurrence of behaviour is counted, correct answers or errors are counted and other types of measures are recorded in terms of quantity. In addition, quantitative research is concerned with the description of characteristics of a large group or the identification of differences between the groups. However, the number of mathematics teachers at the site of the study is only five (5). This makes the sample too small to make inferences. In addition, the aim of the study is to understand and not to describe the adoption of technology. As such, there is need to obtain the actual accounts from the participants through an in-depth investigation. Thus, qualitative research is more appropriate as it gives attention to context as the goal of the study is to rely on the participants views of the situation being studied. It shows that the research will follow a constructivist world view. Creswell (2014: 8) stated that constructivist researchers focus on the specific contexts in which people live and work together "in order to understand the historical and cultural settings of the participants". The researcher's intent is to make sense of the meanings participants have about the world. In

order to be able to make meaning the researcher has to use open ended questions in order for participants to share their views, the researcher has to gather data personally in the setting of the participants and meaning is obtained through social interactions with the participants.

To address the research questions, a case study approach was used. Biggam (2008) defines a case study as a study of one example of a particular type. The purpose of a case study is to investigate thoroughly and to analyse the phenomena (Biggam, 2008). A case study is appropriate for this research as it allows for the integration of information from various participants as well as for documenting and understanding similarities and differences of individual cases within their settings (Yin, 2009). The advantages of using a case study are that it ensures high construct validity, in-depth insights and allows for establishing rapport with research subjects (Mouton, 2001).

3.2 Context

Monash South Africa is the campus of Monash University, a public institution in Australia was the site for this study. Most of the students in the bridging programme are school leavers and there a large number of international students from African countries and other continents. These students are required to attend a lecture and two tutorials per week which are conducted by a teacher. The tutorials are each an hour long and are facilitated by a lecturer. Lecturers are referred to as teachers. The requirements to be a teacher are a teaching qualification, at least an Honours degree in Mathematics and at least three years teaching experience in a post schooling environment. The teachers teach the students in a class with an average of twenty-five students. They teach theoretical analysis, interpretation and modelling techniques twice per week to different classes. A semester is 12 weeks long. Most of the students in the ADP passed Mathematics as a school leaving subject but achieved a low mark, or have a Mathematics literacy background or have done Mathematics at General Certificate of Secondary Education Ordinary Level.

3.2.1 Population

The setting for this study is Monash South Africa (MSA) in the Foundation Degree Programme. The Foundation Degree Programme has eighteen permanent staff members and

more than twenty sessional staff members. However, the focus of the study was on the use of technology in the teaching of mathematics. A population is defined in terms of a) elements, b) units, c) extent and d) time (Struwig & Stead, 2013).

In research, a sample is drawn from the population. In qualitative research, the study's research objectives and the characteristics of the population determine which and how many people are to be selected. As this was a case study that was specific to one institution, no sampling procedure was followed. This is because the population had five mathematics teachers. There were three female and two males who all had more than fifteen years of teaching experience at either a high school or a university setting. All teachers had at least a first degree in mathematics and a teaching qualification. In this study the teachers are referred to as Teacher A, Teacher B, Teacher C, Teacher D and Teacher E. The characteristics of the teachers in the sample are as follows:

Table 1 Characteristics of teachers

Teacher	**Teaching Experience**	**Qualifications**	**Gender**
Teacher A	50 years	PhD	Male
Teacher B	17 Years	Honours Degree and Teaching Diploma	Male
Teacher C	13 Years	Honours Degree and Teaching Diploma	Female
Teacher D	36 Years	Honours Degree and Teaching Diploma	Female
Teacher E	30 Years	Teaching Diploma and Degree	Female

3.3 Research instruments

The research instruments used in a study depended on the purpose and aim of the study. The collection procedures used in this study are discussed below.

One of the data collection procedures used in this study were interviews. According to Ary, Jacobs, Razavieh and Sorensen (2006), an interview is a useful method for collecting data as it allows for one-to-one interviews and enables the exchange of views between the researcher

and the participant on a topic of mutual interest. Interviews that can be used can either be structured, semi-structured or unstructured. Willis, Jost, and Nilakanta (2007) added that structured interviews involve the researcher taking the lead in the interview schedule and types of questions. An unstructured interview involves the researcher conducting the interview without any preconceived ideas.

Interviews are intended to obtain views and opinions from the teachers. Other benefits of interviews are that they enable interviewers or interviewees to discuss their interpretations of the world in which they teach and to express how they regard situations from their personal points of view. Interviews also allow the researcher to control the line of questioning (Creswell, 2014). Interviews are also flexible for data collection as they allow the interviewer to make adjustments as the situation requires. In this study, each teacher participated in one interview sessions which lasted about 45 minutes. The interviews were held from 3 November 2014 beginning with Teacher A. The naming, for example Teacher A, was based on the order of the interviews. Each teacher was invited to select a date for the interview and depending on the date chosen they were then allocated a letter from A to E.

For this study, structured and semi-structured interview questions were used to collect data. This involved open-ended questions and the responses were recorded using a voice recorder. The interview guide for this study was derived from previous studies (see Appendix D (see Davis, 1989; Kamau, 2014; Lee, 2004). In this study, the interview questions were developed using the five DI characteristics as well as the communication channel and social system variables as guidelines. Each of the variables had multiple questions associated with it, as shown in table below. In addition to these questions, general questions were used to determine the interviewee's background with using technology and how they related the use of technology in their practice. The interview questions were developed partly based previous studies that had operationalized the DI characteristics (Hill & Lee, 2010: Kebritchi 2010; Samarawickrema & Stacey, 2007). A semi-structured interview style was selected based on the complexity of responses from individuals. There was a need to individualize the interviews so that the teachers' unique perspectives could be captured. The researchers did not want to assume that they could get all the information they needed from using a fixed set of questions, as would be the case in a closed-ended interview. Thus, the protocol for the interviews had a question set to allow for consistency, but still allowed participants to expand their answers and to delve with greater detail into areas they felt were important.

3.4 A framework for data analysis

Table 2 provides a summary of the questions asked for the participant interviews and the DI characteristic they illustrate.

Table 2 Interview Questions and DI attributes

DI Characteristic	Questions	Examples of how DI attribute appeared in the teachers transcripts
Background Questions	How long have you been teaching mathematics? How long have taught at MSA? How long have you been a mathematics teacher at MSA? How has being a ZHC1010 teacher influenced you to adopt technology teaching?	
Relative Advantage	Has your typical instructional style swayed you to adopt technology in your practice? Can technology be joined with other instructional methods of teaching mathematics? If yes, in which ways? If no, why not? Do you think the teacher's experience with technology might influence whether they adopt technology or not in mathematics teaching?	*The truth is a student must actually see the beginning of the sum and not the end of the sum. So by saving that on the, using the smart boards, I was privileged enough to be able to use those venues with the smart boards and the fantastic equipment there* (Teacher E Interview 1)
Compatibility	With regards to technology, have you ever considered using it in teaching? In your opinion do you think a mathematics teachers' prior experience with technology in teaching and learning influences whether they adopt technology or	*Not really, no, because there, because of the level of the topic it's more of a basic maths course, so it doesn't really require like an intensive use of technology and for that reason I didn't try* (Teacher B Interview 1)

	not? How has being a ZHC1010 teacher influenced you to adopt technology teaching? Do you think in-service learning in the use of technology could assist in technology adoption? From your experience and beliefs, do you think that technology is beneficial in the teaching of mathematics? If yes why? If not, what are the reasons? What barriers affect your ability to use technology in your practice at MSA? Do these barriers hinder your ability to adopt technology?	
Complexity	Do you feel that your knowledge of technology is sufficient for you identify and adopt technology? Does the accessibility of technology at MSA allow you to adopt technology in your Practice? If so, how? If not, explain why? In your opinion would owning a device for example an Ipad influence you to try and use it for teaching and learning ? If so, how? If not, why not?	*No, it's not a problem of knowledge of technology it's more about motivation and the time we have to spend preparing for that*. (Teacher B Interview 1)
Trialability	Does your use of technology outside of lectures and tutorials influence you to try the technology in the classroom? If yes why? If no, why not? Have you ever used technology or wanted you could try using technology in a classroom? In what ways does time affect your decisions to adopt or not to adopt technology?	*So and for some I have shown them, in some instances how to generate graphs, mainly with Excel and also with some, what you call that, open source software's, but because we don't have like a specific tutorial located to in the computer lab that's the reason why I don't do that, but is feasible if we could schedule for instance, 1 hour per week of a computer lab and we can go to a computer lab with the students.* (Teacher B Interview 1)

Observability	Have you experienced the use of technology in the teaching of mathematics? If yes, what did you gain from this experience or what did you understand about the use of technology? If no, what would you expect to learn if given an opportunity?	*And I've seen the students sitting in the corridors and at, in empty venues and so on. On the ground they will sit with their computer, watching these videos and then next to them they will have a piece of paper and they will close the video and start to do their examples and then they will open up again and look at these videos* (Teacher E Interview 1).
Communication Channel	With regards to collaboration, who do you collaborate with? Why do you collaborate with the individual or individuals? How do you collaborate?	"*We didn't have a special meeting about it, but some, two or three of us chat a bit about it, but it's all to do with student learning because by enlarge, my impression was the students that I was involved with at Monash"* (Teacher A Interview 1)
Social System	How has senior Management at Monash been supportive to teachers in process of using technology in the classroom?	*I mean Teacher B hasn't got the time to actually sit with me and because he's got such a full timetable that he's so busy teaching, you know, and then his only bit of spare time is his lunch hour. Then he's got this old bat here, asking him all sorts of questions, but that's, that's the reality of it* (Teacher D Interview 1)

3.5 Data analysis procedures

All the interviews were recorded. They were then transcribed verbatim and uploaded into Atlas TI as a new project (See Appendix E). The transcripts of the interviews were first read in Atlas TI to obtain an understanding of the overall responses. The researcher then undertook an initial coding exercise, which is referred to as descriptive coding to "see what is there" (Krathwohl, 1998:308). This involved mapping the participant responses to one of the attributes of the DI theory. Atlas TI software was then used to analyse the data. The reason for the use of the software was that the "code manager" feature in Atlas TI. The 'code manager' allows the researcher to manage all the codes in the list. This is based on the need for thematic coding (Mohamad & Friese, 2014). Using the code manager, "segments of the data are coded based on the respective themes using the constant comparative analysis method" (Mohamad & Friese, 2014:4). During the coding process, the researcher began to look for emerging themes within the DI attributes.

Using Atlas TI software analysis tab and selecting the Codes-Primary Document Table option, the results of this coding process revealed that:

Table 3 Number of quotations per DI attribute

DI attribute	**Number of codes**
Relative Advantage	56
Compatibility	84
Complexity	33
Trialibility	25
Observability	10
Communication Channel	11
Social System	24

3.6 Validity and reliability

There are two main validity threats that had an effect on this study. These were not the only threats to this study but they were the most important. These were reactivity and researcher bias. These are discussed below.

Reactivity refers to the "influence of the researcher on the setting or individuals studied" (Maxwell, 2013:124). The influence of the researcher cannot be removed from the research process but it should be understood and used productively (Maxwell, 2013). In order to deal with reactivity, there was need to emphasise to the mathematics teachers that the researcher supported them as teachers and that the study was focused on learning more about their views and experiences in using technology in their practice.

Researcher bias is linked to the selection of data that fits the researcher's existing theory, goals or preconceptions, and the selection of data that "stand out" to the researcher (Miles & Huberman 1994 as cited in Maxwell, 2013:124). These two are linked to the subjectivity of the researcher which is known as bias. Possible biases included trying to protect fellow colleagues and seeking only data that portrayed them in a positive light and seeking data that showed that technology was effective due to the belief that technology should be used in higher learning. To deal with bias the researcher exercised extensive reflection and reflexivity in the data collection and analysis which led to the researcher's own awareness.

Member checking was used to determine the accuracy of the findings through taking the final report or specific descriptions to the participants to determine if they viewed the information as being accurate. Maxwell (2013:126) states that this is the most important way of:

> "ruling out the possibility of misinterpreting the meaning of what participants say and do and the perspective they have on what is going on, as well as being important way of identifying your biases and understandings of what you observed".

In this study the major findings and the social cultural descriptions were emailed to the participants. They were given an opportunity to comment on the findings.

Peer debriefing was another validity check that was used. Creswell (2014) describes this as a process whereby the researcher locates a person who will review and ask questions about the qualitative study. He further adds that this process involves obtaining an interpretation beyond the researcher through the use of another person. The researcher utilised a lecturer in the institution (MSA) under study for the peer debriefing.

3.7 Ethics

Educational qualitative research makes use of a human participant from whom or about whom the data are collected and therefore ethical considerations must be considered during the study. Informed consent (see Appendix C) was obtained from each of the participants by providing a detailed consent form for participants to read and sign before the interviews were conducted. There is a responsibility to respect the "rights, needs, values and desires of the informants" (Creswell, 2003: 201). The consent forms outlined the study to participants as being voluntary, clearly articulated the purpose of the study in order to assure that individuals understood the nature of the study and its impact, provided a description of the procedures of the study so that the participants could anticipate their involvement, and made reference to the participants' privacy (Creswell, 2003).

As the study was undertaken using departmental colleagues that the researcher taught with, the research could harm the teachers. The teachers risked that the findings could reveal that they lacked skills in using ICT but they would have reported to the promotions committee

that they had the necessary skills. To minimise this risk, the researcher assured the mathematics teachers that only the teachers who participated in this study and the thesis readers would be informed about the results and conclusions unless if the teachers gave permission to do otherwise.

McMillian and Schumacher (2001) were of the opinion that settings and participants should not be easily identifiable in print. This was supported by Cohen, Manion and Morrison (2007) who emphasized the need for confidentiality of participant identities and state that the essence of anonymity is that information provided by participants should in no way reveal their identity. This means that there is a need to ensure anonymity by not using the names of the participants or any other personal means of identification. Teachers who took part in this study were given full assurances of confidentiality and anonymity.

Ethical clearance for the study was obtained from both the University of Cape Town and Monash South Africa. Monash South Africa has an ethical clearance process which the researcher followed (see Appendix D).

3.8 Conclusion

This chapter outlined the research design and research methodology for this study. The data collection methods used is the interviews. The validity and ethical considerations were also presented. Chapter 4 presents the results of the study.

Chapter 4

Results and Findings

4. Introduction

This chapter presents the results and findings of the study. The data was collected using interviews at the site of the study. This study examined the applicability of Rogers' DI model, specifically mathematics teachers' perceptions of educational technology (innovation's) characteristics, for analysing teachers' perceptions toward using education technology in their practice and how they adopt new technology. Below, the table shows how each teacher in this study taught using technology.

Table 4 Tools used by each teacher

Teacher	Tools Used	How technology is used	Examples of teacher's narrative
A	Learning Management System, Visualiser, PowerPoint, Excel, Projector, Computer, YouTube	• PowerPoint and Excel for presentation • Projector to show PowerPoint slides • In the course outline references are made to relevant YouTube videos • Developed an Excel interactive programme	• *I was showing them where the constant "e" comes from, as in limiting, the limits of the function and so I just went into Excel and I did it live in front of them but I was the one who did it and they sat and watched (Teacher A Interview 1)*
B	Learning Management System, Projector, Visualiser, Projector, PowerPoint,	• Uses Learning Management System to store learning material • Projector to display notes • Excel to generate graphs	• *They can see on one side the display from the overhead projector or another projector and on the other side I use the whiteboard to*

		• Refers students to Khan Academy for extra support • Developed a Skype intervention for discussion for student consultations	*show them how to obtain the results (Teacher B Interview 1).* • *You want to get this graph okay, go to Excel, you input your data this way, you use this function it's going to give you this graph" and sometimes I show them: "Okay you can modify the labels this way" but it is really very basic (Teacher B Interview 1).* • *"He will have, on the one screen, he will have the content typed out, but on the other screen he will work with a visualiser and he will develop it in handwriting, the thought processes of how the whole problem, you know, is set out" (Teacher E Interview 1)*
C	YouTube videos, Learning Management System, PowerPoint, LinkedIn, Email	• Projector to display slides • Shows a video clip during the lesson to break the monotony of lessons • PowerPoint slides with reference to Khan Academy for extra support • LinkedIn to explore new	• *In my current job I use a lot the videos, Khan Academy and so forth and then there's a lot of programmes for helping you to draw graphs and things like that, that I make use of, in addition to equation editor of course when I type my test and worksheets*

		tools • Developed an email support progamme	*(Teacher C Interview 1)* • *My students fill in a little piece of paper for me with their name and their student number and how they feel about the lesson. So, this one said she that she feels good about second order equations but she is not sure about exponential applications. So, I can immediately address that problem by emailing the student back and saying: "Please go look at this YouTube (Teacher C Interview 1).*
D	Projector, Learning Management Sytem, Visualiser	• Store class notes on shared drive • Refers students to videos stored on LMS created by Teacher D for extra support	• *So I'm definitely still more a "board and chalk" but here I use the visualiser and I develop what I need to teach (Teacher D Interview 1)*
E	Video Camera, LMS, Shared Drive, PowerPoint, Projector, Visualiser, Smartboard	• Smartboard to show students and save the solution • PowerPoint to display class notes • LMS to store class notes • Shared drive to store videos	• *Create a video and make sure that they can watch this video and then you are with your student even on a Sunday or a Saturday that is why I created that (Teacher E Interview 1)*

4.1 Presentations of the findings

A comparison was made within categories (DI attributes) to look for variations and nuances in meanings. As some DI attributes were too large, all the quotations within the categories were analysed in order to identify sub-themes. The sub-themes identified are presented below with an explanation of their meaning according to the researcher's interpretation.

Table 5 Sub-themes and their meaning

Sub-themes	**Researcher's Interpretation**
communication channel external	This refers to communication channels outside of MSA
communication channel internal	This refers to internal communication channels within MSA
Communication channel mass media	This refers to the use of mass media (news, online groups) channels
Compatibility negative attitudes	This refers to the negative thinking or feeling towards technology
Compatibility pedagogy (teaching experience)	This refers to how technology is suited with the teacher's teaching experience
Compatibility negative beliefs	This refers to negative trust or confidence in technology
Compatibility pedagogy (learning experience)	This refers to how technology is suited with the teacher's perceived learning experience in as far as the students are concerned
Compatibility positive attitudes	This refers to the positive thinking or feeling towards technology
Compatibility positive beliefs	This refers to the positive trust or confidence in technology
complexity tasks	This refers to the ease of creating, performing and using technology in mathematical related activities
complexity technology	This refers to the ease of use of the actual tools
Observability	This refers to how a teacher's use of technological intervention is visible to students or other teachers

social system collaborate culture	This refers to how teachers collaborate with each other
social system expertise	This refers to whether there is professional support at the institutional with regards to ICT
social system institutional support	This refers to how MSA supports teachers
Trialibility availability of resources	This refers to how teachers are able to access technological tools available
Trialibility expertise	This refers to whether the teacher has the ability to develop a technological intervention

4.1.1 Compatibility

The distribution of quotes with regards to compatibility is presented in the table below:

Table 6 Distribution of compatibility quotes

	Teacher					
	A	B	C	D	E	Total
Compatability - negative attitudes	2	2	3	5	7	19
Compatability - pedagogy (teaching experience)	5	3	4	3	2	17
Compatability - negative beliefs	0	1	2	4	4	11
Compatability - pedagogy (learning experience)	1	3	5	4	2	15
Compatability - positive attitudes	7	9	1	1	3	21
Compatability - positive beliefs	3	3	3	2	2	10

4.1.1.1 Compatibility - Pedagogy (teaching experience)

This refers to how technology is suited with the teacher's teaching experience or practice. Two of the teachers (D and E) explained that technology was not a necessity with regards to their teaching preferences. Teacher E stated that: *It's nice to have the technology but I can teach exactly as much as what I'm teaching on all of this technology, I can teach on a piece of paper* (Teacher E Interview 1). Teacher E on the other hand stated that:

> *You know if somebody, if somebody showed me how effective it is, ja, then I would, could use it, but I have not been shown that. I'm not, I'm not convinced that it's any better than my piece of paper and*

my pen and talking and discussing and going through (Teacher D Interview 1).

This shows that the preference is for the use of paper and pen in their teaching. This finding is similar to the one found in the work by Pierce and Ball (2009) who found the use of the pen and paper as a barrier in the use of technology in teaching mathematics.

On the other hand, Teacher A was of the opinion that technology is a necessity as it improves teaching and learning. This is seen in the following quote:

> *Whereas we've got technology, I mean look, 10 or 15 years ago I had a calculator that could factorise algebra expressions, differentiate polynomials and integrate functions and my question was if here is a machine that can do this, why must I spend 3 months teaching students how to do it by hand*? (Teacher A Interview 1).

Two teachers (B and C) while not dismissing the use of technology as a necessity, were of the opinion that from their experience in teaching time was a constraint that impacted their use of technology. *I do not see how I will now take that extra time and spend it into trying to enlarge my teaching, incorporating technology and all the other things* (Teacher B Interview 1). Furthermore, Teacher C stated that:

> *I think it's just a time constraint, you know, we've got a lot of teaching, I teach despite the fact that it's actually not part of my job description and that probably takes half a day at the moment, it used to take a full day out of a 5 day week* (Teacher C Interview 1).

This shows that teachers B and C have a time constraint with regards to exploring and using technology in their practice. Teacher E reported that that with regards to time, technology would not lessen the time required to perform some task. This is evident in the following quote: *Now if a student can draw a square root easily why will they go to click, click, click, click and then they've only got a square root, you know* (Teacher E Interview 1). Teacher D reported that as they were not competent in technology they were only concerned with completing the syllabus: *Look you've got your basic syllabus to carry on, but you know what I am not that au fait with getting around on the computer* (Teacher D Interview 1). What is emerging amongst the 5 individuals there are 3 different views of teaching with technology. Teachers D and E due to their preference to use paper and pen in their pedagogy do not prefer to use technology as they believe that it does not solve mathematical problems. Technology is viewed by Teacher D and E as a tool to enable access and communication. Teacher A is of the view that technology would not make their classes static and would improve interaction.

For Teachers B and C, technology could assist in providing opportunities for supplementary instruction.

4.1.1.2 Compatibility - Negative Attitude

This refers to the negative thinking or feeling towards technology. None of the teachers had a negative attitude towards technology. The concern was that some of the teachers (B, C, D and E) did not see the value of technology in some aspects of the teaching of mathematics. For example Teacher E explained that:

> *But really for mathematics, as long as you've got a whiteboard and you can wipe it off, it is as good or a good blackboard, and you can wipe it off, a blackboard is messy, it is exciting to use the smart board, but it's not really that you have to have it* (Teacher E Interview 1).

However, as the interview progressed the attitude towards technology changes. Later in the interview Teacher E explained that to supplement instruction she had to:

> *Create a video and make sure that they can watch this video and then you are with your student even on a Sunday or a Saturday when they, when it's, you know, when there aren't any lessons and that is why I created that* (Teacher E Interview 1).

Teacher E later added that:

> *Maths, you know if I think where do, I want to use technology, it's to make the learning process easier. But it won't and to make the assessment easier, but what do I want to achieve by assessment. This change in attitude was also evident in Teacher D who stated that: When I first started here I did because I didn't know how to, I could never get the things, the things going and you know the system is quite slow very often* (Teacher D Interview 1).

This change was made evident by the following quotation: *So I'm definitely still more a "board and chalk" but here I use the visualizer and I develop what I need to teach* (Teacher D Interview 1). The visualizer is used as follows:

> *He will have, on the one screen, he will have the content typed out, but on the other screen he will work with a visualiser and he will develop it in handwriting, the thought processes of how the whole problem, you know, is set out* (Teacher D Interview 1).

The visualiser is used for demonstration during teaching in the classroom.

The second concern with regards to technology was due to the lack of expertise in using educational technology. This was alluded to by Teacher D who stated that: *So the technology side is actually more my problem* (Teacher D Interview 1). Teacher B on the other hand believed that the nature of the content covered in the module did not warrant the use of technology:

> *Not really, no, because there, because of the level of the topic it's more of a basic maths course, so it doesn't really require like an intensive use of technology and for that reason I didn't try that.* (Teacher B Interview 1).

It is noticeable that Teacher B expressed a concern even though the teacher has not tried to use technology in the classroom.

4.1.1.3 Compatibility - Positive Attitude

This refers to the positive thinking or feeling towards technology. In order to determine the positive attitude the following question was created: From your experience and beliefs, do you think that technology is beneficial in the teaching of mathematics? If yes why? If not, what are the reasons?

Four of the teachers (A, B and C) strongly supported the use of technology in the teaching of mathematics. Teacher B stated that:

> *"I think so, but it influence you in my case, in a more positive note because when you see what you can do with technology, it shows you that the possibilities are infinite I can say, I can put it that way* (Teacher B Interview 1).

Teacher C: *Absolutely, I don't, I don't even for a moment see why not and I in fact, I think it's critical* (Teacher C Interview 1). Teacher A: *I suppose because I enjoy the technology. I'm always looking for, to keep up to date that way* (Teacher A Interview 1). Teacher D on the other hand was still undecided as they were wanted to be shown how technology could be effective. Teacher E was positive about some aspects of the technology for example providing supplementary instruction and communication but was negative with regards to how technology could assist students in the solving of mathematical problems.

This study found that teachers who readily integrate technology do not possess constructivist teaching styles. Teacher A teaching pedagogy is described as: *Ja, well broadly speaking,*

problem based and interactive (Teacher A Interview 1). Teacher B described his instructional style as:

> *I have more of a traditional approach. I use the whiteboard extensively to show students, to show to students how to get to a, the result, how to solve, but I also use, some technology, the notes necessarily or the notes mostly. I display the notes, I show them what it is we are going to talk about today. They can see on one side the display from the overhead projector or another projector and on the other side I use the whiteboard to show them how to obtain the results* (Teacher B Interview 1).

Teacher C described their pedagogy as being:

> *Okay, the students say that I aim it, kind of between a lecture and tutorial, so there is quite a lot of, I don't want to say "chalk and talk", but similar but it is interactive as well. I move around a lot, the students ask a lot of questions, there will be a little bit of going through the work making sure that the, the concepts are understood towards the beginning of the lesson and then towards the end of the lesson there will be examples for the students to practice, either individually or in small groups as they prefer* (Teacher C Interview 1).

Furthermore, Teacher D described their pedagogy as being: *So I'm definitely still more a "board and chalk" but here I use the visualiser and I develop what I need to teach* (Teacher D Interview 1). Teacher E described their pedagogy as:

> *So therefore, I like to teach for a little while, open up the context to them, but then they've got to do it themselves and then I will go students and say: "Show me what you are doing" and I will look and see what they've been doing and say, ¾ through the lesson then I will go back to the smart board, or whiteboard or whatever way and I will then pick a few of the sums that they've done and show them that the most common errors that they've made and discuss that again* (Teacher E Interview 1).

In all five teachers, there is a preference for teacher-directed or lecture-based instruction. Gunter and Gunter (2015) reported that teacher directed instruction is used in many classes because of its ability to deliver information quickly. It is also evident that teachers A, C, and E support constructivists as they provide opportunities for students to participate in the learning process as they allow them to use critical thinking skills to analyse a problem. Teachers B and D prefer the behaviourism approach where learning is controlled and students learn by mimicking behaviour.

4.1.1.4 Compatibility - Positive Beliefs

All the teachers were willing to adopt technology if it would be assist the students and their teachers in their mathematics module. This was best explained by the following quote: *Bearing in mind how helpful it could be not only to us but our students as well* (Teacher C Interview 1). In addition, some teachers (Teacher A and E) who were not regular users of technology had positive beliefs about technology. This is shown in the following quotes:

> *You see I don't do video games so I, but I mean if I was shown that there is, that there's something nice then yes, but whether you would get the same, if it's as effective, I don't, I don't know, I wouldn't, if someone could show me how to, you know, a game, then possibly I would look at it, yes, absolutely* (Teacher D Interview 1).

The quote from Teacher D reveals that the lack of expertise with regards to using some educational technology tools was a hindrance but they were willing to adopt technology. This is a view that was shared by all teachers in this study. However, despite positive beliefs about the use of technology, there was still some reservations about its importance and effectiveness in particular with Teachers B, C, D and E. This was evident in the following quotes: *You know if somebody, if somebody showed me how effective it is, ja, then I would, could use it, but I have not been shown that* (Teacher D Interview 1).

> *So, technology can come into those but it is not a necessity in terms of that, in terms of what Monash provides we have a photocopying budget and that's really all that's being needed* (Teacher C Interview 1).

However, in the same interview Teacher C was of the opinion that technology was critical as evident in the following quote: *Absolutely, I don't, I don't even for a moment see why not and I in fact, I think it's critical* (Teacher C Interview 1). The interpretation of this could be that technology use in the teaching of mathematics has not been fully understood and that its effectiveness is appreciated. Only Teacher A had fully understood and was willing to adopt technology as he saw it to be a must when it came to the teaching of mathematics.

4.1.1.5 Compatibility - Negative Beliefs

This refers to negative trust or confidence in technology. In order to determine the beliefs the following question was asked: Have you ever considered using technology in your teaching? Four of the teachers (B, C, D and E) expressed doubt about the belief that technology was a

necessity in the teaching of mathematics. An example is from Teacher E who stated that: *So technology, we use it but it's not really of any, it doesn't make it better, in the way that, you know, a whiteboard works, because I like to start it again* (Teacher E Interview 1). Teacher A did not express a negative attitude towards technology. He stated that*: I mean the technology I had, I couldn't work without it because it is such a big, it is on a large scale, so you've got to use computer* (Teacher A Interview 1). This shows that Teacher A believed that they had to use technology. The reason for this was because Teacher A saw technology as having the means to help him to make his classes interactive. This is shown by the following quote: *Because I don't, I don't like students just sitting and looking and listening. I believe learners have to be involved, actively* (Teacher A Interview 1). This again shows that technology will be adopted if it has the ability to influence classroom practice.

4.1.1.6 Compatibility – pedagogy (learning experience)

In this study the decision to adopt technology is dependent on how the teacher perceives technology in as far as the learning experience is concerned. Two of the teachers (Teacher D and E) emphasized that students need to actually be solving mathematics problems. Teacher E explained that: *You know it's all very well working on your, on your iPad and that but you know when it comes to real mathematics, you need to be able to actually do the doing, what is important from a mathematical point of view* (Teacher E Interview 1). From this quote Teacher E may have an underlying pedagogical belief that an Ipad would show students a method to solve a type of mathematical tasks whilst their pedagogical belief is that teachers use students' generated solutions and approaches to enact mathematical concepts in the classroom. The following quote supports this statement:

> *So therefore, I like to teach for a little while, open up the context to them, but then they've got to do it themselves and then I will go students and say: "Show me what you are doing" and I will look and see what they've been doing and say, ¾ through the lesson then I will go back to the smart board, or whiteboard or whatever way and I will then pick a few of the sums that they've done and show them that the most common errors that they've made and discuss that again* (Teacher E Interview 1).

This shows technology will be adopted by a teacher who believes it enables students to learn mathematics in a similar manner as the current practice.

Teachers A, B and C explained that they would adopt technology as it would improve classroom practice and provide opportunities for supplementary instruction. An example is seen from the following quote:

> *You know as you change from just talking, to showing a movie clip or just talking to allow the students to use their technology that they have at hand or you know it's, it just breaks the monotony of a lesson and it redirects, refocuses, brings the student back, you know making sure that they are using their learning time, wisely* (Teacher C Interview 1).

Teacher B, with regards to the learning experience, reported that it would assist students with regards to supplementing or reinforcing concepts:

> *Even in, for concept yes, if for instance they can obtain some YouTube videos, that explain differently a concept, maybe it's the approach of one teacher that may seem difficult to a student but if someone else explain the very same concept differently a student may come to understand better* (Teacher B Interview 1.).

Teacher A emphasised that technology would make the classes interactive and not static as they were currently.

4.1.2 Relative Advantage

The distribution of quotes according to relative advantage is presented in the table below:

Table 7 Distribution of quotes according to relative advantage

	Teacher					
	A	B	C	D	E	Total
Relative advantage - access	6	4	7	3	6	26
Relative advantage - learner support	1	4	5	1	4	15
Relative advantage- pedagogy	3	4	9	2	1	19
Total	10	12	21	6	11	60

4.1.2.1 Relative - Advantage Access

In the context of this study, this refers to how technology enables students and staff to obtain and view module resources. All five of the teachers thought that technology provided

unlimited access to learning material, was convenient as teachers and students did not have to carry their learning material as it was available online, saved paper as students did not have to print lecture material and enabled communication between teachers and students. For example, Teacher D states that: *"All you need to do is just print out the exercises because then you've got a hard paper and then you can tick off as you're going along, the ones you can do and the ones that you cannot do."* (Teacher D Interview 1). This is because lecture slides and class notes which were uploaded onto the Learning Management System (LMS) could be accessed from a number of devices such as smartphones. Thus, students did not need to print them and the teachers did not need to make copies for the students. In addition, students who miss class could still obtain the lecture notes and that the students could access the learning material from anywhere.

> *Then I decided, but there is an easy way of being close to your student. Create a video and make sure that they can watch this video and then you are with your student even on a Sunday or a Saturday when they, when it's, you know, when there aren't any lessons and that is why I created that* (Teacher E Interview 1).

On the other hand, despite the advantage of access all teachers mentioned drawbacks. Teacher A, B, C, D and E mentioned the following drawbacks slow response times, unreliable software and hardware, limited capabilities and lack of access to the computer labs for mathematical lessons and demonstration. Teachers A and C mentioned the availability of technology as a drawback as the students did not all have the same technology for example iPads in the classroom for activities to be assigned. Other Teachers A, B, D and E mentioned that they did not know the functionality of some tools to be able to use them for teaching. For example the issue of limited capabilities is explained by Teacher B as:

> "*The problem with Skype is that sometimes you don't have, if you have to write a solution it won't be like really a live interaction, they won't see how you have solved, you have to take a picture for instance, upload it, then they receive on the other side, they need to follow, but it can be done* (Teacher B Interview1).

Here Teacher B is referring to how he uses Skype to communicate with his students outside of the classroom. Students are assigned only three contact sessions per week with the teachers which are one hour long per each session. To assist students, Teacher B has created and shared a Skype account. Students can use Skype to communicate with Teacher B from 18:00 to 20:00 on Mondays to Thursday during the semester. It should be noted that Teacher B would be conducting the Skype sessions outside of the campus. However, the challenges that

Teacher B has encountered are that not all students cab use Skype especially the students that do not stay on campus. In addition, Teacher B encountered challenges during discussions when it came to displaying the results. Another issue raised by Teacher B was that they had to use their own data bundles as they would be communicating with students outside of the campus. This supports the view by Teacher C that technological interventions are a teacher's "own baby". Lee, Feldman and Beatty (2012) classed these as extrinsic factors and intrinsic factors which are to do with the context and knowledge and skill related to using technology in the teaching of mathematics.

4.1.2.2 Relative Advantage Learner Support

This refers to how technology provides students with supplementary instruction or additional learning resources and support**.** With regards to a supplementing instruction, 2 of the 5 teachers (Teachers B and C) explained that they could select online videos that were relevant to the students and refer them to the students. As Teacher C notes:

> *So, this one said she that she feels good about second order equations but she is not sure about exponential applications. So, I can immediately address that problem by emailing the student back and saying: "Please go look at this YouTube."* (Teacher C Interview 1).

This would ensure that the students had access to supplementary instruction even when they were off-campus. This would ensure that concepts were reinforced and provided additional opportunities for students to practice.

However, four of the five teachers (B, C, D, and E) were of the opinion that they tended not to allow students to access their own online material due to fear of the students being exposed to wrong methods and that the students generally were "weak" in mathematics and thus they tried to ensure that they only accessed relevant material. Teacher C who stated that:

> *So, I have watched them and made sure it won't conflict with the methods of teaching that we've used and that it will be understandable for the student so it will reinforce rather that confuse* (Teacher C Interview 1) .

Teacher D did not approve the use of online resources as she stated that: *You know what Sabelo, our students that come in are generally quite weak, if, in mathematics, if they didn't, if they were of a higher calibre they wouldn't be doing the foundation programme* (Teacher C

Interview 1). She was of the opinion that there was a need to consolidate their understanding of mathematics. The finding that teachers prefer to review the content that students access supports the findings of the study by Clements and Pawlowski (2012), whose study found that 75% of the respondents reviewed Open Educational Resources that they recommended to their students. It can be interpreted that there is need to ensure that students should use online resources that are recommended and approved by their teachers. This can restrict independent learning as students are discouraged from using resources that are not recommended by their teachers. The one teacher (Teacher A) did not believe in restricting what students were exposed to:

> *No, I don't believe in controlling what they learn. I believe in opening doors and windows and just saying: "Go through, find out for yourself." I would hate to think any student of mine, were held back in any wa*y (Teacher A Interview 1).

This shows that Teacher A supports self-discovery and independent learning as a learning strategy.

4.1.2.3 Relative advantage - Pedagogy

This refers to how technology provides students with supplementary instruction or additional learning resources and support. Despite the relative advantage of access with regards to the actual process of solving a mathematical problem, all the teachers except Teachers A and B preferred to use pen and paper. This is shown in the quotes: "*That is the first thing that I will do, I'm a bit of a, I mean, I like technology and all but I'm a bit of a paper girl*". (Teacher C Interview 1). This shows that there is an inconsistency with regards to technology. An example is seen in Teacher C who stated that: "*I cannot expect the students to go and sit and type mathematics. It will take them forever. You need to sit and take a piece of pen, paper and a pencil and scribble down notes*" (Teacher C Interview 1). This again shows that the tool cannot meet the educational goal as the tool will create an educational challenge for the students. Furthermore, Teacher D stated that: "*I'm not, I'm not convinced that it's any better than my piece of paper and my pen and talking and discussing and going through*" (Teacher D Interview 1). This shows that the teacher is not against technology in teaching and learning but Teacher D was of the opinion that technology did not improve the process of solving mathematical problems by yourself.

Teacher A did not prefer to use the paper system as he said:

> *So all my stuff was static, but I would've liked to have had, as I said earlier and as I said 1 hour a week in the computer lab, where they could've done some interactive stuff, because there's a lot of, a lot of material through, not mathematical specifically, but through Wolfram there is a, they've got lots of basically mathematical apps, but there is all kinds of stuff that you can do so that what you are doing is dynamic, rather than static* (Teacher A Interview 1).

Wolfram is a question-answering search engine whose aim is to make all systematic knowledge immediately computable and accessible to everyone. In addition, Teacher B was of the opinion that: *You have the conception phase that can be done on paper but the solving is the software* (Teacher B Interview 1). This shows a preference by the Teachers A and B to use technology for the actual solving of mathematics problems.

In addition, some teachers (B, C, D and E) viewed technology as being useful for communication amongst teachers and between the teacher and the students. Four of the five teachers (Teacher B, C, D and E) used technology as a communication tool for the module teachers.

> *Yes, I would like them to use the technology, because then I can communicate more easily to everyone. You know, if everyone is on track with the technology, you know, if everyone knows where to go and look for something and where to find it and how to use it, it obviously makes it easier, yes.* (Teacher E Interview 1).

Teachers B and C saw technology as a tool to communicate with students outside the classroom: *On Skype, yes, I have for instance when they have problems they have my Skype address, they can phone me on Skype. We can have a discussion when they don't understand the concept (Teacher B Interview 1).* From the above, it is evident that communication amongst the students is not currently being used. The communication is between the teachers or between the teacher and the students.

4.1.3 Complexity

4.1.3.1 Complexity - tasks

This refers to the ease of creating tasks or activities using technology. All teachers reported difficulties in creating, performing and using technology in their practices. The table below shows the distribution of quotes with regards to complexity of the task:

Table 8 Distribution of quotes according to complexity of tasks

	Teacher A	Teacher B	Teacher C	Teacher D	Teacher E	TOTALS
Complexity - tasks	1	3	2	2	2	10
TOTALS:	1	3	2	2	2	10

The table above shows that all teachers had some complexity issues. The complexity issues that affected teachers are presented in the table below:

Table 9 Main Complexity attributes

Teacher	Preparation Time	Technical ability
A	1	1
B	1	3
C	1	3
D	1	3
E	2	2

From the table, it is evident that preparation time and the technical ability to develop tasks such as assessments and videos are the two main complexities of the task issues that faced teachers. All teachers mentioned the issue of preparation time once excluding Teacher E. The reason why Teacher E may have alluded to this is due to the video initiative that she undertook. Technical ability to prepare, create and use the task was the major complexity of

the task issue raised. Examples are found in the quote below. Teacher E reported a difficulty in creating short instructional videos by stating that:

> *I tried to work that the camera will only photograph it over my shoulder on a piece of paper, but then my hand was in the way and that didn't work and I tried several ways* (Teacher E Interview 1).

This again showed a lack of expertise.

4.1.3.2 Complexity – Technology

This refers to the ease of use of the actual tools. The distribution of quotes with regards to Complexity of Technology is as follows:

Table 10 Distribution of complexity of technology quotes

	Teacher					
	A	B	C	D	E	Total
Complexity - Technology	3	3	3	8	5	22
Total	3	3	3	8	5	22

The issues raised with regards to complexity of technology are presented in the table below:

Table 11 Main complexity of technology issues

Teacher	**Technical Knowledge**	**Technical Support**
Teacher A	6	0
Teacher B	4	2
Teacher C	3	3
Teacher D	5	3
Teacher E	6	2

The two issues with regards to complexity of the technology where with regards to technical knowledge and technical support. All teachers reported that they had technical knowledge challenges for example how to use an iPad to write mathematics equations, how to create assessments using technology, how to upload on Skype or how to use video games for teaching and learning. Three of the teachers (Teachers A, D and E) reported that they were

not “au fait” with technology but were willing to be shown and would then consider to use it. The end result of teachers not being au fait with technology is explained by Teacher D:

> *Look you’ve got your basic syllabus to carry on, but you know what I am not that au fait with getting around on the computer. So I tend to, I tend to shy away from it within the classroom situation* (Teacher D Interview 1).

Teacher B reported technological challenges by stating that:

> *And also people who can provide training, in case we are faced with a problem because sometimes you have a problem with the software you don’t know who can help you overcome the problem, the difficulty. So, if you can’t solve yourself the problem it becomes difficult that you go with that technology in the classroom and get embarrassed in front of all of the students* (Teacher B Interview 1).

This shows that the unfamiliarity with the tool hinders its adoption as teachers do not want to be embarrassed in class.

Technical support was seen as being inadequate. Technical support was required on how to design, implement or problem solving. Adoption of technology was described by Teacher C as being “your own baby”. Some teachers (A, B, C and D) were willing to experiment so long as they had some form of technical support. For Teacher D this was evident from the following quote: *If I could see, if someone could show me how effective it is, yes, then I would use it* (Teacher C Interview 1). This shows the need for assistance to be provided.

Teacher D has the number of quotes with regards to technology. Teacher D described themselves as not being “au fait” with technology (Teacher D Interview 1). This is evident in the following quote:

> *Look you’ve got your basic syllabus to carry on, but you know what I am not that au fait with getting around on the computer. So I tend to, I tend to shy away from it within the classroom situation* (Teacher D Interview 1).

The reason why they tend to avoid technology is due to*:*

> *So the technology side is actually more my problem. It’s my fault, the institution or whatever, but ja, I definitely think they need to be taught, they really need to be taught something, but you know it will be outdated in 3 years time* (Teacher D Interview 1).

This shows that Teacher D has is aware of the changing nature of technology. They may also be using this as an excuse not to adopt technology given that all tools are continuously being upgraded to make it easier to use them.

4.1.4 Observability

The distribution of quotes with regards to observability is presented in the table below:

Table 12 Distribution of quotes with regards to observability

Column1	A	B	C	D	E	TOTALS:
Observability		1	1	2	1	1	5

This refers to how a teacher's use of technological intervention is visible to students or other teachers. In this study, the technological intervention that was visible was the videos created by Teacher E. All the teachers refer to these videos which are stored on the modules shared drive to be accessed and used by all including the teachers. Other teachers reported their PowerPoint slides as the only form of output that was visible as they were stored on the Learning Management System. Individual interventions such as Teacher B's use of Skype, Teacher A interactive Excel programme and Teacher C email support programme are only visible to the students that are taught by the teachers. This concluded that technology is being integrated in an individualized manner with some teachers not sharing their work amongst themselves. As in study by Kebritchi (2010), observability does not seem to have a strong influence on the decision to use technology. None of the teachers reported that the presence of the videos from Teacher E influenced them to attempt a similar initiative. Zhang, Wen, Li, Fu, and Cui (2010) added that observability which refers to visibility should stimulate peer discussion of a new idea as colleagues should request innovation-evaluation information about it.

4.1.5 Trialability

The distribution of quotes with regards to trialability is presented in the table below:

Table 13 Distribution of quotes with regards to trialability

	Teacher					
	A	B	C	D	E	Total
Trialability - Availability of resources	4	5	11	3	4	27
Trialability - Expertise	4	2	5	2	3	17
	8	7	16	5	7	44

4.1.5.1 Trialability - Availability of Resources

This refers to how teachers are able to access technological tools. As can be seen in table 13, all five teachers referred to the unavailability of resources for them to trial technology interventions. The resources mentioned in this study referred to the hardware, actual tools, time and place for example computer lab times. Trialability was affected by the lack of resources. This is evident in the following quotes: *I don't have a place where they do that* (Teacher C Interview 1) this is when asked about online collaboration. Teacher D:

> *That's absolutely, that's priority number 1 and you know if, if out of students, 2 have got iPads you cannot just teach on an iPad if 3 of the students haven't got access to that. You know, you've got to, you've got to cater for everybody and not everybody is in that league to actually have an iPad* (Teacher D Interview 1).

On the other hand, Teacher B stated:

> *I have shown them (students), in some instances how to generate graphs, mainly with Excel and also with some, what you call that, open source software's, but because we don't have like a specific tutorial located to in the computer lab that's the reason why I don't do that*. (Teacher B Interview 1).

The issue that can be discussed in this instance is how technology is conceptualised. It seems as though teachers believe that for technology to be used, there is need to use high end tools such as laptops and iPads. The reason for this could be that there is a dearth in examples of teachers who have created interventions without using latest and expensive equipment which is the situation for many teachers (Ertmer, Gopalakrishnan, & Ross, 2000). This will provide teachers with information such as how Teacher E used her own resources to create an intervention. Teacher E used her own resources to create videos for supplementary

instruction. There is need to demystify the notion that a technological intervention should be large scale and involve expensive tools.

4.1.5.2 Trialability – Expertise

This refers to whether the teacher has the ability to develop a technological intervention. Four of the teachers (Teachers A, B, C and E) had developed a technological intervention. In all four instances the teachers had to develop technological interventions by themselves with little or no technical and resource support. This is evident by the quote from Teacher C who stated that: *Because they (teachers) find that, it now has, it's going to be their own baby. They are the ones who are going to have to nurture the baby, create the baby…* (Teacher C Interview 1). The reason for this could be that the teachers have a positive attitude towards technology and also due to the need to scaffold their students learning. Despite their ability to develop technological interventions, the four teachers mentioned that they experienced challenges with some aspects of integrating technology.

4.1.6 Communication Channel

The study sought to understand the communication channel that influenced teachers' decisions to adopt technology. Rogers (2003) introduced the concepts of homophile and heterophony. Homophily is described as "the degree to which two or more individuals who interact are similar in certain attributes, such as beliefs, education, socioeconomic status and the like" (Rogers, 2003:19). Heterophily is described as the degree to which individuals differ in certain attributes Teachers at the institution can be described as being heterophony which is described as the degree to which individuals differ in certain attributes. The table below shows how teachers are different.

Table 14 Heterophily differences of the teachers

	Teacher A	Teacher B	Teacher C	Teacher D	Teacher E
Beliefs	Interactive	Student Centred	Content focused	Teacher Centred	Teacher Centred
Education	PhD	Honours Degree	Honours	Honours	Degree
Pedagogy	Socioconstructivist	Cognitive	Behaviourist	Behaviourist	Behaviourist
Experience	50 years	17 Years	13 Years	36 Years	30 Years
Role of Technology	Access, instruction, administrative, supplementary	Access, Supplementary instruction	Access, communication, self-study	Access	Access, communication, supplementary instruction

The table shows that there are differences in education, pedagogy and experience. Thus, the teachers can be classified as heterophony and could learn from each other. Below the different communication channels used by teachers to obtain information about adoption are discussed. The table below shows the distribution of quotes with regards to the communication channel of the teachers:

Table 15 Distribution of quotes with regards to communication channel

	Teacher					
	A	B	C	D	E	Total
Communication Channel External	1	1	1	1	1	5
Communication Channel Internal	2	2	3	1	4	12
Communication Channel Mass Media	2	1	5	0	1	9

4.1.6.1 Communication Channel External

This refers to communication channels outside of MSA. As evident in the table above, all the teachers reported that they discussed the use of technology with colleagues who are not part of the site of the study. Teacher A communicated with a colleagues who is in the IT industry, Teacher B communicated with colleagues from the University of Johannesburg where they used to work, Teacher C communicated on the social media site LinkedIn for guidance on interventions, Teacher D communicated with teachers at private schools who were former

colleagues and Teacher E communicated with colleagues at the University of Johannesburg. The nature of all communication was informal. Examples of these can be seen in the following quotes: *Not a lot, but the one guy on LinkedIn that I talk to, has put some links in there so I've been through and had a look at what is available* (Teacher C Interview 1). Teacher A stated: *I have got one friend, who is very computer knowledgeable, any technical queries I will go to him or otherwise these days one tends to go onto Google* (Teacher A Interview 1). The external communication channel is characterised by social interactions with colleagues from different contexts that range from high schools, universities and the information technology industry. Teacher E concluded by stating that*: Now I have gone to the iStore and I have asked them whether I can have words on it and whatever*. (Teacher E Interview 1).

4.1.6.2 Communication Channel Internal

This refers to internal communication channels within MSA. Four of the teachers (A, C, D and E) reported that they consulted with another teacher at MSA with regards to the use of technology. Teacher C communicated with another teacher in the Foundation Programme who taught a different module. Teacher A, D and E communicated amongst themselves. The discussions where mainly to seek assistance for example Teacher D would seek assistance from Teacher E on how to upload files onto the shared drive or learning management system. The discussions were mainly informal. Furthermore, with regards to mathematics teachers, Teacher A reported that*: We did talk about other things with regards to the unit but it wasn't with regard to technology* (Teacher A Interview 1). With regards to communication with other teachers in the Programme and the university, three of the teachers (Teacher B, C and E) reported that they discussed using technology with their peers. Teacher C communicated with a fellow teacher in the programme whilst Teachers B and E communicated with lecturers in the School of Business and Economics at the same university who taught Statistics. Again there communication was informal and involved social interaction. Part of the reason why teachers were not communicating was explained by Teacher C: *I think we don't make enough time within our teaching to allow technology teachers to sit down and chat about technology* (Teacher C Interview1).

4.1.6.3 Communication Channel_Mass Media

This refers to the use of mass media (news, online groups) channels. As can be seen in the table, only three of the teachers (Teacher A, C and E) use online tools which are LinkedIn and Google to search for information. Teacher A used Google to search for information, Teacher C used LinkedIn and Teacher E modelled herself according to other mathematics teachers she had seen on television:

> "*Where and it was one of my, one of my colleagues that I've worked with, that people will phone in with questions and then on the TV, you know SABC whatever, the lady will listen to the question, write it on the board and then explain it and yes*" (Teacher E Interview 1).

However, Teacher C discussed that there is too much information available on the Internet: *I think there's quite a lot of technology out there and you don't really know what available (*Teacher C Interview 1). All the teachers mentioned that time was a barrier that prevented them for exploring the different technology that was available. The problem that teachers could be experiencing was where to look for technology that they could adopt as there was no instructional designer employed at MSA. There was no one who was responsible for technology innovations who could provide guidance to the teachers and also show them what tools were available and how they could be used.

The table below summarises the communication channel of teachers.

Table 16 Teacher communication features

Communication Channel	Teacher A	Teacher B	Teacher C	Teacher D	Teacher E
Teachers within the Mathematics Department	x		x	x	X
Other Teachers in programme			x		
Within the university		x	x		X
Colleagues from other institutions or organisations	x	x	x	x	X
On Social Networks	x		x		

4.1.7 Social System

The study sought to understand the social system at MSA to establish if there was a supportive collaboration culture and whether there was sufficient expertise and support from the institution.

The distribution of quotes with regards to the social system is presented in the table below:

Table 17 Distribution of quotes with regards to the social system

	Teacher					
	A	B	C	D	E	Total
Social system - Collaborate Culture	0	2	2	3	0	7
Social system - Expertise	1	1	6	3	0	11
Social System - Institutional Culture	1	0	1	0	4	6

Societal culture has been shown to be an enabler of technology adoption (Twati, 2014). Two of the teachers (Teacher B and C) reported that there was little collaboration between the mathematics teachers at MSA with regards to use or adoption of technology. An example is seen in the explanation by Teacher B: *The colleagues, not really no, not yet*. On the other

hand, one of the teachers (Teacher D and E) reported that they assisted each other. Teacher E assisted Teacher D. This was explained by Teacher E who explained that:

> *Yes, I have, you know, for instance with Teacher E. I have shown her, you know, how to use these things and we've worked together and it's easy to say you know: "Go and look there and there", but it is just another way of storage, technology.*

From this quote, it is evident that this cannot be described as collaboration but is more of providing support to a colleague. Teacher A did not refer to the collaborative culture at MSA preferring to seek support from a colleague in the IT sector.

4.1.7.1 Social System - Expertise

This refers to whether there is professional support at the institutional with regards to ICT. All teachers explained that the only support they received in ICT was in the lecture and tutorial room with regards to trouble shooting from the institutions IT Department. With regards to technology adoption, the teachers who had requested for assistance in developing technology interventions (Teacher C and E) reported that the assistance was not effective. Teachers B and C suggested that there was need for an instructional designer to be appointed to assist teachers with technological interventions. Teacher A found the support offered by the universities ICT Department for problem solving as being effective. However, Teacher A does not allude to the expertise that is required to adopt tools.

4.1.7.2 Social System Institutional Support

This refers to how MSA supports teachers. Teachers A, B, C and E reported that there was little or no support from senior management with regards to technology adoption. The view of the teachers was that senior management was concerned with teaching venues. One of the teachers was of the opinion that: *It looks like management didn't see the need to put more resources into software's that students could be using more frequently* (Teacher B Interview 1). Two of the teachers had previously sought the assistance from senior management and they did not receive any support. This was explained by Teacher E who stated that:

> *No, well they, I went to Estelle and she then had to go to Australia and then she had to go and find out, you know it was endless problems. So, I thought that's not how I am going to do it, because it will, my students will fail because the 6 weeks of the summer semester will be gone and nothing, you know they will still be busy working.*

The lack of support from senior management did not hinder teachers from pursuing their technological intervention. Teacher D was silent on the issue of institutional support. The reason for this could be that Teacher D relies on Teacher E for technology issues and will tend to consult Teacher E.

4.1.8 Conclusion

This chapter presented the results of the study. The chapter was divided into three sections which focused on the description of the data obtained, the application of the DI theory and the discussion of the findings. The next chapter discusses the findings that were presented in this chapter.

Chapter 5

Discussion of Findings

5. Introduction

This chapter presents the findings of the study in relation to the research questions and literature review. The discussion seeks to highlight how mathematics teachers at the site of the study adopt technology in their practice, and the factors that enable or inhibit the adoption of technology.

5.1 Summary of research questions.

The discussion below will focus on the key research findings according to the research questions:

5.1.2 How did the attributes of technology affect adoption of technology in teaching mathematics?

Rogers' DI states that a users' acceptance of an innovation is influenced by the attributes of an innovation, communication channel, time and social system. "The benefits and burdens of a change will first be weighed to determine its relative advantage" (Lee 2004:238). Rogers stated that these benefits include a reduction in discomfort, savings in effort and time and other incentives (Rogers, 2003:238). Mathematics teachers in the current study believed that they provided for increased avenues for supplementary instruction. This shows that an innovation which can assist in providing supplementary instruction was more likely be adopted. However, teachers mentioned drawbacks such as slow response times, unreliable software and hardware, limited capabilities and not user friendly tools that could not be used to write equations. Lee *et al*., (2012) mentioned these as extrinsic factors and intrinsic factors which are to do with the context and knowledge and skill related to using technology in the teaching of mathematics. If teachers are to spend endless hours trying to write mathematical formulas using technology, this would lead to an increase in workload and the chances of them adopting technology will be reduced. These factors lead to an increase in stress which may decrease a teacher's acceptance of using technology in their practice.

In this study four of the teachers were not convinced about the role technology in the teaching of mathematics. These four teachers held beliefs that the nature of the mathematics they taught did not require technology and in addition they believed that the pen and paper was effective in their practice. They also lacked practical knowledge on how to perform certain tasks and had limited knowledge on different tools available in the teaching of mathematics. These teachers tended to avoid technology in preference to methods that they have established as being essential in the teaching of mathematics. Braun (2014) added that a failure of technology to convince teachers of its relative advantage could prevent teachers from adopting it. It can be concluded that in this study some of the teachers had not been convinced about technology and this impacted their decision to adopt it.

The second factor influencing the adoption of technology in the teaching of mathematics is compatibility with users' values and experiences. Two of the three teachers prefer to the chalk and talk approach. Writing on the chalkboard has been valued as allowing for flexibility to add new content and has been seen as the "main pedagogical genre of the undergraduate mathematics lecture classroom" (Artemeva & Fox, 2011; Kuteeva & McGrath, 2015; Wittek & Habib 2013). The teachers in this study alluded that technology affected their practice and increased their workloads. Researchers have criticised the use of technology in undergraduate classes as affecting pedagogy and leading to an increase in teachers workloads (Abuhmaih, 2011; Neyland, 2011). This shows that an innovation that affects pedagogy and increases the workload of teachers will most likely not be adopted.

In addition, in this study technology is seen as a mere access tool not capable of solving mathematics formulas or allowing students to actually solve a problem. This supports the views of researchers such as Clark (1994) who stated that media will never influence learning. Cheung and Slavin (2013:105) added that "educational technology applications produce a positive but small effect (ES=+0.15) on mathematics achievement". This supports that view of the mathematic teachers who state that technology does not have an impact on the ability of the students to be able to solve mathematical problems. This shows that when technology is to be introduced in the teaching of mathematics it has to be aligned to values and beliefs. In the present study, using technology was not viewed as adding any value to the teaching of mathematics.

In this study, the role of technology is viewed as to support learning. Technology should provide access and supplementary instruction. Its actual role in the classroom has not been

accepted. The reason for this could be that the impact of technology on teaching of mathematics is unknown by the teachers. There is a need for further research on how technology could influence the teaching of mathematics. Rienties, Brouwer, Lygo and Baker (2013: 123) added that "the challenge is not only designing effective, pedagogically sound professional development but also demonstrating the impact that this has had". The unknown impact of technology on the teaching of mathematics can thus have an impact on its adoption. An example of this was provided by Teacher A who referred to the introduction of the calculator by stating that:

> *And the same thing applies with calculators. When pocket calculators, as they used to be called, first hit the market, there were many teachers who said: "No, you can't use calculators in the classroom. Children won't learn their tables."* (Teacher A Interview 1).

It can be concluded that a tool will be adopted if its value to teaching and learning is accepted.

The third major factor influencing the acceptance of technology is the complexity. Teachers complained that some of the tools were not able to perform tasks that they could easily perform on paper and which took little effort and took less time. This shows that the adoption of technology is influenced by the affordances of the technology. This finding is similar to that of Margaryan, Littlejohn, and Vojt (2011) who found that the ease of use and the features of a tool can impact its adoption. Kiani, Malik, and Ahmad (2012) suggested for professional development with regards to mathematics teachers in areas such as operational skills.

The fourth factor was trialability. In the current study, some teachers were not happy with the current mathematics content they were teaching. Teachers reported that the "nature" of the mathematics course they taught affected their ability to adopt technology. However, the teachers are in a position to change the syllabus but are not. This supports the research by Delialioglu and Yildirim (2007) which found that a rigid syllabus had an effect on teachers' ability to experiment with technology in their practice.

In addition, time was seen as a major drawback in adopting technology. The study found time factors such as lack of time to learn new skills, a large teaching load and lack of technical and pedagogical support. This time factors were similar as those found in the study by Peralta and Costa (2007). The result of this was a preference for the use of chalk and talk as well as

paper. Teachers in this study were less inclined to use their existing methods than they were to use technology. For this reason it may be stated that technology did not meet their needs, which could have an effect in their motivation to adopt it.

The fifth factor influencing user acceptance is observability, which is the degree to which an innovation is visible to its users. The lack of support from the institution in as far as developing an innovation and its use led to teachers to question why they should explore and develop technological innovations. Bullock (2004) cited in Buabeng-Andoh (2012) supported the need for institutional support adding that it had an influence on whether a teacher decides to adopt technology or not. In addition, the technological innovations are only visible to colleagues teaching the unit and students enrolled for the unit. There was no system to place for teachers to showcase their innovations as well as due to the non-availability of resources in the lecture room and tutorial rooms teachers could not use some of the tools. Buabeng-Andoh (2012:143) added that when "teachers were given time to practice with the technology, learn, share and collaborate with peer, it is likely that they will integrate the technology into their teaching". In this instance they have limited opportunities to learn, share and collaborate with their peers due to a high workload, lack of time, need to complete syllabus and lack of technical know- how.

The attributes of the innovation that were significant were relative advantage and compatibility. Decisions to adopt were mainly influenced by relative advantage and compatibility. With regards to compatibility the central issues were attitudes and beliefs. As Dillion and Morris (1996:6) concluded, "innovation that offers advantages, compatibility with existing practices and beliefs, low complexity, potential trialability and observability will have a more widespread and rapid rate of integration". In this present study complexity (ease of use) also played a part in that if a teacher could not easily write an equation using a tool there were mostly likely to revert to the old paper method. Observability did not play a great part due to the lack of support from the institution were an intervention was seen as "your own baby" even though results can be seen by the students. Thus, this study can conclude that Rogers' DI is significant in the prediction and explanation of technology adoption the teaching of mathematics (Rogers & Wallace, 2011).

Technology adoption in this study seems to be greatly influenced by beliefs (compatibility). The results of the study indicate that there is a mismatch between beliefs and practice. This is similar to the findings by Chen (2008) found that there was inconsistency between the

teachers' expressed beliefs and their practices. This finding was also found by Judson (2006) who found that there was a misalignment between beliefs and practices. In this study this mismatch is evident in that some teachers believe that technology is critical but they state the mathematics module is too basic to use technology, the students need consolidation and that they prefer "chalk and talk". This shows that there is a misalignment between beliefs and practice.

Teachers in this study who are likely to adopt technology in their practice are those who can be described as being personal innovationists. Agarwal and Prasad (1998) defined personal innovativeness as individuals' willingness to try out any new information technology. "As innovative users tend to be more venturesome and daring, they are more likely to adopt a new technology innovation despite a high level of uncertainty in new IT adoption" (Agarwal & Prasad, 1998:1214) . Teachers A, C and E can be described as being personal innovationists as they are willing to adopt technology despite the challenges of technology and lack of institutional support.

Teachers in this study did not refer to the issue of a change in pedagogy that is required. The negative beliefs to technology could be a result of unwillingness for mathematics teachers to change their pedagogy. This would require that teachers re-examine their existing practices and in some cases to alter their existing practices. This may be too daunting to some of the teachers as they would need to acquire new competences and practices. The use of existing practices is thus seen as providing a buffer. In addition, teachers preferred to maintain the existing model of teaching that involves lectured-based, teacher-centred instruction, which required students to engage in much test-taking practice (Chen, 2008). The reason for this is because these methods have been tried and tested and they believe that they will achieve their goals.

The ease of use of technology is seen by Teo and Milutinovic (2009) as one of the significant facilitating conditions for teachers to use technology. In this study the teacher's desire to assist their students is seen as being more significant. This will be illustrated using Teacher A, B and E. Teacher A used Excel as an interactive tool by learning Excel by themselves, Teacher B used Skype to communicate with students after hours using his own resources and Teacher E decided to create videos for students to watch to supplement instructions. Teacher E was able to create the videos using her own resources and without any support from the institution or from an instructional designer. This shows that teachers had to learn to use a

tool at their own expense and use it in order to assist their students. The teachers did not view the institution as being supportive to technology initiatives and thus developed their own.

The results of this study dispute the results of previous studies in as far effective use and technological comfort levels. Gorder (2008:68) reported that a teacher experience is "significantly correlated with the actual use of technology". In Gorder's study, it was revealed that effective use of the computer was related to technological comfort levels. In this study Teacher E even though was less comfortable with using technology was responsible for the creation of independent study videos. Also, Baek, Jong and Kim (2008) claimed that experienced teachers are less ready to integrate ICT into their teaching. However, in this study Teachers A, B, C and E were ready to integrate ICT even though they had more than 15 years teaching experience. Teacher D who had 36 years of teaching experience was the exception to the integration of technology. This supports the results of Lau and Sim (2008) who found that the older teachers are more likely to use technology as they have a rich experience in teaching, classroom management and also are competent in the use of computers can easily integrate ICT into their teaching.

Braun (2014) added that a failure of technology to convince teachers of its relative advantage could prevent teachers from adopting it. If teachers are to spend endless hours trying to write mathematical formulas using technology, this would lead to an increase in workload. These factors lead to an increase in stress which may decrease a teacher's acceptance of using technology in their practice. This failure to convince teachers shows that there is need for training. Teachers may not be convinced about the usefulness of technology if they are not provided training opportunities. Training is important as it enable teachers to for examples to identify applications for each technology, integrating content and pedagogy (Boris, Campbell, Cavanagh, Petocz & Kelly, 2013). Cheon, Lee, Crooks, and Song (2012) found that in order to adopt technology educators need to be trained on how to use the different tools first and then the students as well need to be trained.

An issue that teachers did not mention was the subject/topic variation between countries with regards to online resources. Mathematics is taught differently in different contexts. Thus, some of the content my not be appropriate for the South African context. The reason why teachers may not have mentioned this could be that they are not aware of this or it is something that they had not considered before.

5.1.3 How does the communication channel influence teachers' decisions to adopt technology?

The teachers can be described as being heterophily. Heterophily is described as how individuals differ in certain attributes. Rogers (2003) further argued that diffusion of innovation does not occur between individuals with similar information technology skills because no information exchanges occur between the two. It occurs when individual are different. The teachers in this study were different in as far as beliefs, education, pedagogy, perceptions on the role of technology and technology competence. This means that diffusion of innovation can occur within this group. However, even though diffusion of innovation can occur, there is little or no evidence that the communication channel between the mathematics teachers at the institution plays a role in the adoption of technology. It was reported that discussion amongst the teachers revolved around the syllabus and that there was no formal opportunity reserved for teachers to discuss the use of technology. The teachers in this study preferred to communicate with people in other departments or external institutions or on social media. The reason for this may be that the teachers may not believe that in their context the other mathematics teachers would have the necessary knowledge or experience in using technology for teaching. Henderson and Dancy (2007) distinguished two characteristics that affect technology adoption. These are the instructor (individual) characteristics and the instructional context (situational characteristics). Using this it may be concluded that teachers perceive their situational characteristics as not being relevant to support their technological adoption.

The mathematics teachers seem to consult more with colleagues from other institutions rather than internally. Howell and Annansingh (2013:39) stated the reasons for this as being a "lack of formal mechanisms in place to encourage knowledge sharing as well as the absence of stimulus knowledge sharing policy or a champion". O'Dowd (2013) added that another barrier to internal collaboration was finding suitable partners within the institution to consult and work with. Another reason could be that colleagues are unaware of the skills possessed by other colleagues due to a lack of a forum for them to discuss or showcase their abilities

5.1.4 In what ways does the DI social system influence adoption of technology?

The current culture at MSA is for a teacher to develop their technological interventions by themselves. An example is Teacher C who created the videos without the assistance of her

colleagues. This shows that an individualism culture exists. Lee, Trimi, and Kim (2013:22) defined individualism as the "degree to which the individual emphasizes his/her own needs as opposed to the group needs and prefer to act as an individual rather than as a member of a group". Teachers adopt technology for the own purpose. This is a finding that is similar to the study by Graham, Woodfield, and Harrison (2013) who found that lecturers adopted blended learning for their own purposes and not driven by policy or management. The social system that exists is thus confined to individualism in the development of a technological intervention. This intervention is only visible to fellow teachers teaching the module and the students who are part of the intervention.

There are different types of change management that can be used in technology adoption. The first is a top-down approach that is driven by management, bottom-up which is reflecting emergent or participatory-driven change, or combinations of the two (Marshall, 2010). The bottom-up initiatives are generally driven by individual 'early adopters' (Marshall, 2010). In this study the social system is characterised by bottom up initiatives. The top-down approach is assumed to be aware of the dynamics and culture of their universities, enables creation of systems for change and providing the resources needed to endorse new ideas (Lee *et al.*, 2013). However, as alluded by Teachers A, B, C and E there is a lack of support from the management. There is a belief that management may not have realised the importance of adopting technology. The end result is that teachers have to practice a bottom-up approach if they are to adopt technology in their practice.

With regards to change agents, there seems to be no clear change agent. According to Rogers (2003:238), "change agents would not be needed in the diffusion of innovations if there were no social or technical chasms between the change agency and the client system". In this instance change agents are required as there are social or technical chasms. Teacher E was described as a technology champion for having created instructional videos for the students. However, Teacher E mentioned that the reason for the creation of the videos was to assist students during a short summer semester and it was a once off occurrence due to issues such as lack of equipment, time and lack of support from the institution.

5.2 Overall summary

Although this study was conducted at a private institution of higher education in South Africa and may not be generalised to mathematics teachers in other institutions, the findings indicate that Rogers' DI theory can be used appropriately to describe mathematics teachers' perceptions towards the use of educational technology in their teaching practice. Researchers have recognised the benefits of applying Roger's model to the adoption of new technological interventions (Kamau, 2014; Pundak *et al*., 2014; Rogers & Wallace, 2011). The use of the three elements of the DI theory which are the innovation, communication channels, time and social system were able in this study to show the factors related to technology adoption in mathematics education.

The findings of this study revealed that teachers (1) lacked technology training especially in mathematics teaching, (2) had mixed views on the effective use of technology in their practice, (3) time affected their ability to explore and use educational technology, (4) did not perceive technology could assist students to accomplish the tasks that they were required to perform, (5) had little or no pre-teaching training on educational technology, (6) there is need for a technology champion to mentor and assist teachers, (7) lack of institutional support which acted as a barrier and hindered teachers from experimenting with technology and (8) teachers preferred to discuss technology with colleagues from other institutions as there were no formal structures in place for them to engage colleagues internally.

For the innovator, they perceived educational technology as having a relative advantage. These teachers mostly collaborated with colleagues from other institutions to learn about different tools, how to use the tools and to obtain guidance. These teachers used Internet sites such as YouTube and Khan Academy to provide students with supplementary instruction but only after they had viewed and recommended them. They also used Internet sites for guidance on how to create instructional videos and also resources such as Skype to communicate with their students. The findings also revealed that the teachers in most instances were using personal video camera, Internet modems, smartphones and tape recorders which played a role in supporting them to adopt the technology in their teaching. The innovators were both male and female, with degrees. This is different from results from

studies by Kamau (2014) who found that early adopters were male and older with more years in teaching.

5.3 Conclusion

The chapter presented the main research questions and how it is answered by the findings of the study: examining how mathematics teachers adopt technology. The research questions were presented and answered in detail with the aid of literature. The last chapter, Chapter 6 presents the conclusion of the study.

Chapter 6

Conclusions and Recommendations

6.1 Final Comments

The study sought to understand how technology was being adopted in the teaching of mathematics in the higher education sector in South Africa with a focus on one institution. The results of the study indicated that the choice to adopt technology is greatly influenced by a teacher's attitude towards technology, their perceptions of how students learn the availability of support within an institution. At present, the teacher's adoption is seen as "your own baby" with little support from the institution. To be able to adopt technology, a teacher is required to avail their own time, use their own resources, and learn how to create a technology intervention on their own. Thus, the choice to adopt requires a willing teacher. It can also be concluded that the "technology space" of the ADP is utilised for storing teaching and learning material.

The attributes of the innovation that were significant were relative advantage and compatibility. Decisions to adopt were mainly influenced by relative advantage and compatibility. With regards to compatibility the central issues were attitudes and beliefs. As Dillion and Morris (1996:6) concluded:

> "innovation that offers advantages, compatibility with existing practices and beliefs, low complexity, potential trialability and observability will have a more widespread and rapid rate of integration".

In this present study, complexity (ease of use) also played a part in that if a teacher could not easily write an equation using a tool there were mostly likely to revert to the old paper method. Observability did not play a great part due to the lack of support from the institution were an intervention was seen as "your own baby" even though results can be seen by the students. Thus, this study can conclude that Rogers' DI is significant in understanding the problem of the use of technology in mathematics.

Four of the ADP Mathematics teachers in this study reported that their educational goal required that students solve mathematical problems individually and the process the students followed should be visible. The teachers reported that paper was readily available and could

accomplish their goal which was for students to solve mathematical problems on their own. The teachers also added that their goal was for students to be able to solve problems and that they must see the entire process of solving mathematical problems. As the paper was able to do this, they did not feel that technology was useful as they could accomplish their goal without it. Some teachers (three teachers) who had an interest in technology felt that students should have access to supplementary instruction outside of the classroom. It should be noted that these are teachers who communicated with colleagues from outside the site f study with regards to improving their teaching. With this in mind, one of the teachers was creating short videos that would show students how to solve a problem and then uploading activities on the LMS for students to practice. Technology was seen as a means to accomplish a goal.

Technology was not seen as being influential in teaching and learning by three of the ADP mathematics teachers. These teachers felt that the nature of the mathematics course they were teaching did not require technology. They were also of the opinion that technology would expose students to wrong methods. What is evident is that these teachers view technology as disruptive as it would require that they spend large amounts of time preparing, it would require that they change their practice, it would require that additional resources be allocated, and they would need support to be able to use the tools in their teaching. These teachers viewed effort as being useful in the teaching of mathematics. To these teachers, even if technology was not present it would not affect their classroom practices as students could still learn without the technology. All they required was "chalk and talk" and paper for the students to be able to practice. The belief of these teachers was that all that students required was the ability to apply a formula to solve a problem. Thus, these teachers were not willing to adopt technology as it did not alter their beliefs when it comes to the teaching of mathematics. The two teachers who view technology in a positive manner can be described as being innovative as they continuously seek for solutions to assist their students. These teachers have a keen interest in using technology to supplement instruction and also to avoid their classes from being static. However, the technology interventions of the two teachers are merely to supplement instruction and not to create a student centred environment. All the teachers were reluctant to create environments were students could collaborate. The view held shows that mathematics in this study is still seen as a subject was social learning has not been embraced.

All the mathematics teachers were using tools that were already in teaching venues which they found easy to use and they therefore used them extensively. These included projectors

and the computers in the venues. All the teachers indicated that all they were required to do was to log in. They viewed these tools as being user friendly. However, some other tools such as smart boards that had complex functions tended to be ignored in preference to the whiteboard. The reason for this was that they were deemed not to be user friendly and the teachers were not taught how to use them and they preferred to use the whiteboards which were convenient and easy to use. The complexity of the tool therefore played a part in decisions whether to adopt or not.

Three teachers complained that existing tools did not meet their needs. For example, some of the tools did not allow them to be able to write mathematical equations. Two of the teachers also thought that existing tools did not show the process of students solving problems. Therefore, they did not see how technology could replace paper and thus were comfortable with using paper as it enabled them to meet their goals as technology was not able to perform some of the tasks that were essential in their practice. They could do without the technology.

The social system is characterised by relationships with colleagues from other institutions. The mathematics teachers seem to consult more with colleagues from other institutions rather than internally. Howell and Annansingh (2013:39) stated the reasons for this as being a "lack of formal mechanisms in place to encourage knowledge sharing as well as the absence of stimulus knowledge sharing policy or a champion." O'Dowd (2013) added that another barrier to internal collaboration was finding suitable partners within the institution to consult and work with. Another reason could be that colleagues are unaware of the skills possessed by other colleagues due to a lack of a forum for them to discuss or showcase their abilities.

6.2 Recommendations

From the findings as discussed, the following are recommended by the study:

- MSA should provide opportunities to improve mathematical teachers understanding of how to adopt technology in their practice. One of the findings of this study was that there seemed to be a lack of capability to use technology in the teaching. This resulted in attitudes that technology could not assist students in problem solving. This research supports the views of Waits and Demana (2000:53) who argued that "adoption of technology by teachers requires professional development that focuses on both conceptual and pedagogical issues, on-going support in terms of "intensive start-up

assistance and regular follow-up activities" and a desire to change from within the profession." This would ensure that mathematics teachers have support instead of relying on their own abilities.

- There is need to increase observability with regards to technological innovations. This could be through organising workshops or symposiums where teachers could be able to showcase their innovations. Such opportunities will enable teachers to see how technology could be effective and may aid in changing attitudes towards technology.
- There is need for expertise to recommend and guide teachers on the technology that they could use in their practice. This would be in the form of an instructional designer. There is need for an instructional designer to be able to assist the teachers. The instructional designer will ensure that teachers have support in instructional design.

6.3 Recommendations for further study

This study could be repeated using a bigger sample that is not restricted to one institution. In addition, the data collection methods could be increased. This would enable comparisons to be made and also to identify best practices that can be adopted in other contexts.

As is the case in Lee (2004), a longitudinal study of different stages in the innovation adoption process and related factors would be useful to assist institutional managers to identify and apply relevant strategies to assist in the diffusion of an innovation. This would identify barriers and allow for the identification of solutions to overcome those barriers as the innovation is being rolled out.

There is need for research into how technology can be integrated into the formal mathematics course. The interventions found in this study focused more for outside of the classroom and not in the actual classroom. This leads to questions such as how technology can be integrated into the class environment. The factors that aid and inhibit the adoption of technology in the formal classroom need to be investigated. The end result of this would be for a technology adoption model to be developed.

There is a need for investigation into the best training practices for experienced teachers. These teachers have the subject knowledge and they have perceptions on how that knowledge

should be shared with students. There is a need to investigate how attitudes and collaboration may influence these teachers to adopt technology in higher education in South Africa.

6.5 Conclusion

The use of technology in the teaching of mathematics in this study was greatly influenced by the teacher's attitude towards technology. Teachers who saw the affordances of technology were willing to utilise it for the benefit of their students whilst teachers who were concerned with simply completing the syllabus were reluctant to adopt technology. This research sought to understand the reasons why mathematics teachers adopt technology. Technology has a part to play in the teaching of mathematics as it provides students with support outside of the classroom. Though technology could have a negative effect on students by for example providing access to incorrect methods, institutions could use technology to provide assistance to at risk students by ensuring that teachers are able to provide support outside of the classroom and to provide an environment for stronger trained students to mentor at risk students.

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APPENDIX A – ARTEFACTS

Semester 1 2014 Unit Guide

ZHC1010

Mathematics B

Unit synopsis

Welcome to ZHC 1010 Mathematics B. In this unit you will be involved in further theoretical analysis, interpretation and modelling techniques, carried over from Math A.

This will be evidenced in the study of logarithmic graph functions, transformations; logarithmic expressions, equations, and word problems, and the study of differential calculus.

1. Inverse Relations: Graphic method; algebraic method; exponential and logarithmic functions.
2. Logarithms: Graphing transformations; definitions, log laws (addition, subtraction, exponents, change of base); expressions and solving equations; problems and applications.
3. Introduction to Limits Concept: 'from above and below'; terminology; ('tends to') calculations.
4. Average Gradient: Equation derived from $m = \frac{y_2 - y_1}{x_2 - x_1}$; how gradients

change according to the position on a curve; average speed; concept of 'average'.

5. Instantaneous Gradient: Gradient at a point; tie in the concept of limits; gradient of a curve; differentiation rules, product, quotient, power and chain rule.

6. Curve Applications: Curve sketching and interpretation. Tangents,

7. Word Applications: Word problems; interpretation; analysis application of above theory in real life situations. Examples where calculus is used in the economy.

Mode of Delivery	
Workload	1 hour lecture, 3 hours tutorials per week This unit carries 15 credit points towards the total of 120 credits needed to meet the requirements of this programme. These 15 credit points equate to 150 hours required for the ADP1010 course. 36 of the hours are notional hours (face-to face contact hours) comprising 1 lecture and 3 tutorials per week. The other 102 hours are to be spent on pre-reading, tutorials, assignments and studying for tests and the exam in this unit. This means that you need to spend 9.5 hours per week over and above the time spent in class to meet the demands of the unit.
Unit Relationships	Same as in the Student Handbook
Prerequisites	ADP1017 [Mathematics A]
Office hours	08h30-16h30
Tutor(s)	Details will be made available in class and details will also be available at https://www.monash.ac.za/students/msafp// under the section "Current Students"
Consultation hours	See teacher timetable on notice board for consultation

	times

ACADEMIC OVERVIEW

Learning Outcomes

1. To expand on content knowledge in Mathematics, at school level regardless of specific qualification obtained.
2. To build knowledge confidence of students, seen by their change in approach to the progressive challenges in course content.
3. Develop a problem-solving mentality and ability in students, with the co-operation of students, dealing with a) abstract/theoretical, b) practical and c) 'real life' problems.
4. Analyse word problems, by breaking them into smaller, more manageable parts, demonstrating that they have not been overwhelmed by the amount and complexity of the problem; in as many different fields of study as possible.
5. Thorough interpretation of basic graphs and some of their transformations in terms of real life situations is essential in order to demonstrate the potential in further undergraduate study to analyse situations encountered in different disciplines.
6. Manipulation and interpretation of secondary data, so as to present it in a format understandable to the ordinary reader. (Qualitative and quantitative; and interpretation is inferential)
7. Students need to develop the ability to draw basic graphs of linear, quadratic, exponential and logarithmic functions.
8. The ability to draw basic transformations of the above graphs is necessary in theory, so that the following can occur: graphical representations of life situations, understanding of problems faced and interpretation of trends.
9. Students must be able to choose and use mathematical formulae where necessary to solve problems once initial analysis has occurred.

Graduate Attributes

1. responsible and effective global citizens who:

a. engage in an internationalised world

b. exhibit cross-cultural competence

c. demonstrate ethical values

2. critical and creative scholars who:

a. produce innovative solutions to problems

b. apply research skills to a range of challenges

c. communicate perceptively and effectively

Critical Cross field outcomes

In addition to the specific outcomes there are also seven critical-cross field outcomes outlined by the DoE that are necessary to achieve. We will work towards achieving these outcomes as described below:

1. Identify and solve problems in which responses display that responsible decisions using critical and creative thinking have been made.
2. Work effectively with others as a member of a team, group, organisation or community.
3. Organise and manage one's activities responsibly and effectively.
4. Collect, analyse, organise and critically evaluate information.
5. Communicate effectively using visual, mathematical, and / or language skills in the modes of written and or oral presentation.
6. Use science and technology effectively and critically, showing responsibility toward the environment and health of others.
7. Demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation.

Assessment Summary

Assessment Task	Value	Due Date

Assessment 1	8%	Week 3
Assessment 2	15%	Week 6
Assessment 3	7%	Week 9
Assessment 4	15%	Week 11
Practice Exam	5%	Week 12

Teaching Approach

The teaching approach in ADP1010 is lecture and tutorial based. There is one lecture and 3 tutorials for ADP1010.

During the lectures the content of the course is explained and discussed.

During tutorials, students get the change to practise what they have learnt during the lecture. There will be interaction between students and the teacher. Peer assisted learning can also take place during tutorials. Problem-based learning will be encouraged.

Feedback

Our Feedback to You

1. In class: you will get immediate feedback during tutorials, when you approach me as a teacher with a problem regarding Mathematics B. Verbal comments, as well as written examples of feedback on the whiteboard, to the whole class, to groups, or individuals will be given.

2. During consultation: There are 2 hours of consultation per week, during which you may bring any problem regarding Mathematics B to me that you have encountered. I will help you with work that you have done by yourself. No re-teaching of content will be done during consultation.

3. Tests: tests will be handed back to you within 2 weeks after the group of Mathematics B students have written the test.

You may find some written comments in the test. A memorandum of the test will be available online. (an example of a similar previous test, with a memorandum will also be available online before the test is written)

Your Feedback to Us

Monash is committed to excellence in education and regularly seeks feedback from students, employers and staff. One of the key formal ways students have to provide feedback is through SETU, Student Evaluation of Teacher and Unit. The University's student evaluation policy requires that every unit is evaluated each year. Students are strongly encouraged to complete the surveys. The feedback is anonymous and provides the MSAFP with evidence of aspects that students are satisfied and areas for improvement.

For more information on Monash's educational strategy, and on student evaluations, see:

http://www.monash.edu.au/about/monash-directions/directions.html

http://www.policy.monash.edu/policy-bank/academic/education/quality/student-evaluation-policy.html

Previous Student Evaluations of this unit

If you wish to view how previous students rated this unit, please go to https://emuapps.monash.edu.au/unitevaluations/index.jsp. Monash is committed to excellence in education and regularly seeks feedback from students, employers and staff. One of the key formal ways students have to provide feedback is through SETU, Student Evaluation of Teacher and Unit. The University's student evaluation policy requires that every unit is evaluated each year. Students are strongly encouraged to complete the surveys. The feedback is anonymous and provides the Faculty with evidence of aspects that students are satisfied and areas for improvement.

Required Resources

No textbook is prescribed for this semester. The content will be on the T drive and on Moodle.

Recommended Resources

Classroom Mathematics.

Field trips

There are no field trips for ADP1010

Additional subject costs

There are no additional subject costs for ADP1010.

Examination material or equipment

Students need to have a scientific calculator with exponential and logarithmic functions e and $\ln x$. Students may not use a programmable calculator.

UNIT SCHEDULE

Week	Activities	Assessment
Week 0. 24 Feb - 28 Feb	Orientation	
Week 1. 3 March - 7 March	Logarithms: definition and laws	
Week 2. 10 March -14 March	Logarithmic equations	
Week 3 17 March - 20 March	Exponential & Logarithmic (Graphs)	

21 March Public holiday	Inverse Functions:	
Week 4 24 March - 28 March	Exponential & Logarithmic (Graphs) Transformations	Test 1
Week 5. 31 March - 4 April	Logarithms Applications	
Week 6. 7 April-11 April	Logarithms Applications	Test 2
Week 7 14 April-17 April 18 April Public holiday	Limits Average Gradient; Inst gradient (First principle)	
Mid semester break 21 April - 24 April		
Week 8 28 April – 2 may	Rules of differentiation 3 hours	
Week 9	Calculus: cubic graphs	Test 3

5 May – 9 May		
Week 10 12 May – 16 May	Calculus: Applications	
Week 11 19 May – 23 May	Calculus: Applications	Test 4
Week 12 26 May – 30 may	Revision	Practice Exam
2 June – 6 June	SWOT VAC	No formal assessment is undertaken SWOT VAC
9 June – 13 June	Examination period	LINK to Assessment Policy: http://www.policy.monash.edu/policy-bank/academic/education/assessment/assessment-in-coursework-policy.html

ASSESSMENT REQUIREMENTS

Assessment Tasks

Assessment 1: Test 1: Transformation of logarithmic functions; logarithmic laws and equations.

Date: Week 4

Details of test: Open book test. Short questions on transformations of logarithmic functions, logarithmic laws and equations.

Value: 5%

Assessment 2: Test 2:. Questions will be based on all of the content of Logarithms covered in Math B

Date: Week 6

Details of test: Students must be able to draw logarithmic graphs; to answer any question related to the knowledge of transformations of logarithmic functions and its inverse. Students must be able to do algebraic conversions from Exponent to Logarithm and from Logarithm to Exponent; Find the x-intercept, domain, etc. Simplifications (+/-3 examples) of Logarithmic expressions; 3-5 logarithmic equations and logarithmic problems related to everyday life.

Value: 17%

Assessment 3: Test 3: Short questions on Calculus (Introduction to the theory of Calculus) First principles, average gradient, limits and differentiation and Cubic functions.

Date: Week 9

Details of test: Open book test. The format of the test will be short questions.

Value: 5%

Assessment 4: Test 4: Calculus: Questions on limits, differentiation, using rules and First Principles in differentiation. Cubic graphs, equation of a tangent. Calculus applications: questions on real life examples especially, examples from finance and the economy, where Calculus can be used to solve the problem.

Date: Week 11

Details of test: Question will be based on all of the Calculus covered in Math B.

Value: 18%

Additional assessments:

- Practice Examination:

Date: Start of week 12.

Details of test: Based on all work done in the semester, the practise examination will be in the same format as the final examination and will help prepare the students for the final examination.

Value: 5%

Examination(s)

A final and formal examination will be written at the end of the semester.

Assignment submission

Hard Copy Submission: Assignments must include a cover sheet. The coversheet is accessible via the MSAFP website (https://www.monash.ac.za/students/msafp// under the section "Current Students"). Please keep a copy of tasks completed for your records.

You must submit all assignments in the assignment box, located in the library building on the top floor, outside the FP administrators' office.

Extensions and penalties

1. The due dates for the submission of assignments are provided in the unit guides. Please make every effort to submit work by the due dates. Students are advised to NOT assume that granting of an extension is a matter of course.
2. All assignments must have an assignment cover stapled to them. A copy of the assignment cover provided in section 4 of this information handbook. It is also available under the general folder of the shared drive for the MSAFP.

3. Assignments for submission are to be placed in the assignment box outside the MSAFP Administrator Office (Learning Commons Building, Floor 2) by no later than 10h00 on the stipulated day for submission.

4. Tutorials are submitted in class to teachers in person and not in the assignment box.

5. There is a late assignment submission penalty of 5% per day. Student handing in an assignment after 10h00 on the stipulated day will be penalised by 5%.

6. Where medical reasons exist for late submission of work required, a medical certificate, issued by a medical practitioner registered with the South African Medical and Dental Council (SAMDC) is required to hand over to the Teacher and Student Support Advisor.

7. If you need an extension for any of the assignments, your request must be submitted in writing to your teacher at least 48 hours before the submission date.

8. Requests for extensions may or may not be approved by your teacher.

9. Along with your written request for an extension, please attach supportive evidence such as medical certificate with your written request. The appropriate pro-forma is available at http://www.monash.edu.au/exams/assets/docs/in-semester.pdf.

10. Note that other teachers not taught by you cannot grant extensions for work submitted in this unit.

11. The relevant teacher will indicate at the time of granting the extension whether any penalty marks will apply to the submitted work.

12. If an extension is granted, the approval must be attached to the assignment.

Returning assignments

Students will receive their marked assessments back during a tutorial.

Referencing requirements

State the requirements for referencing, and refer students to the appropriate Faculty or School/Department referencing guide or relevant convention.

OTHER INFORMATION

Monash South Africa Foundation Programme website

MSAFP has its own website with documentation and information specifically relevant to our Foundation Programme students: https://www.monash.ac.za/students/msafp/.

Policies

Monash has educational policies, procedures and guidelines, which are designed to ensure that staff and students are aware of the University's academic standards, and to provide advice on how they might uphold them. You can find Monash's Education Policies at: http://policy.monash.edu.au/policy-bank/academic/education/index.html

Key policies for Foundation Programme Students:

1. Plagiarism and Assessment http://policy.monash.edu.au/policy-bank/academic/education/conduct/plagiarism-policy.html.
2. Special Consideration (http://policy.monash.edu.au/policy-bank/academic/education/assessment/special-consideration-policy.html).
3. Grading Scale (http://policy.monash.edu.au/policy-bank/academic/education/assessment/grading-scale-policy.html).
4. Discipline: Student Policy (http://www.policy.monash.edu.au/policy-bank/academic/education/conduct/suppdocs/discipline-guidelines-from-23-07-12.pdf).
5. Important dates (http://www.monash.ac.za/about/important-dates/).
6. Orientation (http://www.monash.ac.za/study/enrolment-orientation).
7. Transition (http://www.monash.ac.za/students/student_dev).

Student Services

The University provides many different kinds of support services for you. Contact your tutor if you need advice and see the range of services available at http://www.monash.ac.za/current/student_dev/

The Monash University Library provides a range of services and resources that enable you to save time and be more effective in your learning and research. Go to http://www.lib.monash.edu.au or the library tab in my.monash portal for more information

APPENDIX B – EXPLANATORY STATEMENT

EXPLANATORY STATEMENT

(Relevant Participant Group)

Project**: Using diffusion of innovation theory to understand how technology is adopted in the teaching of mathematics at a South African higher education institution**

Chief Investigator's name: Sabelo Chizwina
Foundation Programme South Africa
Phone : +27119504114
email: sabelo.chizwina@monash.edu

You are invited to take part in this study. Please read this Explanatory Statement in full before deciding whether or not to participate in this research. If you would like further information regarding any aspect of this project, you are encouraged to contact the researchers via the phone numbers or email addresses listed above.

What does the research involve?

This dissertation study seeks to understand how technology is adopted in the teaching of mathematics in the Foundation Programme. The literature also reveals that teaching with technology can be a daunting task for most teachers due to a number of factors. One is the use of technology "involves rethinking the format of activities and what counts as an acceptable explanation and solution" (Bowers & Doerr, 2001:126). The effect of this is that it can lead to teachers not using technology in their teaching of mathematics if they find rethinking the format of activities too difficult to comprehend

Participants will be observed during a tutorial for an hour. Participants will then be interviewed for forty five minutes (45).

Why were you chosen for this research?

You have been selected to take part in this study as the focus is on the use of technology in teaching mathematics. Thus, as you are a mathematics teacher in the Foundation Programme at Monash South Africa you form part of the sample to be used in the study.

Consenting to participate in the project and withdrawing from the research

I am inviting you to participate in a dissertation study. Your involvement in the study is voluntary, so you may choose to participate or not. You can withdraw at any stage of the project without being penalised or disadvantaged in any way.

Possible benefits and risks to participants

The risk to you for participating in this study is that you may feel uncomfortable being interviewed or recorded or talking about some of the questions during the interview. If at any time, you no longer wish to continue, you have the right to withdraw from the study, without penalty.

Confidentiality

I will use the following procedures to minimize risks during this study:

(a) gaining voluntary permission to participate in the study, (b) providing pseudonyms for you, the class, and Monash (c) providing permission for withdrawal from the study at any time, (d) keeping data in a locked cabinet, and (e) destroying the audiotapes at the end of the study. All articles written about this study will adopt pseudonyms for you, your class, and Monash South Africa to conceal your identity.

The data will be destroyed after a 5 year period unless you consent to it being used in future research.

Results

Any data that the researcher extracts will not, under any circumstances, contain names or identifying characteristics. You will be given a transcript of data concerning you for your approval before it is included in the write up of the research.

Any information you provide during the interviews or identified during observations is confidential, and that no information that could lead to the identification of any individual will be disclosed in any reports on the project, or to any other party.

The results for this study will be reported as part of the dissertation to be submitted for evaluation for the requirements of the degree. The results will be available from May 2015 and participants will be provided with a copy of the submitted dissertation. All information provided will be kept confidential.

Thank you,

Sabelo Ransome Chizwina

APPENDIX C – CONSENT FORM

CONSENT FORM

(Relevant Participant Group)

Project: Using diffusion of innovation theory to understand how technology is adopted in the teaching of mathematics at a South African higher education institution

Chief Investigator: Sabelo Ransome Chizwina

I have been asked to take part in the research project specified above. I have read and understood the Explanatory Statement and I hereby consent to participate in this project.

I consent to the following:	Yes	No
Audio recording during the interview	☐	☐
Observation during teaching	☐	☐

Name of Participant:

……..

Participant Signature : **Date :**

…….. ……

APPENDIX D – INTERVIEW QUESTIONS

Interview Questions

1. How long have you been teaching?
2. How long have you been teaching at MSA?
3. With regards to technology, have you ever considered using it?
4. Do you feel that your knowledge of technology is sufficient for you identify and adopt technology?
5. How long has been a mathematics teacher at MSA? How has being a ZHC1010 teacher influenced you to adopt technology teaching?
6. Have you ever used technology or wanted you could try using technology in a classroom?
7. Has your typical instructional style swayed you to adopt technology in your practice?
8. How has senior Management at Monash been supportive to teachers in process of using technology?
9. Does your use of technology outside of lectures and tutorials influence you to try the technology in the classroom? If yes why? If no, why not?
10. Does the accessibility of technology at Monash allow you to adopt technology in your Practice? If so, how? If not, explain why?
11. In your opinion do you think a mathematics teachers' prior experience with technology in teaching and learning influences whether they adopt technology or not?
12. In your opinion would owning a device for example an IPad influence you to try and use it for teaching and learning? If so, how? If not, why not?
13. Have you experienced the use of technology in the teaching of mathematics? If yes, what did you gain from this experience or what did you understand about the use of technology? If no, what would you expect to learn if given an opportunity?
14. Do you think in-service learning in the use of technology could assist in technology adoption
15. From your experience and beliefs, do you think that technology is beneficial in the teaching of mathematics? If yes why? If not, what are the reasons?
16. Can technology be joined with other instructional methods of teaching mathematics? If yes, in which ways? If no, why not?
17. In what ways does time affect your decisions to adopt or not to adopt technology?

18. What barriers affect your ability to use technology in your practice at MSA? Do these barriers hinder your ability to adopt technology?
19. With regards to collaboration, who do you collaborate with? Why do you collaborate with the individual or individuals? How do you collaborate?
20. What else would you say about technology in a classroom?

APPENDIX E – TEACHER INTERVIEWS

INTERVIEWER: MR SABELO CHIZWINA

INTERVIEWEE: TEACHER A

MR CHIZWINA: How long have you been teaching mathematics?

TEACHER A: Oh Sabelo, let me just think. I think it's about 50 years.

MR CHIZWINA: 50 years?

TEACHER A: Hmm.

MR CHIZWINA: Has it been in a private, at a schooling system, University?

TEACHER A: 7 years, 7 years school, 5 years college and the rest at University.

MR CHIZWINA: How long have taught at MSA?

TEACHER A: About 5 years.

MR CHIZWINA: Oh, okay, like in that whole experience with regards to technology, have you ever considered using it in teaching?

TEACHER A: Yes.

MR CHIZWINA: And specifically which types of technologies?

TEACHER A: Well it depends on your definition of technology, a ballpoint pen is technology. So, I guess when I first started teaching we didn't have electronic stuff, so, but more recently, look I have used modules, cardboard modules, wooden modules, if you count that as technology, which I do.

MR CHIZWINA: Yes.

TEACHER A: Worksheets? Do you count that as technology?

MR CHIZWINA: Yes, we do. It is anything that is, that can enable students to be able to….

TEACHER A: Well then…

MR CHIZWINA: Ja.

TEACHER A: Well then obviously things like the old blackboard and whiteboard, and geoboards. You know well, pick your apparatus for enhancing the learning of mathematics and then more recently of course the electronic stuff. I mean I've used, obviously used Word, Excel, PowerPoint. I mean I have used PowerPoint and Excel in parallel for presentations, when I was teaching, before I came to Monash.

MR CHIZWINA: In your opinion do you think a mathematics teachers' prior experience with technology in teaching and learning influences whether they adopt technology or not?

TEACHER A: Sorry say again, do I think?

MR CHIZWINA: The teacher's prior experience might influence whether they adopt technology or not?

TEACHER A: Well I would think so. I mean if a teacher is familiar with the technology, himself or herself, then I think they are more likely to embrace it and if they know that the, well what the technology can do, what it is capable of, then I think that they'd be more inspired to use it in the classroom. If it's stuff that you don't know, it might be different. I mean for example, I know whiteboards are very good. You can, because they link to a computer. I have never actually used one but if I had an opportunity I would, if that answers your question.

MR CHIZWINA: Yes, it does. As a Unit Co-ordinator this semester, did your position as a Unit Co-ordinator, did it influence you like to adopt technology? Did you find that it is…

TEACHER A: Specifically being the Co-ordinator?

MR CHIZWINA: Yes.

TEACHER A: No, not in itself, I mean, I mean all that technology was a given, or what I did, you know, in the sense of me giving the lecture, or the two lectures, in the lecture theatre. I mean the technology I had, I couldn't work without it because it is such a big, it is on a large scale, so you've got to use computer. You've got to use projectors and but to support

that I made sure that I used PowerPoint in a particular way. I don't just, well it is difficult to describe in words, but I tried to make it interactive, to put it that way.

MR CHIZWINA: Okay.

TEACHER A: Because I don't, I don't like students just sitting and looking and listening. I believe learners have to be involved, actively.

MR CHIZWINA: Okay. Right, so how can you describe your instructions style in the teaching of maths?

TEACHER A: Ja, well broadly speaking, problem based and interactive.

MR CHIZWINA: Has your typical instructional style swayed you to adopt technology in your practice?

TEACHER A: Well here at Monash it, not in the lectures, in the lectures I was just using PowerPoint and voice.

MR CHIZWINA: Hmm.

TEACHER A: But in tutorials, well of course everybody has got calculators and then they can't do much of the stuff without calculators. I used a projector there and I use there is a white, a whiteboard. So you know there's a combination of what was projected on the screen, the questions for the students to do, plus me giving interpretations and asking. I mean my technique, I suppose the style is to ask questions, if the student asks me a question, I ask another question back, because I want to stimulate their thinking.

MR CHIZWINA: Okay.

TEACHER A: I, I avoid if, as much as possible, just giving somebody the answer, which is in effect doing the problem for them.

MR CHIZWINA: Do you think in-service learning in the use of technology could assist in technology adoption?

TEACHER A: Well look, teachers, teachers need to be up to date. I used to say, when I was involved in teacher education for about 35 years and I used to say to students at different times: "If you're doing this 1 year post-graduate certificate in education, if that's all you ever do, then your experience is going to be 40 years x 1, instead of 1 x 40 years. There is a very,

very big difference. So whether it is, in service education provided by the Department of Education, that's one thing, I think the Department of Education should provide in service education but not to force it on teachers. You've got, teachers have to be motivated and I think there are a lot of teachers in our system who are there because there is nothing else for them to do and they're not really, I don't think they are inspired, at all inspiring, but that is a very biased view. It is, because I have been in teacher education and I have observed a lot of people in the classroom. Not in the last 10 years, but because I haven't had the opportunity, but whilst I was observing, as I say, there are teachers who believe that, the way to teach is to say: "Right, turn to page 53" and then they read what is written on the page and then they write upon the board what is written on the page and then they tell the children to learn what is, you know, to copy it down. So you'll get and I've actually seen this happen, something which is in the textbook which children could read for themselves and the teacher could ask questions on, the teacher takes it from the textbook, write it on the blackboard. The children write it into their books and it takes half an hour and to me that's a waste of time. But so, you've got to have teachers who are inspired, who enjoy their teaching and who want, their goal has got to be to get children to learn and so there's the formal side of in service education but there is also the personal side and to me a dedicated teacher will improve him or herself as a matter of course. You know as you, as you, otherwise you don't grow in your teaching skills or in the profession and your knowledge of learning and so on.

MR CHIZWINA: Does your use of technology outside of lectures and tutorials influence you to try the technology in the classroom? If yes why? If no, why not?

TEACHER A: I'm sure it does, because you get to know the technology and you, well if you're thinking about teaching then you can look at some technology and say: "Well, yes, this has, this will give me the edge" if you like. "This I could use to great effect in the classroom", but then in some cases you have got to adapt it or modify it, because I'm just thinking for Excel for example. Well, this is not teaching mathematics, its teaching statistics but they're closely linked and to me, I unless it was with a theoretical mathematical statistics course. The thought of teaching statistics without something like Excel, as an interactive tool, all the time, would be crazy. I mean, I have seen it happen, you know, with students. I taught the statistics and they're taught it by methods of 50 years ago. Which were fine then and they still work, but that's all by hand. Whereas we've got technology, I mean look, 10 or

15 years ago I had a calculator that could factorise algebra expressions, differentiate polynomials and integrate functions and my question was if here is a machine that can do this, why must I spend 3 months teaching students how to do it by hand? I want to teach them, they need the concept and they need to be able to use them and apply them, but sometimes the in's and out's, it's like long division. Kids in Grade 4 spend about 8 weeks learning long division which, to me, is a waste of time for those little ones because they don't need it until they get to Grade 12. Well look I am sounding off on other things now.

MR CHIZWINA: Okay. How has senior Management at Monash been supportive to teachers in process of using technology in your classroom??

TEACHER A: Sorry, did I find that I had what?

MR CHIZWINA: Support?

TEACHER A: Support?

MR CHIZWINA: From senior management or from management?

TEACHER A: No, I can't, I can't that. I mean if there was a problem there was support from the, not the IT…

MR CHIZWINA: ITS?

TEACHER A: Is it the IT section?

MR CHIZWINA: ITS, ja.

TEACHER A: Because they were very good. I mean because there was a phone on the console here and anytime there was a problem I would just dial the 4077, speak to someone and in a minute or 2 somebody is there to help you or they would give me instructions over the phone. So that, that was excellent support.

MR CHIZWINA: Okay.

TEACHER A: But I can't claim it from sort of management or anything. I don't think they had anything to do with it.

MR CHIZWINA: Have you experienced the use of technology in the teaching of mathematics? If yes, what did you gain from this experience or what did you understand about the use of technology? If no, what would you expect to learn if given an opportunity?

TEACHER A: Yes.

MR CHIZWINA: And how was that experience? What did you learn from that experience?

TEACHER A: What did I learn from it?

MR CHIZWINA: Ja.

TEACHER A: Well in some cases what I learnt was this teacher needs to learn it better. I could do better than that, but otherwise I don't think I, you know there were a few occasions, I guess with computer-based stuff, where I learnt something new but often not, because I wasn't, I wasn't observing fully qualified teachers, they were mostly student teachers. So they are still learning, but I don't, I can't say that I have learnt a lot from them. It was the other way around really.

MR CHIZWINA: Okay, like what, what could you have learned, what were you expecting to learn from them?

TEACHER A: Well, I think any time that you watch somebody else teaching you learn something, because I would always look at it and say: "Well okay I won't compare them with how I would do it" or there were many times where I would say: "Well that is a good lesson but I wouldn't teach it that way" but I'd never mark anybody down on that basis. It is a matter of, my goal was, or the criteria was: "Did the children learn anything" and if the children learnt some maths then the technique, whatever the teacher did was deemed to be successful and there are times when somebody does something. They teach it in a slightly different way and you think: "Oh ja, that's good, I'll remember that and then I will try it myself next time." So there is always that.

MR CHIZWINA: Do you feel that your knowledge of technology is sufficient for you identify and adopt technology?

TEACHER A: I don't know that it does. I mean I've always, I know there are teachers who and I'm not too keen on the technology side of things. I embraced it fully, I mean I'm always looking for some new way. So I don't, you know if there's something there, I mean check

something out, check on Google, you accidentally come across something you think: "Yes, I can use that" a different way of presenting a topic or a concept, a different way of teaching something but, I mean, I'm always open to it.

MR CHIZWINA: Hmm.

TEACHER A: I suppose because I enjoy the technology. I'm always looking for, to keep up to date that way.

MR CHIZWINA: Do you refer your students to, for example to Khan Academy and sites like that or you, you feel that you need to be able to control what they learn?

TEACHER A: No, I don't believe in controlling what they learn. I believe in opening doors and windows and just saying: "Go through, find out for yourself." I would hate to think any student of mine were, were held back in any way, but as for other things like Khan Academy, from time to time I would mention things, I didn't deliberately, unless when I, it didn't apply in this, at Monash, because everything was all cut and dry, but in other institutions where I wrote the course outline and various notes for students, reference is, I would have references to things on YouTube for example and other places because there is a lot of good material there, but in day to day teaching, just a casual reference, from time to time. If there was a difficult concept, I mean some, some students found it difficult to understand the basis of calculus, but there are lots of good videos on YouTube, so you can refer people to that, but a blanket, go to YouTube or go to Google, I do not think it is helpful. Students initially want something specific, so that's what I would do.

MR CHIZWINA: Okay, does Monash have enough technological resources for you to experiment with?

TEACHER A: No, no, because I mean the technology, the availability at Monash is good, I don't have a problem there.

MR CHIZWINA: Ja, because some teachers they have raised a concern that they should actually have computer lab sessions with the students in this unit.

TEACHER A: Well, look, yes. Look my, the previous institution I was at the structure was different. I mean, let me just share something with you, it's maybe not part of the interview formally but one lecture and three tutorials is unbalanced. There was no, no workshop, no lab session, computer lab session. So yes, I'm in favour of that even for the maths that we

were doing in maths B, I would have expected at least 1 hour a week in the lab. It would've been I suppose tricky to organise with so many students but then that is management's problem, not mine.

MR CHIZWINA: Okay.

TEACHER A: If the management wants to offer first class education then they address those issues.

MR CHIZWINA: Okay, because like I saw like in, do you, are you in favour of these lab sessions, where students are taught maybe to use different types of software, because some teachers still believe that they should actually be teaching the students how to solve a problem manually?

TEACHER A: Look, it's a bit of both, I and I'd been influenced, you see, I have never been a professional mathematician but I have been a professional statistician so it's, my view is a bit biased, but I have tended to look at things and say: "Okay, this topic that we're on now, if we were not here in the classroom how would we do it?" And the answer is: "Well if you didn't know the formula you would go to a book and look it up, or you'd Google it and if you wanted to do a calculation you grab a calculator or you go to Excel or you'd use some specialised stats software like SPSS or Stata." Now if you don't teach the students that way then I think you are doing them a disservice. Sure, they have got to learn to solve problems but how do they learn to solve problems? Do they learn to solve problems the way we would solve problems, because if they don't we're doing them a disservice.

MR CHIZWINA: Because there is this belief that, like many teachers they still believe in the chalk, the chalk method of writing a formula and solving the formula with the students. Do you think that we need to use technology more because the students actually prefer to use the technology and not just…

TEACHER A: Well, look I think it depends where you are. If you are at Monash, then yes, take advantage of the technology. If you are down in Lusikisiki, if you are out in the sticks in a rural school where they don't have electricity, you've got to think of something else.

MR CHIZWINA: Okay.

TEACHER A: But the same, the same principle applies. You know if it is just chalk and talk, then it is at best old-fashioned and boring.

MR CHIZWINA: Okay, right. From your experience and beliefs, do you think that technology is beneficial in the teaching of mathematics? If yes why? If not, what are the reasons?

TEACHER A: Undoubtedly, ja and there's a whole load of, well look there's such a lot available. Yes, I think it's definitely beneficial.

MR CHIZWINA: Because some teachers still believe that technology is just there to provide access to the resources that is out there, they see technology…

TEACHER A: Well, sure that's one use for it, yes but it's also, it's also a tool. You've, there's a problem solving tool, but the problem is that some teachers do not know how to use the technology that way, they don't use a computer that way.

MR CHIZWINA: Okay, so you are, you are not of that belief that technology is just there to provide access to the resources? It should actually be a tool to solve the problem?

TEACHER A: Well, yes. It's there, it can do all of those things and the limit is imposed by us or by the teacher. If the teacher says: "No, you can only do it for this purpose or for this reason…"

MR CHIZWINA: Okay.

TEACHER A: I give you a simple example, this goes back many years. When, you were too young to know, but I remember when the first ballpoint pen hit the market, it was revolutionary, because we used to use ink pens. Suddenly there is a ballpoint pen on the market. Do you know what teachers used to say? "You may not use a ballpoint pen because it will damage your handwriting." It is true, now, you tell me today, how many people do not have ballpoint pens?

MR CHIZWINA: None.

TEACHER A: And the same thing applies with calculators. When pocket calculators, as they used to be called, first hit the market, there were many teachers who said: "No, you can't use calculators in the classroom. Children won't learn their tables." Guess what? We got calculators. Children haven't learnt their tables but the reason is that teachers don't teach the tables anymore. Instead of exploiting the technology, turning it to your advantage, teachers simply hide behind it or avoid it. That's a bloody broad generalisation but…

MR CHIZWINA: Is it maybe because a lack of knowledge or a lack of confidence or the training has not…

TEACHER A: Well, it's a mixture. It isn't any one of those, it certainly is a lack of confidence, because if you don't know the technology, if, for example if you're looking at using a laptop in the classroom, now if you've never taken your laptop into a classroom to use it then you are going to be apprehensive the first time, because all sorts of things could go wrong or not work the way they do when you are sitting at your desk. Using it in the classroom is a different story. So its teacher confidence and also I think teachers don't want to appear in front of their learners, their students, they don't want to come across as: "Oh, this joker doesn't know how to do this." So teachers many, I'm generalising, many teachers are not willing to take the risk. I'm old enough now. I don't worry about that. I will try anything in the classroom, I will whistle Dixie if I have to. No, look I think there are teachers who are insecure, they lack confidence in their teaching skills, their ability to control the class and so they control the class by not allowing certain freedom, if I can illustrate it with a short story?

MR CHIZWINA: Yes.

TEACHER A: 2 minutes, 1 minute?

MR CHIZWINA: Yes it's fine.

TEACHER A: When I was a Professor in Umtata, you know what the University of Transkei was, I took a sabbatical and part of it didn't work out according to my plan and I ended up being the full time teacher for a Grade 10 class, at a local high school. I was their maths teacher. Initially it was going to be for 6 months, it ended up I taught them for the whole year. Now I looked upon it as a great opportunity to put into practise all the ideas I have been telling my students they should do. Like: "You don't have to have whole class teaching for all 35 minutes of a lesson. You can have small" you know put the children into small groups. You can have discussions. You can give them activities to do with worksheets. So I designed a whole programme for this, but there was one day when the whole, I got the class, they turned their desks around, they're working in groups of four. They had worksheets. They'd got apparatus. They were doing stuff and there was a buzz of conversation and this is in a private school where there should be no noise coming from a classroom, but here was a buzz of noise and I actually had the teacher from the next door class came in and told

everybody to be quiet. She didn't see that I was at the back of the class with a group of children. I was actually kneeling down so, to be at their level. She didn't see me, because she thought the kids were just fooling around. So I stood up and said: "Excuse me, we are working in here" but she, she thought that the noise meant no work, no learning.

MR CHIZWINA: So like using this example is it maybe we can also use an example of technology and say: "Maybe the reason why teachers don't want students to use their cell phones in a classroom is because they will think that there's no learning that is taking place?

TEACHER A: There is that and also you see, I think for a confident modern teacher there, it's… How do I put it? Many teachers think that they have got to be in control all the time and if you allow children to use an iPad or a cell phone they're going off to do something that you didn't tell them to do and some teachers see that loss, apparent loss of control, as a threat and they're not willing, they, it is like learning to swim. You look at the water in the pool, you think: "I'm not going to jump in there, I'm going to sink" and it's the same thing where the teachers saying, instead of: "You know you've got an iPad, go, bring it out, let's use it. What can you do with it? Show me how to solve this problem." Instead of saying: "No, you're not allowed to use that."

MR CHIZWINA: Because I've heard like another teacher was saying that mathematics there shouldn't be group work, because the students should actually learn to solve a problem by themselves.

TEACHER A: Well that is true, I agree with that, that each child has got to learn to solve the problem but the point is group work is part of learning. You learn from the other children, not just the teacher.

MR CHIZWINA: Okay.

TEACHER A: And you don't use group learning all the time, just as you shouldn't use whole class teaching all the time.

MR CHIZWINA: Okay.

TEACHER A: Well, look, let's face it. If, I had my students once saying to me: "Why do you not like the Kelling (?) method?" And I say: "Well first of all because of its name and secondly because if it really worked everybody would get A's in everything at school because

we know what you've got to do to get an A in matric. All I've got to do is to tell you" and truly it doesn't work.

MR CHIZWINA: Okay, can technology be joined with other instructional methods of teaching mathematics? If yes, in which ways? If no, why not?

TEACHER A: Is it possible? I would say it's essential.

MR CHIZWINA: Hmm…

TEACHER A: Well, sure yes, of course it's possible, but I would say in the year 2014 it is not something that you say: "Oh yes, it is possible to do this." You should just say: "Yes, this is something I will do, this is something I am doing." I do it every day.

MR CHIZWINA: Have you ever used technology or wanted you could try using technology in a classroom?

TEACHER A: Well it, again it depends on the kind of technology.

MR CHIZWINA: Hmm?

TEACHER A: Simple things.

MR CHIZWINA: Hmm.

TEACHER A: I am just thinking of one I which I've used for the younger children, which is, some people call it a pin-board. Some call it a geoboard but it was a piece of work, a piece of wood square, where the graph paper stuck on a chunk, a piece of graph paper and small nails in a square, no 9 nails and lots of rubber bands and they had a worksheet. They had a, I asked them questions and the one particular question involves making triangles. Now and I've done it myself. I mean that is technology and I could've done it all on the blackboard. They could've done it all in their exercise books, but then they would've lost out on all sorts of things and the very simple question: "Can you make a tri..." Starting with: "Can you make a triangle" and the answer is: "Yes, I can. Well show me." And then: "Can you make another one? Are they the same? Are they different? How many different triangles?" Once you get to that point I've done this with Grade 4's and I've done it through to honours students and when you get to the honours, level you can give different exercises, as you get up, up through the system, as people mature and you can end up by asking them to prove what they've done and that requires permutations and combinations and a bit of numbers theory, but you

wouldn't ask the Grade 4's and 5's to do that. They will just be experiencing things in a concrete fashion. So it, you know, it's, it depends on the situation you know where, who you are you teaching? For what purpose, how much time have you got, am I with Grade 4's, 5's, 6's or am I with my 4th year honour students, because I can adopt different ways.

MR CHIZWINA: Does the accessibility of technology at Monash allow you to adopt technology in your practice? If so, how? If not, explain why?

TEACHER A: Well, other than what Monash already has, as I say I think, the lecture theatre and the seminar rooms work, I mean I thought they were very well equipped in that, you know they've got computers and you can access stuff from the shared drive and so on and project it up on the screen and work from there, but that, I didn't have any videos. So all my stuff was static, but I would've liked to have had, as I said earlier and as I said 1 hour a week in the computer lab, where they could've done some interactive stuff, because there's a lot of, a lot of material through, not mathematical specifically, but through Wolfram there is a, they've got lots of basically mathematical apps, but there is all kinds of stuff that you can do so that what you are doing is dynamic, rather than static. It would've been good to have help students with that. You know, when they are doing all their log graphs, you could actually have, instead of showing a completed one, they could've seen one being drawn. I know I could do that on the blackboard or on the, sorry, I could've drawn, I did, I can drawn it on the board but that's not the same as getting a computer. You can see it happening and it is actually, not my rough drawn things on the board. So there is an announcement there, I think.

MR CHIZWINA: Okay. In what ways does time affect your decisions to adopt or not to adopt technology?

TEACHER A: Time?

MR CHIZWINA: Time, ja.

TEACHER A: Well, look every teaching situation that I've been in is, there is a constraint of time. It is laid down by somebody else. You've got 40 minutes or you got 1 hour or you have got 2 hours per session and you've got 3 months or you've got 6 months or you've got 1 year for the course, whatever. So there is a time constraint automatically imposed and so when you're planning a lesson you've got to take that into account and some, if you are thinking of using the computer or the iPad or something like that, it tends to take a bit longer.

You need more time and that doesn't always fit in easily if you're in a school situation where they are locked into changing classrooms or changing lessons every 35 or 40 minutes then it is difficult to fit that in.

MR CHIZWINA: Okay. What barriers affect your ability to use technology in your practice at MSA? Do these barriers hinder your ability to adopt technology?

TEACHER A: Time, besides time?

MR CHIZWINA: Ja.

TEACHER A: Well there's, things like, am I the one with the technology?

MR CHIZWINA: Yes, you're the one with the technology.

TEACHER A: And what is in my question you know, is it me as the teacher, I have the computer and I'm projecting and I'm showing people. Like when I am, like I did this semester when I showed them something in Excel. They didn't do it hands on because they did not have it available. I had, I just did it, I was showing them something. I was showing them where the constant "e" comes from, as in limiting, the limits of the function and so I just went into Excel and I did it live in front of them but I was the one who did it and they sat and watched. Now for me, ideally, they should've, each one of them should've had access to the computer so they could've done it for themselves, they are more likely to remember it.

MR CHIZWINA: Okay. Do these barriers, do they influence you in any way in your teaching? Do they make you like maybe now have to re-, to change your teaching approach?

TEACHER A: Well, I'm not sure that I would change, no. I don't change my teaching approach. My teaching approach is all, for several decades now has been, it's got something to do with problem solving. It's got something to do with investigations and it is interactive, hands on learning. Now how do I do it? Well, as I've said before, it depends on the situation. I will still abide by that approach towards teaching, at whatever level, for whatever purpose. The constraints are usually imposed by other people. In that, I do not have my own school or my own private University, so I cannot say: "Well Monday will be for maths" and then there's still a time constraint because you have only got 8 hours but imagine what you could do if it was highly structured in 8 hours in 1 day. When you get, you know, in-depth learning and explore all sorts of things on a, within a theme. You know when your units of time are smaller, then its economy of effort.

MR CHIZWINA: Okay so…

TEACHER A: I don't know whether you follow cricket but there's a difference between the 20/20, the 1 day internationals and the test matches.

MR CHIZWINA: Okay, ja, I get it, I understand that, ja.

TEACHER A: The purpose…

MR CHIZWINA: Ja, because the 20, the…

TEACHER A: With 20/20…

MR CHIZWINA: Ja.

TEACHER A: It's 20 over's.

MR CHIZWINA: Ja.

TEACHER A: So it is like 2 hours.

MR CHIZWINA: Ja.

TEACHER A: The 1 day you've got 50 over's so you've got 4 hours.

MR CHIZWINA: Your test matches you've got 5 days.

TEACHER A: Test matches you've got 5 days.

MR CHIZWINA: Ja.

TEACHER A: So, so the objective is still the same to win the game and it will be the same with, with my teaching. You know if I, if you tell me: "Well, you've got 30 minutes" then I would have to structure what I'm going to do, to fit it within the 30 minute timeframe.

MR CHIZWINA: Okay.

TEACHER A: But the goal is still what do the children learn.

MR CHIZWINA: Okay.

TEACHER A: I mean, I personally can give a brilliant performance but if the children learn nothing then I'm useless which is what I used to tell my students, which they didn't like.

MR CHIZWINA: Like what is your opinion, because it seems like teachers are only using technology to make their lives countable. Is that how you view the technology in the classroom?

TEACHER A: Oh, well look, actually that's a good question. Certainly that is one part of it. If you can make things more comfortable for yourself, make things more easier, then yes. So that things like you know, I've got to give regular tests to the kids or the students and I do not keep the mark lists on a piece of paper. They're on an Excel spreadsheet. So I can obtain whatever, you know, summary statistics they want. I can do a MINO standard deviation, a max and a min. I can do it in two clicks of the mouse, instead of hand, you know when I started teaching, all that stuff was done by hand. We had to have a special book for it, with squared paper and you've had to write out the children's names and all the rest of it. So ja, there is the convenience of it, of using technology for the administrative side of one's teaching job but on the other side, you can make learning more interesting and more effective. It is a question of engaging minds and the, it's not just one thing or, it's not "either/or" it's "both and" so that technology is just one of the tools that, all the different forms of technology. It is a matter of saying if the children are going to learn this concept today, my question to myself is: "Right, what do I think here and now, for these children, in this situation, on this day, within this timeframe, what do I think is going to be the best" and that's what I will organise.

MR CHIZWINA: Okay. Like if the students have to come and maybe say they want to have maybe their lessons, maybe they want to use the iPad, would you like take, would you like accommodate them or you wouldn't want to…

TEACHER A: Well look that's a tricky one. I mean if we go back, I don't know whether it still exist but calculators were not allowed to be used at one time. They were all there: "No, you can't use your calculator in class." Now how insane is that?

MR CHIZWINA: At home I can use it?

TEACHER A: Because you, once you get outside the classroom…

MR CHIZWINA: Ja.

TEACHER A: Naturally you're going to use your calculator.

MR CHIZWINA: Ja.

TEACHER A: So the same with, to me, would apply to the iPad. If somebody says: "I want to use my iPad." I say: "Okay, how? What are you going to use it for" because as we all, as we both know, give it 5 minutes and they're on Google or something else or they are on YouTube, but not for maths or they are on Twitter or they are sending emails to their buddies, or they are on Skype. I mean they won't be doing stuff relating to their mathematics. So I am not sure if a student came to me and said: "Oh", well if they said: "Can I use my iPad?" I would say: "Well of course you can, but what are you going to use it for? Show me." Unless I had pre-planned and said: "Okay, get your iPads out, this is what we're going to do. Go here, right, open this, let's do that" and show them.

MR CHIZWINA: Okay.

TEACHER A: Again you see, it comes back to opening doors and windows for students.

MR CHIZWINA: Hmm.

TEACHER A: Helping them because if, if you don't show them and help them or give them a start not all of them will get there. Although, mind you, if you're teaching 5 year olds, 5 year olds will be ahead of both of us, Sabelo.

MR CHIZWINA: Ja.

TEACHER A: They have no inhibitions, they just go for it and they do whatever they like and they do all sorts of wonderful things.

MR CHIZWINA: In your opinion would owning a device for example an Ipad influence you to try and use it for teaching and learning ? If so, how? If not, why not?

TEACHER A: Well, I suppose, it might do, I mean if, once you become familiar with the possibilities and what you can use an iPad for, then I guess yes. I could see, I mean as in there, I can't quote this as an example, because it hasn't happened, but I could see. I mean for example, I've got a granddaughter who is just in Grade 8. The whole school, sorry, her whole class, has iPads. Everybody in the class has an iPad, bought through the school and I think they've got laptops as well, because the school doesn't provide them with textbooks. They give them all this e-books on the iPad.

MR CHIZWINA: Hmm.

TEACHER A: Now that is a fantastic use of technology.

MR CHIZWINA: Yes.

TEACHER A: But then, they are at a very wealthy, well-endowed school and there are many, many situations where that can't happen, because of poverty, economics.

MR CHIZWINA: So like you'd, it depends on your context for example like…

TEACHER A: Oh, yes.

MR CHIZWINA: Ja.

TEACHER A: Ja, it definitely depends on the context. I mean there's, ja I mean I sort of mentioned that already in an answer to other questions. It does depend on the context, on what situation you find yourself in.

MR CHIZWINA: With regards to collaboration, who do you collaborate with? Why do you collaborate with the individual or individuals? How do you collaborate?

TEACHER A: I have done sometimes, yes, ja.

MR CHIZWINA: Has it been fellow lecturers, management, or experts in the field?

TEACHER A: Well, again it depends on the context. It could be your colleague. It's been a colleague or just a friend. I have got one friend, who is very computer knowledgeable, any technical queries I will go to him or otherwise these days one tends to go onto Google. Google seems to answer just about every question.

MR CHIZWINA: At Monash, did you ever collaborate with anyone?

TEACHER A: You mean about technology?

MR CHIZWINA: Do you ever discuss, ja did you ever discuss anything, any use of technology with anyone?

TEACHER A: Not, well, not once I've been shown how, I had to find out how to use the stuff at Monash, but that was like 5 minutes and then you're away. Any other queries, ja I think I might have asked but I don't recall anything specific.

MR CHIZWINA: Oh, so you never like, ever once had a meeting where you discussed: "There's this technology that I think should be introduced in the unit."

TEACHER A: No.

MR CHIZWINA: No, oh, okay.

TEACHER A: We did talk about other things with regards to the unit but it wasn't with regard to technology.

MR CHIZWINA: Okay, so the emphasis is actually more on getting the contents instead of improving it through experience, the learning experience?

TEACHER A: It certainly, yes, improving the learning experience, not, which was not specifically technology related.

MR CHIZWINA: Oh, okay.

TEACHER A: In my, I mean yes, in my, ja we didn't have a special meeting about it, but some, two or three of us chat a bit about it, but it's all to do with student learning because by enlarge, my impression was the students that I was involved with at Monash, they have a very surface level approach to learning, which is short term, learn enough to pass the exams and that's it. They don't get down, don't get deep down and dirty, very few of them.

MR CHIZWINA: Okay. Finally, what are your, what are your views on the use of technology in the classroom? What would you advocate for? What would you say, how would you see technology being used in the classroom?

TEACHER A: Well again, again it depends on context, but in an ideal world, I would think that there should be no limits. If we want the youth of the country to, we want each individual to achieve his or her potential then there are no boundaries, there are no limits. We should impose no limits on the children or students, but of course there are all sorts of constraints, one of which, is money, is never enough. Another one is the competency of the teacher, it might not be up to scratch and ja and then there's attitudes of people. I mean you know, I might be in favour of a certain approach, somebody else might not be and if that person is in a position of authority over me, I've got no chance. It is difficult to generalise on that one, Sabelo.

MR CHIZWINA: Yes, yes, yes, oh okay. No…

INTERVIEWER: MR SABELO CHIZWINA

INTERVIEWEE: Teacher B

MR CHIZWINA: Okay, I'm now recording, like how long have you been teaching mathematics?

TEACHER B: I've been teaching maths for the past 17 years.

MR CHIZWINA: How did you end up being a maths teacher?

TEACHER B: Well, it was more an ambition when I was in high school. I wanted to become a maths lecturer at University, that's how I ended up teaching maths.

MR CHIZWINA: What was the major, like the attraction for you to teach mathematics at University?

TEACHER B: It was more about the intellectual challenge. I was finding the topic both challenging and I have a passion for maths at the same time and the history of maths that's what drawn me to maths actually.

MR CHIZWINA: Okay, and at for Monash how long have you been teaching mathematics at Monash?

TEACHER B: For almost, for 9 years now, for 9 years.

MR CHIZWINA: And you have been teaching mathematics for all those 9…

TEACHER B: Mathematics, yes.

MR CHIZWINA: Okay, like, have you ever, like in the 9 years that you have been here, have you ever used technology or wanted you could try using technology in a classroom?

TEACHER B: Not really extensively, it was just for, let's say storing the teaching materials, okay capturing, teaching materials and mainly for that. I never really used technology for assessing students, though I have been thinking that we could give a technological called dimension to maths by the use of mathematical software's that students can use for, especially solving equations and obtaining graphs but unfortunately this, this dimension hasn't been explored totally at Monash. The reasons I'm not too certain but I was under the impression that it was because of budget constraints and also because of the limited scope of offerings at Monash. It looks like management didn't see the need to put more resources into software's that students could be using more frequently.

MR CHIZWINA: Do you think that your experience with using all these software's influences whether they adopt technology or not in your teaching?

TEACHER B: I would like to, yes, but for it to be really effective I believe the first step would be diversifying or enlarging the offerings like for, if we could have a faculty of sciences or a faculty of or engineering it will make things easier and then technology will fit, pretty well into that framework.

MR CHIZWINA: So, like were you, in your previous maybe where you have taught or where you have studied, you've actually seen that the teachers experience is the one that has got an impact on how they use technology?

TEACHER B: Not necessarily on how they use technology, but well I can say yes and no. A good teacher would be able to stimulate the students to use technology for solving a few problems, yes, especially in the applications that's where it becomes very handy.

MR CHIZWINA: Like, for example as a senior ZHC1010 mathematics teacher, have you ever like tried to introduce technology that can be used in the whole unit?

TEACHER B: Not really, no, because there, because of the level of the topic it's more of a basic maths course, so it doesn't really require like an intensive use of technology and for that reason I didn't try that.

MR CHIZWINA: Okay, do you think in-service learning in the use of technology could assist in technology adoption?? Do you think that there should be maybe courses or there should be programmes or there should be in service training in how teachers can actually use technology in the teaching of maths?

TEACHER B: There should be, especially for specific topics in maths because they require some software's that maybe teachers are not really familiar with. So, I think even a basic training would be very helpful. It can help lecturers and teachers to make better use of technology.

MR CHIZWINA: What is your instructional style, how do you teach in the classroom?

TEACHER B: I have more of a traditional approach. I use the whiteboard extensively to show students, to show to students how to get to a, the result, how to solve, but I also use,

some technology, the notes necessarily or the notes mostly. I display the notes, I show them what it is we are going to talk about today. They can see on one side the display from the overhead projector or another projector and on the other side I use the whiteboard to show them how to obtain the results.

MR CHIZWINA: So, do you think it's possible to combine technology with your instructional style?

TEACHER B: It can be done, for instance we can have pre-recorded tutorials, short tutorials, where we can present a concept, very shortly, briefly and then students can have the opportunity with that to maybe visualise the tutorial in advance, have an idea of what it will cover, what it is about and then they can come prepared to the lecture or to the tutorial and start asking for questions.

MR CHIZWINA: Like, outside of the classroom do you like, are there specific tools or technologies that you use or you experiment with?

TEACHER B: It's more mathematical software's, yes, that I do, like for instance MathLab, how you can solve specific equations, how you can plot a beautiful graph in match with your access that appears well, a book scan you put a legend on your graph, that I do. I explore that with certain software's.

MR CHIZWINA: Does your use of technology outside of lectures and tutorials influence you to try the technology in the classroom? If yes why? If no, why not?

TEACHER B: No and for some I have shown them, in some instances how to generate graphs, mainly with Excel and also with some, what you call that, open source software's, but because we don't have like a specific tutorial located to in the computer lab that's the reason why I don't do that, but is feasible if we could schedule for instance, 1 hour per week of a computer lab and we can go to a computer lab with the students. We can now show them how to use technology to obtain results to mathematical questions or problems.

MR CHIZWINA: But that will require that you learn how to use the, the software?

TEACHER B: Yes.

MR CHIZWINA: It will also like, I mean you will have more extra hours in your teaching…

TEACHER B: Exactly.

MR CHIZWINA: At a given week…

TEACHER B: Exactly.

MR CHIZWINA: So given those factors would you be willing to, to use this MathLab in the teaching of maths?

TEACHER B: Then that is the constraints we have, if we can get to a compromise about the teaching hours or the teaching load, yes, I would be willing to.

MR CHIZWINA: Okay, do you feel like the time you spend using technology outside the classroom might influence you how you use technology to teach maths?

TEACHER B: I think so, but it influence you in my case, in a more positive note because when you see what you can do with technology, it shows you that the possibilities are infinite I can say, I can put it that way. So we can use it in order to enrich the experience students have at University. They can have a very positive experience if we can also use the technology to assess them. For instance what I mean by that is, they can have an exam in two modules or in two parts. Part number one, it's the traditional way, they have a piece of paper they have to answer a specific number of questions, they have to show how they derive their answers and the second part we can assess them on how they use technology. Do they have a good mastery of technology? Can they generate a graph? Can they solve an equation using a specific software? So I think if we could also introduce that in the teaching it may, I believe a student can have less fear towards maths. It can draw them to maths and because they are generally curious about technology they, it can help them come to have less fear towards maths, if I can put it like that.

MR CHIZWINA: How is senior management at Monash been supportive to, for example the use of mathematical software that you are referring to?

TEACHER B: Very little, very little, as if they haven't understood, understood the possibilities and importance of introducing that.

MR CHIZWINA: So, like you might, you find that maybe it's because of lack of understanding of the, of the software that they are refusing or not, or not really encouraging the use of the technology?

TEACHER B: It might be that, it might be just budget constraint. I'm not certain exactly and it's also maybe their own background when it comes to maths, maybe it's a topic they don't understand very well or they have also that phobia of maths so they are not really prepared to spend money into some exploration of how it could be taught.

MR CHIZWINA: Okay.

TEACHER B: Or improved.

MR CHIZWINA: Like in your experience have you ever seen an instructor like uses technology in the teaching of maths, someone that's reading engages uses different like tools?

TEACHER B: Hmm.

MR CHIZWINA: And what did you gain from that experience?

TEACHER B: I have seen that at UJ for instance in the times I was teaching them, I was teaching there. The maths course was taught in two ways, they had the normal tutorials where we had like exercise's to solve and then we also had computer lab sessions in which we were teaching students to use a computer software, in that case it was MathLab for engineering students and how they could use it to solve equations, generate graphs and other things.

MR CHIZWINA: Okay and how was that experience?

TEACHER B: Well…

MR CHIZWINA: From your experience and beliefs, do you think that technology is beneficial in the teaching of mathematics? If yes why? If not, what are the reasons?

TEACHER B: To me it was beneficial and I also saw the students benefited a lot from that, because once they go out into the real world, an engineer has to use a software to, to arrive to solutions, to solve real life problems. You have the conception phase that can be done on paper but the solving is the software.

MR CHIZWINA: Okay, have you ever like tried using different technology in the teaching of maths besides MathLab, have you ever tried any other tools?

TEACHER B: At Monash no, no. Personally in my own investigation I have used MathLab, I have used Mathematica, as well and I can say they are very handy tools if they are used properly.

MR CHIZWINA: And things like YouTube you have never…

TEACHER B: The YouTube's no, very little I should say. I know there is a website, I think it's the Khan Academy…

MR CHIZWINA: Hmm.

TEACHER B: And sometimes I do tell students: "Okay if you need extra support you can go to the Khan Academy you just browse, this topic for instance quadratic functions, see how they solve a quadratic function, maybe it will be helpful" but it is not done systematically.

MR CHIZWINA: But you, would you go and get and take a video from Khan Academy and use it in your teaching?

TEACHER B: I can do that but I haven't done it formally, I am not opposed to that, it's not a bad idea.

MR CHIZWINA: Okay, alright, so and you allow your students to be able to use other people's videos, do you like visit those sites and see if they are very helpful.

TEACHER B: I did…

MR CHIZWINA: Or what they teaching is in line with what you are teaching?

TEACHER B: I have done it for one of two topics in maths especially in quadratic equations for the Khan Academy. I had a look at the video and it's very much in line with what we do. I remember there was a student, Wazati (?) who came to me with a website that contained videos and I had to give her guidance which one can be harmful for her. So I believe she did that and I hope it was helpful, I didn't go back to her and get back some feedback whether she found, finally found it helpful but some of the students are already exploring those avenues.

MR CHIZWINA: Okay.

TEACHER B: And I have a philosophy if it can be an extra help for the students, if it can help them understand the topic better than they can go for it.

MR CHIZWINA: Does the accessibility of technology at Monash allow you to adopt technology in your Practice? If so, how? If not, explain why?

TEACHER B: The resources I think we do have, especially the, the online resources that are available from the library.

MR CHIZWINA: Hmm.

TEACHER B: We can make use of it, of those resources, the main problem is, the workload, the impact on the workload. So, that's where we need to find a good balance and I was talking previously about a compromise. It will require further investigation, how we can incorporate this into the teaching and what will be the impact on our workload. If we can get to a good understanding and agreement around that I think we can move forward in that direction.

MR CHIZWINA: Like, what would you suggest, would you suggest that the workload you just focus on face to face or it should actually accommodate like maybe for example, hours for you to be able to explore on, on using different types of technology, attending in service trainings or even like collaborating with your students on line?

TEACHER B: I think it should include those aspects like, exploring technology, interacting with students online, it should include that because sometimes we find out that even when students are in class they are physically present but spiritually absent. So, we should find other ways to get them to the party, if technology can be one of those ways then we should give it a try, at least and see where it leads to.

MR CHIZWINA: Do you feel that your knowledge of technology is sufficient for you identify and adopt technology?

TEACHER B: No, it's not a problem of knowledge of technology it's more about motivation and the time we have to spend preparing for that. If we don't have like built in hours in our workload that allow us to do that then it means that we have to do it during our spare time and that where the problem comes.

MR CHIZWINA: So, in your spare time you would actually want to engage in your own self-development…

TEACHER B: Yes, in my own self development in my studies and my other activities rather than just working even on a Sunday afternoon at home, working for Monash. I don't find it, it's interesting to do that, no.

MR CHIZWINA: Has there be an opportunity, an, maybe and let's say has there been an example of where like maybe you've discovered the technology in your own reading, in your own self-development that you felt you had to introduce in your classroom?

TEACHER B: Well, it's more about what I know about what the software can allow you to do but because we have never discussed formally the use of computer labs for instance for teaching maths, so I do not do that, but we can. If we can get a good software we can incorporate computer sessions for teaching maths.

MR CHIZWINA: Would you find the technology, would, would you think that having technology benefits the students in learning maths?

TEACHER B: I think it can benefit the students because we don't have all of us the same abilities to understand maths, but if a student can understand a concept, address the concept technology can now help him to get to the results because sometimes they make stupid mistakes in the solving, but those mistakes can be avoided if they use a software that can solve the problem for them. It just requires that they understand what is the input, what are the variables, they need to input to get the correct result. So we can avoid the whole issue of getting wrong results at least and we can also solve the issue of a student not being about to plot manually a graph, if he knows what are the variables, what is the relationship between the variables by using a software he will get the right graph and then we will now focus on showing them how the graph is integrated, what it means and how for instance if they are in a working environment what kind of advice for instance they would have to give to the manager or what are the elements that they can incorporate in the report that they have to submit.

MR CHIZWINA: Have you experienced the use of technology in the teaching of mathematics? If yes, what did you gain from this experience or what did you understand about the use of technology? If no, what would you expect to learn if given an opportunity?

TEACHER B: Yes, a change in the curriculum of maths and a change in the teaching approach maybe, not a major change but we should incorporate some computer sessions for

students, so that they get more familiar with technology or a specific software and how it can be used to solve specific problems.

MR CHIZWINA: So, like won't, won't that like maybe inhibit the introduction of technology in the classroom because some educators might find that now they're having to basically now change the way that they teach and also changing the way that the curriculum is.

TEACHER B: Yes, it can, it can, but unfortunately we live in an ever evolving

world so we have to adapt to the trends and the more you look online the more you realise that work is being done towards that, that you don't need for instance to be a trained statistician to use a statistical software. All we need is, do you understand what are the variables you are analysing? What is the method you want to implement and how you implement it and even if you look at that you will notice that some people may have some problem in applying it or at least interpreting and then they will go back to the experts in the field to get guidance but I believe it should be done.

MR CHIZWINA: For us to get to that, to that, to get to that stage, what is required in terms of like the resources, in terms of support from the ITS, senior management…

TEACHER B: Well, I think it should start with a discussion within a department. What is it that you are teaching? What are the trends out there and how we can, we can improve the teaching? How we can incorporate technology and where do we start? What do we want as a starter? Do we want for instance, simple analysis for instance or do we want at least the students to be able to generate graphs, solve a few equations and if it's equations for instance, which one do we want them to be able to solve using technology and we take it from there. We can do it progressively, it doesn't have to be a sudden change, we can start incorporating it progressively so that also the other teachers get familiar with technology and maybe if they get more familiar they can come to like it and they will be more willing to incorporate it into their, into their teachings.

MR CHIZWINA: What is your current view on the status of technology in the teaching of maths?

TEACHER B: My current view is that technology in the teaching of maths can be very useful in the applications, because the concept I'm not certain... Even in, for concept yes, if

for instance they can obtain some YouTube videos, that explain differently a concept, maybe it's the approach of one teacher that may seem difficult to a student but if someone else explain the very same concept differently a student may come to understand better. So, I think as teachers we should also remain open to the fact that out there, there might, there is absolutely someone else who can explain the same concept to my students differently and even better than me and the student who may come to a better understanding of the topic. I have the philosophy that we should be using anything that works, if it can help a student understanding the topic better then I won't be opposed to that.

MR CHIZWINA: Can technology be joined with other instructional methods of teaching mathematics? If yes, in which ways? If no, why not?

TEACHER B: It is, yes, it just requires also some commitment from the teacher. Some willingness to explore those avenues, it is possible.

MR CHIZWINA: Given your students what would you say, would you say they would find technology easy to use in maths or even if they might struggle?

TEACHER B: They might struggle a little bit but when we look around us, we realise that more and more students are getting connected. More and more have iPhones or iPads, laptops, so, we should be seizing that opportunity.

MR CHIZWINA: In terms of like, your teaching, your assessments, your

instruction, like where do you see technology, how do you see technology playing a part?

TEACHER B: Well, it can be a relief in some assessments, we can give some assessments to students online for instance but it requires some work to design those assessment and in such a way that they can be, they can be done online. That's the, maybe the major problems on the side of the lecturer or the teacher, designing those kind of assessment or mastering the technology in such a way that we are able to design this kind of assessment, but it can be, if done properly it can be a good relief.

MR CHIZWINA: In what ways does time affect your decisions to adopt or not to adopt technology??

TEACHER B: Well time is a big constraint. Is it going to require a lot of investment in time or not? If it requires a longer, a lot of investment in terms of time I might reconsider, let's

say on the short term, if it requires a lot of time generally what I do, I use the holiday period to explore it more fully, what I can do with this and how I can incorporate it. I won't be doing it during the teaching semester, I will do it during the holiday break.

MR CHIZWINA: Okay, and like for example in the, in what situation like, how would you like for example take the teaching, the use of technology to your maths, what should be available for you to be able to feel comfortable in using technology in teaching of maths?

TEACHER B: Software's should be available…

MR CHIZWINA: Hmm.

TEACHER B: And also people who can provide training, in case we are faced

with a problem because sometimes you have a problem with the software you don't know who can help you overcome the problem, the difficulty. So, if you can't solve yourself the problem it becomes difficult that you go with that technology in the classroom and get embarrassed in front of all of the students.

MR CHIZWINA: Okay.

TEACHER B: Ja.

MR CHIZWINA: What barriers affect your ability to use technology in your practice at MSA? Do these barriers hinder your ability to adopt technology?

TEACHER B: Availability more, availability and motivation. Let's say it's the whole work environment atmosphere, is it a good one, and is there job satisfaction? If it's not there for instance especially the aspect of job satisfaction if you are not happy of the conditions, I do not see how I will now take that extra time and spend it into trying to enlarge my teaching, incorporating technology and all the other things.

MR CHIZWINA: Then your students, like do you think that they're at a stage where they can naturally use technology for their learning of maths?

TEACHER B: They can use it at a basic level yes, they can. Okay, you have the basic things like the YouTube videos and if we have some software they can use it for at least the graphs, graphs and solving basic equations, that they can do, if they have proper guidance they can.

MR CHIZWINA: Will your students be able to, for example, create let's say Power Points or to solve the problems online, do you think they've got that ability?

TEACHER B: Not yet, they will need to, to receive some guidance, some basic training, yes. Power Point they may do some stuff but for instance one of the things that we can consider as well will be, when they submit assignments for instance, generally with maths all they do is they write with their handwriting on a piece of paper We can start showing them how to use simple tools, for instance in Microsoft Word, you have the equation editor, how they can use the equation editor to type an assignment in maths. That would be a beginning because as they move further in their studies they will be expected to submit like a research thesis, in which the equation will have to be typed, so we can start progressively like that.

MR CHIZWINA: Okay, in your opinion would owning a device for example an IPad influence you to try and use it for teaching and learning? If so, how? If not, why not?

TEACHER B: I didn't get the question properly?

MR CHIZWINA: For example like, do you think like owning an iPad right…

TEACHER B: Yes.

MR CHIZWINA: Would influence you to use an iPad in your teaching?

TEACHER B: Yes, it can, it can, I believe it can, yes.

MR CHIZWINA: How would it enable you to use it?

TEACHER B: First, there's the curiosity factor, when you own it okay, how can I do this using my iPad. At your own level and once you're at your personal level you know how to implement a few things, you can now go to the classroom and show the students okay: "If you own an iPad this is what you can do, this is how you can do this, this is how you can get to this result using for instance this open source software that you can download on this application that is available on the market. You can download this application and you can use it to, for instance to solve a quadratic equation. If you are not certain of your result, download this application, this is how you input the variables and this is the result, this is what it means and if you want to generate the graph using this function in your application this is how you going to generate your graph for instance."

MR CHIZWINA: So, right now you might say that maybe the, the reason why there is a, you, you're not implementing some of the, the technologies is because of access to those particular technologies?

TEACHER B: The problem of access, yes is there and the access and the issue around the workload. How do we re-define our workload in such a way that we can incorporate those aspects, cause it won't be something that the lecturer brings in, in the classroom and just speaks about for 5 minutes. We have to be in a proper setting, people have for instance their iPads or they have laptops, we have all the same application and we sit and we have to show them how to get to those results, how to use it. It must be done systematically, for the moment is just you tell them: "Okay, you can go here and have a look at this application, play around with it you can see what it can do" but I believe it should be done more systematically.

MR CHIZWINA: With regards to collaboration, who do you collaborate with? Why do you collaborate with the individual or individuals? How do you collaborate?

TEACHER B: Not from Monash, from other Universities yes.

MR CHIZWINA: Okay.

TEACHER B: So I don't bring that input yet here in the Monash environment.

MR CHIZWINA: Do you share what you learn from other people with your colleagues at Monash?

TEACHER B: The colleagues, not really no, not yet.

MR CHIZWINA: Okay.

TEACHER B: The reason, I don't know but it look like, we need a discussion on how really we can, implement all these technology in maths. We need to sit and agree what should be done in order to start implementing it.

MR CHIZWINA: Are there people at Monash who are like, champions of using technology in the teaching of maths?

TEACHER B: In the teaching of maths, here at Monash, South Africa I would say no.

MR CHIZWINA: Okay.

TEACHER B: Not yet.

MR CHIZWINA: Okay.

TEACHER B: It needs to be, to be done.

MR CHIZWINA: Okay and like for example what would you say would actually, make Monash be a place like that uses technology in their teaching of maths? What would be required to get Monash to become at that stage? For example, let's look at some other subjects where they, where they are already involved in using a lot of tools for their learning, when they allow students to collaborate online, where they allow students to interact, where they allow, where there assess students online, where they provide students with the resources online.

TEACHER B: We have, we have a need for expertise. We have a need for, I would say, we need to have like Unit Co-ordinators with the right expertise and with the vision and also a support from department heads. We need head of departments with a vision on how we should start implementing technology in the various topics and who are willing to put the resources in that area such that it becomes feasible and possible, because it's one thing to say: "We must start using technology" it's another one to put the resources, to make the resources available to the staff, make the expertise available to the staff, so that they can start using it, implementing it effectively.

MR CHIZWINA: Like where would say, like there's serious need for the use of technology in you're, in your unit?

TEACHER B: Is there a serious need for use of technology?

MR CHIZWINA: Where, which aspects do you think really require you or the teachers to be using technology, given our students?

TEACHER B: Well, given our students, in my unit, I won't say it's really critical because as I mentioned it previously, it's really a basic maths course.

MR CHIZWINA: Hmm.

TEACHER B: So, but what we can, is use that technology if we, it's not translated into a use of technology in the classroom effectively, it would be at the teacher's level. The notes that we have, play also a huge role maybe, in how we can draw students to using technology. If

we have software's that allows us to present the notes in a very beautiful fashion, we can now draw the attention of the students to the fact that: "You see this graph that you have in the notes, you can generate it by using this software, this function" and you can do some demonstrations in the classroom. Okay: "This quadratic function or this sphere, this graph I have obtained it using this particular software, this way." So, if this is done we, we, we can start drawing the attention of the students toward technology, it can be done progressively…

MR CHIZWINA: Okay.

TEACHER B: But one good way would be to have a formal tutorial in which we use technology with the students all together.

MR CHIZWINA: Like currently, like where, which, which aspects do you see, are you using technology?

TEACHER B: Currently it's more in solving a few equations, getting some graphs that we use in the, in the classroom. Sometimes I just take the time with the students to show them how to generate a graph using Excel for instance, but I just do it using Excel for the moment: "You want to get this graph okay, go to Excel, you input your data this way, you use this function it's going to give you this graph" and sometimes I show them: "Okay you can modify the labels this way" but it is really very basic.

MR CHIZWINA: Okay, okay what would you say about technology in a classroom, in a nutshell? What would you say are your view in terms of technology in the classroom?

TEACHER B: Well, with maths, technology is something useful when you add it. You can do the whole maths course without technology, you can still manage to do that, but given the trends now in the world, it is becoming part of the literacy that the student can, first the teacher must be able to use the technology and then the students as well and it shouldn't only be like, you must go on Moodle, download the notes, it's part of technology but students must also be able to use some mathematical tools to get some results to the problems they are solving every day.

MR CHIZWINA: Okay, because, like most people they see technology in maths as providing access to resources, what is your view on that?

TEACHER B: To resources?

MR CHIZWINA: Because, most people they find like, they want to use for example, the learning management system just to put their notes there so the students when they are teaching…

TEACHER B: Yes.

MR CHIZWINA: Can follow them, do you find that, that is an accurate view of how technology should be used?

TEACHER B: No, it's not an accurate view, it's just one of the many ways. It facilitates maybe the learning or the access to learning, but it shouldn't be the only way because okay you can put the notes on the given platform, the students can access that but that's it. The student will still be faced with his problems: "How can I understand this concept better or differently" and this is where the lecturer may come in and provide guidance.

MR CHIZWINA: Have you ever tried to engage your students, like on Skype or on Google Hangout?

TEACHER B: On Skype, yes, I have for instance when they have problems they have my Skype address, they can phone me on Skype. We can have a discussion when they don't understand the concept. The problem with Skype is that sometimes you don't have, if you have to write a solution it won't be like really a live interaction, they won't see how you have solved, you have to take a picture for instance, upload it, then they receive on the other side, they need to follow, but it can be done.

MR CHIZWINA: And do students, do they make use of that?

TEACHER B: Not too much, I have put, only a few came back to me *via* Skype, only a few.

MR CHIZWINA: What could be the possible reasons, could it be an access to Skype or…

TEACHER B: It's might be the access to Skype, it might be, because if they are not on campus for instance it will require them to have internet data and if they are in an environment where they don't have those data for free for instance then it might be a problem.

MR CHIZWINA: Okay, but does the, does the policy at Monash, does it encourage you to be able to experiment using for example, the Skype experiment that you have?

TEACHER B: Well, apparently, no one seemed to care, apparently. We don't have sessions in which they encourage you to make use of this or that in a formal way as far as I know. It might be explored, it should be explored.

MR CHIZWINA: Okay, and finally do you think that your students appreciate like, like when you use technology in the classroom or they are more concerned about finding, just getting the solution?

TEACHER B: Many are just worried about finding the solution and this is why I was thinking of having a formal tutorial, an hour per week for instance during which or every 2, 2nd week in which we are going to solve a few problems using a specific software maybe, it can rise their attention, their interest, towards using more, a better use a more efficient use of technology in order to understand maths and to master a few concepts.

MR CHIZWINA: Okay, but ultimately, what is the goal in the teaching of maths? What it your goal?

TEACHER B: My goal is, especially with the kind of students that we have, the most common question we have in class is: "Why do I have to learn maths if I want to do business, this if I want to do this thing?" They don't see the need for them to do a maths course. So, my main objective is to show them that beyond the formulas that they see maths has a meaning and an application in our daily lives. So that's my main objective, to show them that beyond these weird formula's that you see, it has a real impact on your life and this is how you can use maths in your everyday life. So, I focus mostly on the applications and because it's applications technology can be very useful.

MR CHIZWINA: Okay, alright thank you…

INTERVIEWER: MR SABELO CHIZWINA

INTERVIEWEE: TEACHER C

MR CHIZWINA: How long have you been teaching?

TEACHER C: I started teaching mathematics in a secondary environment in 1992 and I have been teaching mathematics in some way or form ever since then.

MR CHIZWINA: Like what motivated you to choose the path to be a maths teacher?

TEACHER C: I think it has always been my passion to teach and mathematics specifically was something that I felt driven towards with the notion that you either could or couldn't do maths, and I felt that, that was wrong. Too many people say they can't do maths and I don't think that, that's true, I think anybody, given the right circumstances can learn and enjoy maths.

MR CHIZWINA: Okay, at MSA how long have you been teaching?

TEACHER C: I started working at Monash almost 5 years ago, I spent 2 years teaching marketing mathematics and a little bit of accountancy in a part time position and then I was called upon to get involved in doing some mathematics interventions for students who were struggling with mathematics. When I started working full time at Monash in the role of teacher and student support I wasn't teaching *per se* but I continue to run the maths interventions for the weaker students.

MR CHIZWINA: Have you ever used technology or wanted you could try using technology in a classroom?

TEACHER C: Yes, I do, I use a variety of things, when I taught in Tanzania for example we used the, the graphic calculators, so that was technology, quite a lot actually. We used a lot of technology in terms of not just the graphic calculator but connecting it to the computers specifically for things like statistics. I, in my current job I use a lot the videos, card academy and so forth and then there's a lot of programmes for helping you to draw graphs and things like that, that I make use of, in addition to equation editor of course when I type my test and worksheets.

MR CHIZWINA: Okay, like what is your view of technology in the teaching of maths?

TEACHER C: I think it remains a scary space for many maths teachers. Maths teachers just want to get their subjects across and technology is now a new area for many of them and so the time needed to, I think explore, experiment and become *au fait* with the technology in the subject is often considered as a barrier and so I think we probably don't use it as much as we could, bearing in mind how helpful it could be not only to us but our students as well.

MR CHIZWINA: In your opinion do you think your prior experience with technology in teaching and learning influences whether you adopt technology or not?

TEACHER C: I do think so, I think the more that I've gotten used to using different technologies the easier it is and I think for new teachers coming into the profession because they have grown up with technology and they're not as, perhaps nervous to experiment with it, it's probably easier, but then having said that even at Monash some of our teachers who are closer to retirement have taken huge steps to working with technology. In our faculty alone one of the teachers, has made short video clips on almost every section of the work in her course, maths specifically and she has put those available for her students to be able to use on or off campus which I think is a real good step forwards, specifically considering she's, it was a huge steppingstone for her to take in terms of understanding the technology around that.

MR CHIZWINA: Okay, as the maths Intervention Co-ordinator, right, how has this position influenced you to adopt technology in your teaching?

TEACHER C: I don't think it's changed what I would have done, perhaps maybe what I've had to think about is because the students that I work with are expected to be weaker, there's a lot of students from mathematical literacy and then the weaker O-level students as well and so they need a little bit more reinforcements and so what I have done at the end of all my lessons I work with power points and at the end of all my lessons on my last power points slide I usually have some examples of where they can go to Khan Academy or any of the other. So, I have usually done my research in terms of which sites have got movies or video clips that they can watch that match or mirror this specific work that we've done in a way that is understandable. So, I have watched them and made sure it won't conflict with the methods of teaching that we've used and that it will be understandable for the student so it will reinforce rather that confuse.

MR CHIZWINA: Okay, like how, what is your typical instructional style, like when you go for a lecture or tutorial?

TEACHER C: Okay, the students say that I aim it, kind of between a lecture and tutorial, so there is quite a lot of, I don't want to say "chalk and talk", but similar but it is interactive as well. I move around a lot, the students ask a lot of questions, there will be a little bit of going through the work making sure that the, the concepts are understood towards the beginning of the lesson and then towards the end of the lesson there will be examples for the students to practice, either individually or in small groups as they prefer.

MR CHIZWINA: Has your typical instructional style swayed you to adopt technology in your practice?

TEACHER C: Maybe not to adopt technology but I'm always looking specifically, but I'm always looking at different styles of teaching. So, for example, I also teach a lot with games. Now the games are not necessarily a technology base but they're a different style of teaching and I look for new and different ways of imparting knowledge to students. So in fact, I think it was about 4, 5 years ago I wrote and published a book for secondary school learners, that was more games orientated rather than technology orientated because I think that is more my strength.

MR CHIZWINA: Okay, there's, there was one like one, the interviews that I've done…

TEACHER C: Hmm.

MR CHIZWINA: Maybe I'll get it, but I'll get to that point where I discuss about other issues, to tie into the games issue.

TEACHER C: Hmm.

MR CHIZWINA: Do you think in-service learning in the use of technology could assist in technology adoption? Should there be in service learning, in service training?

TEACHER C: I think that there should be specifically for teachers perhaps or for lectures at a tertiary level who haven't maybe had a teaching background and they're nervous, you know, it's a research or an educational background *versus* understanding the, for want of maybe a better word the pedagogy behind teaching might be different and so the teacher themselves might be wondering what they need to do. So, in service that is perhaps a little bit more technology based, that the teacher can source without feeling… What's the right word, perhaps as though they, they're going to expose themselves for being uncertain. That is a, I think a very good idea and you know even as you become a, I think a more experienced, older teacher like, like we are, you know you get so bogged down in the day to day things that going back and watching something like that from time to time might be a good idea. It's to remind yourselves of the back to basics so to speak.

MR CHIZWINA: Does your use of technology outside of lectures and tutorials influence you to try the technology in the classroom? If yes why? If no, why not?

TEACHER C: I think it does, I think we spend a lot of time sitting behind our computers these days, sometimes it can help and sometimes it can hinder. I think because we spend a lot of time on our computers and in different sites and doing different things. It allows us to become more used to working in that way but at the same time we also get so bogged down in addressing our emails and working on our spreadsheets that there's maybe not time to go and explore all the marvellous wonders that are out there and so, so it's good to be part of, for example I'm part of a couple of groups on LinkedIn and I've received some really good ideas from other people in groups that are work related in terms of resources that are available out there, that I wouldn't have had access to or known about because there, I think there is just so much overload out there that you don't know what is good and what is bad and what is a waste of time.

MR CHIZWINA: How has senior Management at Monash been supportive to teachers in process of using technology in mathematics?

TEACHER C: I would say yes and no, the reason I would say yes is because Khan Academy, came to my attention through senior managements, I received an email saying: "You know, have you guys seen this? Have you looked at it? We think it would be very useful, please have a look, and give us your thoughts." I think that was when we still had to perhaps subscribe and you know, pay a little bit for it and that occurred over 3 semesters where senior management were the driving force between hoping that we would begin to use Khan Academy in our maths teaching, but I don't think that too many people have adopted it and maybe it's because they haven't had time to look at it, maybe because they don't believe it adds value and maybe it, dare I say, it might be because it came from senior management that it was decided not to be used. Having said that I think budget constraints are problematic for technology where you need to subscribe or buy.

MR CHIZWINA: Because like for example, sorry to interrupt you…

TEACHER C: Hmm?

MR CHIZWINA: Like for example is there like with depending on, is Monash does it allow teachers like maybe to use things like Facebook, Twitter in their teaching?

TEACHER C: I don't know, I've never used Facebook and Twitter in my teaching but I do know that there are privacy policies, so if it was me, I would prefer not to use my personal

space, in terms of that, there is Moodle and a variety of other options that I think I would use for my teaching rather than my personal Facebook space.

MR CHIZWINA: Okay, but the policy allows you to be, to use those, the different tools like for example if you get Khan Academy, does the policy allow you just to use it?

TEACHER C: I don't know, I haven't read the policy.

MR CHIZWINA: Okay.

TEACHER C: However, I have put the links of the different things onto my slides and I hope I haven't done that, breaking any policies. If I have then it would be solely in the purpose of trying to improve the academic position of my students and not through any bad decision.

MR CHIZWINA: Okay, have you ever seen or been to a class where the instructor is using technology?

TEACHER C: Yes, I have, at one stage I was very fortunate to be asked to sit in on many colleagues' classes when we were doing peer evaluations and I have seen the use of technology not only in mathematics but in other units as well and I think from that point of view and just going back in my mind to the encouragement to use various forms of technology in terms of blending our learning I wouldn't think our policies would have any

problems with us, using things like Khan Academy. Just to go back in retrospect to the other question, ja.

MR CHIZWINA: So, what did you learn from that experience of seeing a colleague using technology in their teaching?

TEACHER C: I think it reminded me that different technologies and different offerings in the classroom spark interest. You know as you change from just talking, to showing a movie clip or just talking to allow the students to use their technology that they have at hand or you know it's, it just breaks the monotony of a lesson and it redirects, refocuses, brings the student back, you know making sure that they are using their learning time, wisely.

MR CHIZWINA: Okay, like is there any like technology that you have tried or wished to use in the classroom?

TEACHER C: I would like to find a really nice quick easy graph drawing programme for sketching straight lines, parabolas and showing then the movements, logger rhythm, functions exponential functions because we spend quite an amount of time with our students doing that and technology that could show them how the graphs move with the different transformations that we put into the equation I think would be very helpful and useful and perhaps instead of just drawing those motions into my power points where I shift a curve to the right or shift a curve to the left in the animation. I think having them see it where you've got your graph paper in a programme like that might be, might be a good thing, and would be a good thing.

MR CHIZWINA: And is there like other technologies besides what Monash provides? Is there anything else that you have tried to use?

TEACHER C: Yes, I have, not at Monash specifically but I have used plenty of different technologies you know over time. As I have said the graphing calculator, auto-graph, there were a couple of different graphing programmes that we purchased at different of the secondary institutions where I worked previously that I felt were quite good. I find out about new technologies as well from friends who are still in the secondary teaching space, for example, equation editors how I always used to type my tests and worksheets and still do impact but apparently that is almost older technology and there's, there's easier, better ways since that is, I mean, that's been going for sjoe, probably a good 15, 20 years that, that equation editor and so apparently there are better forms now, but because I don't need to use them as much as I did when I was teaching secondary or when I would have been typing exam papers, I think I don't experiment perhaps as much with them. You know, you've got 24 hours in a day and you divide it up and learning a new technology when you've got one that kind of does the job, is sometimes pushed on the back burner.

MR CHIZWINA: Does the accessibility of technology at Monash allow you to adopt technology in your Practice? If so, how? If not, explain why?

TEACHER C: I don't know if it's the availability of it or if it is the fact that we don't talk about it enough, get involved, we don't always know what is there because, you know, it's not so much a need to know. When I was in a, in a place where I needed to know how to type my exam papers I went and found out. Whereas now, in terms of my teaching I think I've got enough different things going on there. I've got some movie clips, I've got some other ones for the students that they can watch on their own outside, I've got a couple of things that show how things move around and a couple of you know, things that I have taken

off the internet that I use in class. So, I've got a variety of different technologies that I use, but probably I think if we were in space where we talked more about technology in maths and you know, I knew more things I would use different things and more wildly.

MR CHIZWINA: For your like, for the things that you use in the classroom, you store it on Moodle or there's another place that you store the things…

TEACHER C: I don't store any of my things on Moodle simply because there's not a Moodle space for the essentials and I rather leave Moodle for the teacher, you know, it's their unit and I prefer not to interfere in their space so, I store everything on the share drive.

MR CHIZWINA: Do you feel that your knowledge of technology is sufficient for you identify and adopt technology?

TEACHER C: I'm not so sure that I'm inhibited by a fear of technology rather than a time constraint to know what is out there, ja. I don't think I fear technology perhaps as I did when I was starting out and it was all brand new and so much. I think it's just a time constraint, you know, we've got a lot of teaching, I teach despite the fact that it's actually not part of my job description and that probably takes half a day at the moment, it used to take a full day out of a 5 day week. In addition to my actual work, in addition to my studies, in addition to my life away from work and so I would say it's time, rather than, than fear.

MR CHIZWINA: Than fear?

TEACHER C: Hmm.

MR CHIZWINA: Okay, like for your, as you, okay, I think you have mentioned that for you are continuous on LinkedIn that's where you get ideas…

TEACHER C: Hmm.

MR CHIZWINA: And you also explore Khan Academy and stuff like that…

TEACHER C: Hmm.

MR CHIZWINA: So, I think maybe in terms of the knowledge aspect you've got, like avenues where you are able to find and to update your knowledge in terms of the technologies available.

TEACHER C: Hmm, hmm.

MR CHIZWINA: From your experience and beliefs, do you think that technology is beneficial in the teaching of mathematics? If yes why? If not, what are the reasons?

TEACHER C: I do, as I said if we just use our normal chalk and talk it's going to be very boring, lesson after lesson, even I mean, it's specifically called "death by power point" these days. There is only so many power points that they can see time after time, after time and I think even YouTube's are becoming a bit "death by YouTube" now, like "death by PowerPoint." So, I think finding different ways of keeping the students engaged in the work at hand and interested and, and wanting to learn more is, is important and finding different ways of using different technologies throughout your lesson, maybe not every lesson like that, you know depending on the needs of the lesson. I think is important because that is what will help the student to remember and to learn and to want to engage with the work. I saw a lovely clip the other day that said: "No child will ever remember their best days being behind the TV" and that's exactly the same: "No child will ever remember their best lesson as a chalk and talk". We've got to use technology and we've got to engage with different ways of imparting the work, if we want our students to enjoy the lesson and remember the lesson.

MR CHIZWINA: Okay, like what model, like when you are trying to, when you are making a decision to use the technology what influences do you use to make it, is it for the students or for the teaching or it's for the content?

TEACHER C: I think it must be a combination of all of those, a lot of the time when I'm teaching my students, I refer to maths in terms of cooking because most of our students are getting to the point where they need to start cooking for themselves and I think it's the same as when you prepare for a dinner party, you sit down and you think about the people you are inviting and what kind of menu you would like to make for them and then from there you start to decide. What you will do for starters, what you will do for main, what will, you do for dessert, what kind of drinks you will serve. So, for me teaching or preparing for a maths lesson is very much like preparing for a dinner party. What is the level of the students that are coming, what have they learnt in the near past, what do they need to learn from this lesson, how is the best way to teach that, you know, and so forth. So I would prepare for it almost exactly, like I prepare for having friends over for a meal. The technology must fit in with the place where the students are at and it must fit in with the work

That is being taught as well.

MR CHIZWINA: Okay, can technology be joined with other instructional methods of teaching mathematics? If yes, in which ways? If no, why not?

TEACHER C: Absolutely, I don't, I don't even for a moment see why not and I in fact, I think it's critical. So, so when I taught a group of students for example about sketching exponential functions, they started off with a small table that they hand drew and then they put the date into their, their graphic calculators back in the day and from there it went onto the computer and it just grew bigger, to the point that they were eventually learning fractals. So, it started off with a small table but then the data became stored and then analysed through technology so that they could eventually apply what they had learned, in fact the project was in fact about plants. So, we mixed it was a maths/biology directive and so we went out into the gardens at the school that we were at and they looked at the different plants and they could see that, for example a frangipani tree happens in 3's. Okay so, the branch goes up in 3's and then into 3's and then they could see at what point it starts to flower and eventually they could estimate the number of flowers on a frangipani tree using an exponential function:

$$y = 3^x$$

MR CHIZWINA: Okay, you mentioned games…

TEACHER C: Hmm?

MR CHIZWINA: Do you like have, does Monash provides you like with resources to be able to use the games in the classroom, or outside of a classroom?

TEACHER C: Ja, I, as I say a couple of years ago I wrote a book it's actually called "Play Mathematics" and it was aimed at Grade 8 and 9 students, I am busy with the Grade 10, 11 and 12 book, in my spare time that's my hobby, but it's a book that I want to roll out to schools in South Africa and so specifically the purpose was that it wouldn't be a book that would require resources that were above the level of any basic school in South Africa. So, all that is really needed is, for most of the games are paper in terms of some of the card games, I used to make my students bring arterial boxes and we would make arterial boxes into cards. A couple of dice perhaps and things like that. So, I've had a look and I have been in talks in terms of converting some of the games into computer and technologically driven games that can maybe be sold over the internet like that for some of the schools that can do that. So,

technology can come into those but it is not a necessity in terms of that, in terms of what Monash provides we have a photocopying budget and that's really all that's being needed.

MR CHIZWINA: Okay, for like, what is your opinion like for example using multiple choice, online quizzes in the field of maths, do you find that it defeats the whole purpose of mathematics, because there are some teachers who believe that seeing the students developing the sum is more important than just getting the answer.

TEACHER C: Ja, I think it depends what you want to test. I once decided to set a multiple choice question on functions, test, a whole test and it was, it was a real learning curve for me, the students never did as badly as they did in that test and I couldn't understand what had gone wrong. I couldn't see where they had gone wrong, I didn't understand where their logic and their reasoning fell apart. So, effectively that test in terms of understanding whether the students understood the work was an absolute waste of time, okay. All I knew, was that they didn't understand but where they, how far they did understand and where the understanding fell apart, I had no idea because they either got it right or they got it wrong or they guessed. So, so for me, I mean I thought I had set some really clever questions and I was very, very proud of my test. I've still got a copy of it because I had thought it was such a good test but in retrospect it was such a good learning curve for me to know that, that doesn't work. I think that there are places where multiple choice can be useful in mathematics, but that is where you are looking for a specific answer not where you are looking for understanding of the work. I'm not in favour of multiple choice in exams but at the end of a lesson if you just want have a basic understanding of whether the students got that concept or that concept, you know and maybe for things like in the lower grades or you know, if they understand, if you want to test do they understand the actual principle of Bodmas, do they get the order that you must do brackets before you do exponents, before you do dividing, multiplying and then adding, subtracting. You know there a multiple choice questions will tell you quite easily, because they will either get it right or they will get it wrong. In fact even just a simple true/false will be enough, but, ja, I'm not sold on multiple choice for maths, I'll be very honest with you, in fact…

MR CHIZWINA: Hmm.

TEACHER C: Ja, it just, it doesn't help you to understand where you student is at and what they do get and what they don't get and then if you don't understand where you've left the student behind, you don't know where to go back and find them so that you can bring them

forward again and they just get a mark that is absolutely shocking and all that it does is devastate them. So now you're dealing with a double problem. There is an emotional problem and there's a maths problem.

MR CHIZWINA: Okay, because that was one like suggestion of like, how people are using technology that they are at the end of the lesson, they can have, they can get the students who use their phones to be able to do a quick multiple choice…

TEACHER C: Hmm.

MR CHIZWINA: So the teacher can be able to see, to determine if they understood the content of that particular lesson.

TEACHER C: Hmm.

MR CHIZWINA: Are you in favour of using such?

TEACHER C: You know, it depends if it's just like one question with one answer I don't, I don't think so, but if it's a question where you put the original question: "So and so is investing money for this period of time, at this interest rate" as perhaps for the question. Your first module, you could break your module, that doesn't have to be one question it could be a series of 6 multiple choice questions. Question 1: "Which formula should be used?" Question 2: Because now based on whichever answer they have given there you can follow through.

MR CHIZWINA: Ja.

TEACHER C: Okay, alright, using the formula that you've chosen above, what would you substitute and where? Okay, and then an A/B/C: "Which is A, which is P, which is I, which is R, etcetera or I or R which is N etcetera" and so I think if you build your multiple choice questions carefully like that so that you can still test knowledge and understanding, I think that could help, but just to have a question: "So how much did she get at the end of the time period" is like, there's countless possibilities to make mistakes.

MR CHIZWINA: Okay, so we go back to the issue of in service training that maybe there's need for continuous professional learning in the use of technology because some of these issues…

TEACHER C: Hmm.

MR CHIZWINA: Maybe could be resolved or could be, could be discussed in a workshop where people at least could be able to input ideas.

TEACHER C: I think it's more than that Sabelo, not just in terms of that, I think we don't make enough time within our teaching to allow technology teachers to sit down and chat about technology, maths teachers to sit down and chat about maths and I'm not just talking maths teachers in the foundation programme. There needs to be a time where we set aside, we set aside time for a staff assembly, but there needs to be a time where we set aside for people who are teaching similar subjects across the University to come together and have a conversation and that time just doesn't seem to be. I mean we as a foundation programme have very little to do with School of IT. Okay, so it's almost like we work in silos rather than communicating with each other and through the experiences that I've had, when you come together and you work and you share ideas with other people in a similar subject that is when things start to happen. So, in the schools at one stage they had cluster groups where you would have to work with people from other schools and you know, show what work you've done and what work they've done, within your own school you had department meetings regularly now. I don't think it should become burdensome or anything like that, but you know, there should be time set aside that if you, if you want to go and sit down and have a cup of coffee with a group of people over there that are talking maths related stuff, why not, but unfortunately I think we, we get busy and then it becomes rather a burden than, than something we would necessarily go for, so, ja, it's a difficult one.

MR CHIZWINA: In what ways does time affect your decisions to adopt or not to adopt technology?? Do you have time to be able to go and go to LinkedIn, learn a new technology?

TEACHER C: I think it's, there's time where you've got more time and there's times where you've got less time and so I think like round about this time of semester when, after the board of examiners there's normally 1 or 2 weeks before we start to shut down in earnest and then there's time. You know, if at that stage somebody posts something interesting on LinkedIn or you know, if I go back and I have a look through what I've done for the semester, you know I might sort of play around and find something and you know, add something in but for example some of the slides that I make, you know, you can't just do those fast, they take a lot of time. So I don't know if you want to have a look later on at something that I did, I don't know why it's not doing what I want it to do now but, you know, just, just as an example, one of the slides that I did, this slide took for absolutely ever to

make. Hmm, so, this is 31 slides, some of them are quite quick and easy, it's just welcome, this is who I am and this is what we're doing. You know, so if you look at this slide here, it teaches the students about distortions of an exponential function. So it shows them what the basic one is in one colour and then we talk about that specific point over there, so that they understand how the shape of the graph looks and then we look at what a distortion does and then we look at what a different distortion does so they get an idea and then we talk about shifts, you know and how the whole thing shifts. So, to put those animations in where they can now take this power point home and have a look at it so they can see, okay, let's just go back there. I don't know why that one's, I think something has gone wrong or somebody has played with my slides, but they could see there is the original one and then there comes the graph that's been translated one unit up and it shows what has happened to the graph, how it moves one unit up with, with its line of, its asymptote, that the asymptote that was there also moves up so that everything moves up. So, it just reinforces the writing behind.

MR CHIZWINA: Okay.

TEACHER C: Ja, but you know to do that takes time and then unfortunately it's not protected on the shared drive so anybody who goes into your stuff can, can move it around which is a bit annoying because, I know for a fact what was where.

MR CHIZWINA: Have you ever like used open educational resources?

TEACHER C: Not a lot, but the one guy on LinkedIn that I talk to, has put

some links in there so I've been through and had a look at what is available.

MR CHIZWINA: Would you use this content in your teaching?

TEACHER C: So long as it ties in close enough with what we need the students to know, I think that is also one of the problems. Our syllabus here in the foundation programme for maths is very different, which is why there's not a textbook from anybody else's syllabus. So, because there's so much maths out there you've got to be very, very selective in what you choose not just because of the content but also because of the method. You know, you want to make sure that the way that it is taught online or by somebody else, is a way that won't confuse your student from what they've learned already, specifically when they're a weaker student learning something for the first time and that's why it's, another reason why it's important for maths teachers to sit down and talk together,. You know, for example this, I

was teaching, there's about six transformations that they do on one curve, so, I've shown you two of them on here but you know, by the end of it, they, they, there's five. So there's the original graph and then five transformations that they have to do. Now what's the order in which you do that? What happens 1st, what happens 2nd, 3rd, 4th and 5th and there's different ways of teaching what must be done 1st, 2nd, 3rd and 4th. So, it's important that the weaker students get to learn an order and stick to the order and always follow the order. When children are very little and they are learning to brush their teeth, it takes a lot of effort to think about how do, you brush your teeth. We don't even think about whether we have brushed our teeth today, we did. Okay, so, the routine behind it for the weaker student is important so, if somebody else through technology teaches them a different way it is likely to confuse the student to his new to a topic. Later on when they have learned a little bit more and there's, there's time but you know, in 12 weeks for a maths lit student to get up to date with 3 years of maths core and then into what we're teaching them, there's no time to play and find new ways and do exciting stuff. There's, it's busy and they've got to get there and in spite of that some students do. I was very delighted to see one of our maths lit student's marks yesterday, for maths B, he got 60% and he passed maths A, he comes from maths lit. So I mean that just shows me that with, with hard work and with, with the methods that we are using, the technology included it happens, they are successful, but we've, we've got to be very, very careful that we don't confuse them with a bunch of new and different things. I say to my students, I prefer them to not go and try and explore and experiment with different YouTube's and different things that are available out there because it will be more complicated. A lot of them go and get new textbooks and borrow their father's textbook or you know, everybody thinks that because they've done maths they must just hand over all the resources and sometimes that is a dangerous thing.

MR CHIZWINA: Okay, so like maybe then, there's a need for a content aggregator where the teacher is able to go and select the content which they want the students to have access to.

TEACHER C: Ja, Khan Academy is quite good like that. They categorise and group all their different movies but even so, you know, if I have a look at, at a lot of the other Universities and what's TUKS, a Technical University. I have a look at their contents, their maths courses are not as commercially driven, they cover more science and engineering maths as well as some commerce, whereas we cover largely commerce maths because we don't have an engineering and a science faculty. So even a lot of the word sums, our word sums are shopping and business word sums, whereas their word sums will include speed, distance,

time and you know, a variety of other things. So even on that and Khan Academy you can't just go and say: "Words sums, fabulous, I found one." You've got to watch it, you've got to make sure that it's, it's covering the right content, you've got to make sure that it's taught in a similar method so even when it's categorised it's not necessarily enough. You rather want to be picky and choosy than have your students swimming in an ocean of tremulous water.

MR CHIZWINA: Do you feel that your knowledge of technology is sufficient for you identify and adopt technology?

TEACHER C: Hmm.

MR CHIZWINA: Do you feel that your knowledge of technology is sufficient for you identify and adopt technology?

TEACHER C: I think there's quite a lot of technology out there and you don't really know what is available. Some of the technology you actually have to have loaded onto the computer prior to using the computer in the venues and trying to get that up and running. Some of the venues don't have computer using, working when you go into, to give you lesson, just in terms of that it's just a huge problem just on its own. For example I, I always request lecture theatre 1, 3 or 4 because there are two proxima's. So I can use one for my slides and one for doing maths. So that they can see the slide with the steps on because just like cooking there's a recipe, every question in maths there's steps. You know so if you've got your slide with steps, like there's exactly, that's your recipe to sketch that graph. First draw the original then do that reflection then that one, then the translation and so forth, that's the recipe. So, I like to have that on one of the screens and then my work on the other one, but if both the screens aren't working you can't do that. So, so just in terms of our technology that's available it's not always working, sometimes the, the, it used to be called an overhead projector but that's the machine that's…

MR CHIZWINA: Hmm?

TEACHER C: That machine isn't working so, I think without even talking about new and different technologies and, and things that are available just, just our resources that we should have working are sometimes a barrier, getting into YouTube's can take time.

MR CHIZWINA: Ja.

TEACHER C: And then you know, it doesn't help that you've downloaded technology if the students haven't got it for themselves. You've downloaded it because you want to use it as a learning tool or a teaching tool but then they must have it so that they can use it further as a learning tool, you know. I just think in terms of my own studies, I went to courses on how to use SPSS, but if I don't have SPSS on my own computer it's not helpful.

MR CHIZWINA: Ja, yes.

TEACHER C: So, so we've got to make sure that if we teach the students using technology that they are able to download it as well. So in terms of the University buying technologies we must make sure that we have a license where we can let our students use it too.

MR CHIZWINA: There was one, one barrier that was mentioned by a number of teachers is that, this one and two tutorial situation is not really adequate for them, it is also a barrier because they prefer to have computer lab sessions, where they actually showed the students how to solve the problem.

TEACHER C: Hmm are you talking about maths specifically?

MR CHIZWINA: About maths specific, ja, the foundation programme.

TEACHER C: Ja, sorry if it rings again I will take it. I, I think that's probably not a bad idea… Sorry if you can just give me a moment.

MR CHIZWINA: Okay, that's fine.

TEACHER C: Was it the teachers or was it the students saying that?

MR CHIZWINA: It was the teachers.

TEACHER C: Okay, the reason why I ask that is because while I think it could be valuable depending on how much technology you use. I think we've also got to start making time available or insisting that with the time that is available, students start working alone, without the teacher being the overseer if you know what I mean, I think.

MR CHIZWINA: Hmm.

TEACHER C: I think mathematics is a subject where, like accountancy, where the students need to sit down and actually just work hard at it. I mean, I

can go to gym and watch the personal trainer do a seriously good work out but I'm not going to lose any weight until I start working out myself, and we've got to, we can provide the students with all the resources that, that we have but until they sit down and actually engage with the work they're not going to learn anything. Watching a YouTube is a great way to learn, but we don't know what they've learnt until they actually try that question firstly to see if they can do it on their own and then a similar question and then an application into where ever we're going. For me that would be more important than sitting in a computer lab with the students, they have got to start to engage with the work themselves.

MR CHIZWINA: And what about the issue of group work? In that…

TEACHER C: I am very, very much in favour of group work, I always have been. I like my students to sit down together and engage with the work, I am fully *compos mentis* that they won't always engage with the work and sometimes they will talk about their weekend. I was a student too and so I did that also, but I do think that, that working in small groups is beneficial. Not everybody wants to work like that and so, I don't think they should be forced but I, I'm all in favour of group work, when I taught in secondary, every single classroom that I ever had always had my desks in group of four. Generally I allowed the students to choose their group with a couple of shuffling's here or there. I liked my, depending on what section we were on, I liked to have weaker students spread amongst the brighter students, so that there was maybe a top, two medium and a lower student in a group so that they could work together. Not every bright student is able to help a weak student but with that kind of spread, depending obviously on your abilities that is helpful. Having said that, in the foundation programme, because of the time limit they, I really wish that they would look at making the classes up according to whether you did high, maths A level, O-level, core or maths lit, because if we could get the maths lit students together the interventions could happen in class rather as an additional. I think too many of the maths lit students have a look at the essentials and say: "People will know I'm maths lit if I go so let me not go." It's, it's stigmatised almost and I find that a lot of the students to come to the essentials are actually the students who are aiming for the 97, 98, 99% and who end up getting it, because they've put in the effort. Whereas a lot of the students whom it is aimed at never actually arrive and it is very difficult for us to determine or to identify who those students actually are because we don't always have their, their matric background. So, we don't know what maths they did at school short of actually asking them.

MR CHIZWINA: So, is there nowhere like where maybe an intern, an online intervention that can be designed that will be able to assist everyone?

TEACHER C: Dude, if you would do that I would be delighted. Is that minuted? I think, I think something like that and I think that's maybe perhaps now we're starting to talk where technology, where I'm hindered by my technological knowledge is, I don't know how to design those kinds of things because I'm a maths teacher not a technology specialist. So, if we had a technology specialist who specifically went and started designing something like that, that could assist for our specific needs. I mean, as it is we go and pull the different little things that we have on Khan Academy and so off, but if there was something that would, would almost assist our students to build their knowledge because effectively they've got to cover 3 years of mathematics to get to the level of the other students, plus they've got to cover those years because they weren't good at mathematics which is why they did maths lit, Now they've got to do 3 years in 12 weeks of something that they terrible at. I don't actually know how they do it, because that sounds like a huge ask. If you had to ask me to, to do that in a subject that I felt very uncomfortable about, I don't know that I would be able to rise to the occasion that they do.

MR CHIZWINA: Do you provide like, opportunities for them to engage online collaboratively?

TEACHER C: I don't have a place where they do that. However, I do have a lot of students who email me because they, I've said to them: "If you email me…" That is the first thing that I will do, I'm a bit of a, I mean, I like technology and all but I'm a bit of a paper girl. So what I do at the end of every lesson, well not at the end of every lesson, I get them back at the end of every lesson. My students fill in a little piece of paper for me with their name and their student number and how they feel about the lesson. So, this one said she that she feels good about second order equations but she is not sure about exponential applications. So, I can immediately address that problem by emailing the student back and saying: "Please go look at this YouTube."

MR CHIZWINA: Okay.

TEACHER C: Okay.

MR CHIZWINA: Alright.

TEACHER C: So, so this is a piece of paper that they all fill...

MR CHIZWINA: So you combine the paper with the technology?

TEACHER C: Ja.

MR CHIZWINA: Ja.

TEACHER C: This one I don't need to worry about, she's got a smiley face and she feels good, there is another good happy smiley face. This one I need to worry a bit about, maybe I don't know because there is nothing there. Okay, so you know it's very easy now because the students are all doing this together, so nobody feels picked on or whatever, I tell them I'm taking attendance but I also want a little bit of feedback and you know, there is a student who is feeling stressed.

MR CHIZWINA: Hmm.

TEACHER C: So, now because I don't know what it's about, I can refer this student to a tutor or you know say: "Please go through the YouTube's" but it's very quick and easy for me as I'm taking my attendance just to flag these students that show a concern and send a follow up email with some information that can assist them with the problem that they've got. So, I don't find out about the problems by technology but I can use technology to assist the, the student or a tutor or both, depending on what the student then wishes to, to use as their method for solving the problem.

MR CHIZWINA: Okay, right, the last three questions, I'm taking up your time.

TEACHER C: No, it's not a problem at all.

MR CHIZWINA: In your opinion would owning a device for example an IPad influence you to try and use it for teaching and learning? If so, how? If not, why not? For example, do you think like having the Tablet is going to influence you to adopt maybe some of the Apps that are on the Tablet in your teaching?

TEACHER C: I don't have too many Apps on my Tablet and I haven't used my Tablet in teaching. When I had the graphic calculator I definitely used that, even the calculator the simple Casio. The simple Casio that I recommended that the students buy and I'm sure that they think that I'm a "closet Casio sales lady", but it's got a lot of good things in here that I regularly show them even though it's not the method that we, we need them to use. I let them

see that this is now an alternative. So if we go back to that equation over there on the screen, they can actually type that equation into this calculator, in other words they can go all the way down to point number five or they can go in, in pieces and they can get points. So if they don't know how to draw that graph or any of the pieces getting, building up to that graph they can enter pieces of that graph equation that function and build the graph up through points on the calculator slowly. So I show them that in case they can't get it done the other way, so I use technology in that instance to provide them with an alternative method of doing things or if they would prefer because they can do it, as a check.

MR CHIZWINA: Ja, there was one, also comment from one of the teachers to say that, okay, it's good and fine that they have the computers in front of them and they're showing the students…

TEACHER C: Hmm.

MR CHIZWINA: But they find that this thing of not having the students have a computer as well in the tutorial it is also barrier.

TEACHER C: Ja, no exactly.

MR CHIZWINA: Ja, so, that is one that, that many people felt strongly about that.

TEACHER C: Yes.

MR CHIZWINA: As much as they can be able to show them, if they don't have means to be able to practice, then…

TEACHER C: Ja.

MR CHIZWINA: There's no point.

TEACHER C: This is a 100% correct.

MR CHIZWINA: Ja.

TEACHER C: That's exactly what I said earlier on.

MR CHIZWINA: Ja.

TEACHER C: You know its all fine for us to be able to download the programmes and use it, but if the students don't have access it's a problem. So, you know with the calculator, I

know that they've got that in front of them or they must turn to somebody nearby and I recommend to them that if they don't have a Casio calculator then it must be the first thing on their, their next birthday list, because it is a good calculator and they will use it forever. Some of them have got a Sharp and I say to them: "Well that's not a problem, a Sharp is also a very good calculator" as is the Texas instruments etcetera, but you must make sure that you can use the calculator that is in front of you. I've grown up with a Casio simply because Casio had a really good marketing strategy and as a result, this is the one that I put on to the, the screen and I show them. When you turn your calculator on and you go into your setup, sorry you go into your mode, number 3 says "table" so if you push number 3 it gives you a function graph and you can type that in. So I tell them that they can follow step by step and then they learn how to use this because they've got this in front of them but if I showed them this and they didn't have their calculators by the time they got home they wouldn't know what to do they've forget that I had said: "Press mode." They have to be able to have that technology available in front of them, the other teachers are a 100% correct.

MR CHIZWINA: And how do you feel about recording these, your classes and putting them up on Moodle?

TEACHER C: So long as it's not a bad hair day, it's fine. I think it's good, I think you know it's good for a variety of reasons, you are going to have students who are going to miss your classes and when they miss your classes they, the students acknowledge themselves, you miss 1 day of class and it takes you 3 days to catch up what you've missed, because now you're learning on your own and you don't work at the pace of the instructor when you're trying to find out what the instructor has done, that's the first thing. The second thing not everybody catches it up on the first time round. You know, there is so much information being thrown at you, that if your phone happens to ring and you glance sideways you lose your train of thought and then to pull yourself back the teacher's already a little bit further down the road and now you've missed a critical concepts, you know and it just takes you to miss one critical concept and you've got a broken telephone.

MR CHIZWINA: But what I've noticed is the maths teachers, is that they seem to want to have the control that, actual teaching is taking place…

TEACHER C: Hmm.

MR CHIZWINA: They not confident in letting the students, for example, work by themselves…

TEACHER C: Explore, experiment, investigate.

MR CHIZWINA: Ja.

TEACHER C: Find out.

MR CHIZWINA: Ja, yeah.

TEACHER C: I think, I largely agree with you and I will tell you why that is. In my mind specifically in my position, there's just not enough time, I get 24 hours to convert a maths lit student…

MR CHIZWINA: Ja.

TEACHER C: And in fact one of the students that I interviewed recently for my own studies, he was maths lit from the get go, grade, the start of Grade 10. Now he is either going into IT or business, he's got to, not only have most of the maths core knowledge but he's got to pass our syllabus and I get 24 hours of remediation. I always say to my students 24 hours what a difference a day makes, but that is all I've got, we don't have time to play.

MR CHIZWINA: Hmm.

TEACHER C: I wish I could grant them time to play, but you know all those

fabulous games books over there I don't get time to use them in that kind of pressurised situation and that is why I put the YouTube's up there so that they can go and explore, you know, they've got to go and do some work on their own. So, I don't think it's that we're saying to them: "There's no place for you to try and explore and experiment." We're-examination just saying in our classes there is not enough time for you to do that in that controlled circumstance. Which is why I recommend find students who stay in the same res or near you or students that you like that you can work with. Find a tutor, sit down behind your desk, on your own and sweat it because if you don't start sitting down behind your desk you're not going to know what you don't know. Find your friends and work with them, once you know what you don't know because maybe one of them knows. If they can't help you and that's when those discussions should be happening those like: "Well have we thought about this? What if we do it this way?" There's nothing wrong with that, there's nothing

wrong with new or different methods and some of them will have come from a school where they learnt it in one way. Again I would like to just caution though that the student who hasn't learned it at all and he is trying to grasp it for the first time and grapple with it, should just really be taught one method. You know, let's not teach him all kinds of ways of doing things because they will get confused.

MR CHIZWINA: Have you experienced the use of technology in the teaching of mathematics? If yes, what did you gain from this experience or what did you understand about the use of technology? If no, what would you expect to learn if given an opportunity?

TEACHER C: Hmm, ja, I don't think we should be against it. I think we should caution our students, you know. So, so I've pulled out movies that I've said: "These ones work in the same way and I know that Elaine has taught you for example two different ways of doing this in this class and I know that most of you have found this way the easier so I've put those ones first over there, but if that way works for you then there's some more movie clips over there. If the first way worked for you don't look at the second way, just stick with the first way." That's exactly what I tell them and how I tell them even and then you know they understand that there are different ways and they can experiment if they want to but for the poor guy who is lost, lonely and confused and feels like he's just landed in a foreign country he is just going to stick with one way because that's, that's all he needs or all she needs to be able to get through the subject and move forwards.

MR CHIZWINA: With regards to collaboration, who do you collaborate with? Why do you collaborate with the individual or individuals? How do you collaborate?

TEACHER C: Hmm, yes, LinkedIn, other maths teachers that, that I've worked with previously that I'm still in contact with. You know, it's nice to sit down and have lunch, we have a group that gets together from time to time. In fact Teacher D and I know each other from teaching previously and you know, you sit down and you, you find out whose using what and whose doing what and you know, even within our department, Roy regularly comes in and I've got WorkFlowy.com up there, you know, where he's, he's told me about something that he's found recently that is useful and so. So you know as you teach your students the people that are more *au fait* with technology because that's their passion will come and say: "You know what this is like a maths thing" which is exactly where the Khan Academy came from. I don't know who brought it to the attention of Debbie, but somehow Debbie found out about this and she sends all of the maths departments an email saying:

"Have you guys looked at Khan Academy apparently there's some really good stuff on there, I don't understand maths but you guys will understand it, please have a look at it and tell me if you think we can use this." Then, I think it was earlier this year, I got involved in an online discussion for a new textbook and we were talking about technology driven maths there as well. So you know you get some resources that way, but I think, I think you have to go out and look for it, it's not going to come and necessarily knock on your door.

MR CHIZWINA: Okay, finally…

TEACHER C: Hmm.

MR CHIZWINA: What else would you say about technology in teaching maths? You've already mentioned that…

TEACHER C: Hmm.

MR CHIZWINA: There's a need to caution students, you mentioned the need to collaborate, you mentioned the need to… How do you see technology?

TEACHER C: Hmm.

MR CHIZWINA: Do you see technology as being able to just to provide access to the resources?

TEACHER C: No, I think it's got to be fun and I think that there are a lot of

online games and, and things like that, that the students can use but I

think we've, I think I've got a few cautions there, you know, even though we are a private institution there are a lot of students who come to us that haven't sat behind a keyboard before.

MR CHIZWINA: Hmm, yes.

TEACHER C: And to now want them to go and do maths, when they did maths literacy on a computer when they've never seen one before, you know, this is going to be like asking maybe a little bit much. So, there are some cautions that I have and I, I don't know that the teacher should always be the driving force behind using technology.

MR CHIZWINA: Hmm.

TEACHER C: I mean one of our students who has passed through us now was and IT geek and there was a section in maths that was being taught and maybe this is exactly the example that confounds what we were saying earlier on, and he looked at this and said: "Huh, I wonder if I can write a programme to proof that maths concept that I was taught" and he did and he took it to his maths teacher and said: "You know, that concept that you taught us, well here's the technology programme behind it, I wrote it this afternoon." I mean that's fabulous, you know, so, so you're sitting with that kind of brain on one side that, that is enquiring and you know, has a look at mixing the maths and the technology together and it's, it's no question that, that is going to be one of your brighter students and you wonder why they went through a foundation programme then, but any way. Then on the other side you have got the student who just can't, simply because they've never had the resources or the opportunities before. So, enter with caution, you know, but I do think that the, the attitude of the teacher towards technology does rub off on the students, just like the attitude of the teacher towards anything really, you know. We expect our students to learn from us and then we get upset when they do sometimes. In terms of things like, attendance, respect, arriving to class, you know, those kinds of things, they learn what we teach them and the same with technology and attitude, I would say as well.

MR CHIZWINA: What about like this whole thing of many maths teachers are still believing in the "chalk and the talk", but our students are, if you look at our students, where they coming from and how they want to learn…

TEACHER C: Hmm?

MR CHIZWINA: They want to learn on their iPad, they want to learn online…

TEACHER C: Hmm.

MR CHIZWINA: How then can, how then can we, where can the meeting point be established for both?

TEACHER C: Hmm, it's difficult, at University I think there should start being less "chalk and talk"…

MR CHIZWINA: Hmm.

TEACHER C: And I think we also need to make our students put their, their money where their mouth is. So they say they want to learn this way and I'm saying to them: "Okay, these

slides, all of them from week 1 up to week 12 are on the shared drive at the beginning of the semester. How many of you go to week 1 tutorial one before week 1's tutorial one and look at it?" Oh no, nobody: "So you guys are saying you want to use technology to learn, there it is in its most simplest form. Okay, so maybe you didn't know about week 1, tutorial one. In 2 days' time tutorial two is happening, I expect that you go and you find it on the shared drive, this is how you find the shared drive and you were, you just have a look through the slides, print them out and bring them to class." Okay, so in my mind both sides need to start putting their money, their, their money where their mouth is. As a teacher we did not, or not, I go back to that statements, your favourite lesson was not a "chalk and talk" lesson, the one that you sat in, not as a teacher, as a student, you don't remember your "chalk and talk" lessons, so why would you expect your students to remember them. So, why are you teaching like that, you know what I'm saying?

MR CHIZWINA: Yes.

TEACHER C: I mean, I once made my students do a lesson for surface area and volume, where we had a mad hatters' party and they had to make their hat and they had to work out surface area and volume of whatever they had on their hats and then we had a tea party. I don't remember the lesson but many of my students came back and said that was their favourite maths lesson ever in my class, I'm going: "I don't remember it, did we do that?" You know, so it doesn't matter what we remember, it matters what they remember and what they perceive as valuable. So we've got to look at it from that point of view, because we're not teaching ourselves, we teaching them, they are the ones that we've got to focus at. So, so I think that would be my message to the teachers, like: "If you didn't enjoy it, why are you forcing it and it's not about you." We've got to move forward, we've got to have a look and see what works for them,

I'm not told that only technology…

MR CHIZWINA: Hmm.

TEACHER C: You know, as I mean I've given you some examples of some different things that I've done in terms of discovery, with the frangipani activities, games, you know. I think, I think everything has got its place but once again you've got to have a look at your dinner party, who is coming and what you're going to feed them.

MR CHIZWINA: Still if you look at the educational core…

TEACHER C: Hmm.

MR CHIZWINA: What you want to achieve because there is no point in just having technology for the sake of having technology…

TEACHER C: Ja.

MR CHIZWINA: Which is what is happening right now, where we are having Moodle for the sake of having Moodle…

TEACHER C: Ja.

MR CHIZWINA: Which is just a place where we can store our documents. So we're not really…

TEACHER C: Ja.

MR CHIZWINA: Using it for to actually encourage learning…

TEACHER C: Hmm.

MR CHIZWINA: We using it to…

TEACHER C: Ja.

MR CHIZWINA: We using it to store our documents…

TEACHER C: Look…

MR CHIZWINA: Which is what technology…

TEACHER C: Ja.

MR CHIZWINA: Which is where most technology ends up, like we've got the whiteboards…

TEACHER C: Ja.

MR CHIZWINA: What barriers affect your ability to use technology in your practice at MSA? Do these barriers hinder your ability to adopt technology?

TEACHER C: Ja, I think there, I think there is a very good place for in service, those whiteboards. I mean every year I try and remind the Programme Manager has to to remind

everybody to say: "Please don't write on the interactive whiteboards with a normal whiteboard pen."

MR CHIZWINA: Hmm.

TEACHER C: Because I've been into venues where you can't, where you may as well throw the whole interactive away because it's been so badly damaged. So, so having the resources but not training your people on the resources is problematic.

MR CHIZWINA: Hmm.

TEACHER C: And I think one of our problems is that we have too many sessional colleagues who change too regularly, not just in the foundation programme I'm talking Monash.

MR CHIZWINA: Monash ja.

TEACHER C: There are too many sessionals who don't understand the processes, the resources, you know, and all of that. So that's why those boards get damaged because the, the tutors in the schools and the sessionals are not taught how to use the resources properly and so don't.

MR CHIZWINA: The other thing that I also found out is that, it seems

like, like for example, I give the example of Teacher E, it seems like for her to be able to do those videos was, she had to do everything by herself with no support…

TEACHER C: Hmm, there was no support…

MR CHIZWINA: Ja…

TEACHER C: Ja.

MR CHIZWINA: So she had to use her own resources at home.

TEACHER C: Ja.

MR CHIZWINA: To be able to create the videos.

TEACHER C: Ja.

MR CHIZWINA: Which I think maybe that's why people are hesitant to use technology…

TEACHER C: Ja.

MR CHIZWINA: Because they find that, it now has, it's going to be their own baby. They are the ones who are going to have to nurture the baby, create the baby…

TEACHER C: Ja, that's it.

MR CHIZWINA: So in the end people will just end up doing their chalk and talk.

TEACHER C: Ja.

MR CHIZWINA: Because that's all that they think…

TEACHER C: Ja.

MR CHIZWINA: That they can be able to do.

TEACHER C: Well even these, I mean this took ages and ages and ages and you know you've got to look at the short term and the long term benefits.

Okay, so now it's done, it's done. Okay, there's a couple of things that I must now improve and change and all the rest of it, but the basic slog behind all of these slides is done, you know. The questions are all there the, everything's there but, you would think that yes as a University that is able to make, what was it… Those short 5 minute or 10 minute movies…

MR CHIZWINA: Hmm.

TEACHER C: That we would have movie cameras, that we would have a studio where you could go and sit and book whatever it is including a specialist who can be behind the camera and you can make your, your lesson, your online lesson, you know and Teacher E has got it exactly right where her, her video clips are short.

MR CHIZWINA: Ja.

TEACHER C: You know, I have said to the students: "By the time you've finished making the popcorn the movie is over. It's that short but it's got all the information that you need, go and watch it, download them all." You know, Moodle, the only benefits of Moodle over the shared drive is you can access it wherever you are in my mind. I don't think we're using it effectively but I don't, I don't know that we know how to use it effectively either. I mean,

you can put your YouTube's and all your other things in there. I know that you can do online tests…

MR CHIZWINA: Tests ja.

TEACHER C: And only once you've done your online test will it open but I also know that I can log on and ask you to do my test for me…

MR CHIZWINA: Hmm.

TEACHER C: You know?

MR CHIZWINA: Hmm.

TEACHER C: "Do you want to do my test for me, here's a coke?"

MR CHIZWINA: Ja.

TEACHER C: You know, it's done.

MR CHIZWINA: Ja.

TEACHER C: So, so quite how we look at different kinds of restrictions and so forth, you know, is another thing but these slides…

MR CHIZWINA: Okay.

TEACHER C: Have definitely been changed.

MR CHIZWINA: Okay, so like what I was, what I, what one of my findings so far is that there's, there is need for support. There's need to, for someone at least who's like responsible for, the educational technology to, to focus on the different subjects…

TEACHER C: Hmm.

MR CHIZWINA: To be able to sit down with the maths teachers and to be able to provide them with ideas of how they can be actually be able…

TEACHER C: Hmm.

MR CHIZWINA: To use technology in their teaching, which is what is lacking and also like, in terms of time there's, there's a need to be able to remove that time issue, the time factor issue…

TEACHER C: Hmm.

MR CHIZWINA: That it shouldn't be my own baby that if I'm going to create those videos it shouldn't be up to me it should be able, I should be able to get support…

TEACHER C: Hmm.

MR CHIZWINA: Or assistance to be able to do those videos.

TEACHER C: Ja.

MR CHIZWINA: Ja.

TEACHER C: Because you want them to look at it, I mean, Teacher E has done an awesome job. Her movies look good, but you know, but how do you find somebody who is willing to hold a camera. You need a whiteboard…

MR CHIZWINA: Hmm.

TEACHER C: You need all different kinds of resources, you know and where do you find that? In your garage?

MR CHIZWINA: Hmm?

TEACHER C: Fortunately she's got that in her garage, but not everybody does, you know and I think to find that one person who can provide that support across all different subjects and understand different subject's needs, bearing in mind that maths teachers are often quite histrionic, you know, it's difficult.

INTERVIEWER: MR SABELO CHIZWINA

INTERVIEWEE: TEACHER D

MR CHIZWINA: Alright, tell me, how long have you been teaching mathematics?

TEACHER D: Yes, Sabelo, God, how many years is it? Jinne, let me work out, it must be almost 40, no, not quite. 1970, I must now think, 78.

MR CHIZWINA: 78?

TEACHER D: Ja, ja I did my teaching diploma 77, 78, ja, alright. Ja, it's a long time.

MR CHIZWINA: How long have taught at MSA?

TEACHER D: This is my 3rd year, ja.

MR CHIZWINA: 3rd year?

TEACHER D: Ja, so it's actually 2 ½, I taught 3 years ago I only taught half a semester, ja.

MR CHIZWINA: Okay and what influenced you to come to Monash?

TEACHER D: They were short of maths teachers and I wasn't teaching at the time, that's actually what happened.

MR CHIZWINA: Okay.

TEACHER D: Okay so it wasn't actually, I didn't you kind of looked, that they needed someone, you know it was a case of last minute, you know what I'm talking about.

MR CHIZWINA: Okay, in terms of technology, have you ever considered using technology in the teaching of maths?

TEACHER D: You know, Sabelo, I hate to tell you, but in my early years I actually did applied maths and computer science at Wits, where I was and in those days we did punch cards. I mean this is way before you were even born. So we did that and for after 6 months we got a pneumonic and then we could actually work on a… What was it called? It was like a typewriter. It was an IBM typewriter, with, you could have direct access. Otherwise you had to drop your cards off at the computer centre and then they would, you know, they would feed them through the system. Oh, my God, ja and you know what has happened is, I've had a family and you just, you know you've just have too many irons in the fire and I just haven't kind of like kept up. In 1984 they brought in the PC's and after that I basically just kind of

like did not really keep up with the actual computing skills as such. So I am now back on a learning curve.

MR CHIZWINA: Okay.

TEACHER D: Alright.

MR CHIZWINA: Do you think teacher's experience might influence whether they adopt technology or not, in their maths teaching? So like your prior experience, do you think like maybe if you have used a computer before in your maths teaching it would influence you to use it to teach students?

TEACHER D: Ja, you know, I suppose yes, it would do. You know I am very much a "board and chalk" kind of a teacher, so you know I would prefer, I prefer actually discussing, because you know my lessons from 1 year to the next has never been the same because it depends on what questions the kids ask and sometimes you do go off at a tanager. Look you've got your basic syllabus to carry on, but you know what I am not that *au fait* with getting around on the computer. So I tend to, I tend to shy away from it within the classroom situation. If you've got a little bit of more time, then you can play and you explore, but I, you know, particularly I've always taught at the top end of a school system and you're then under such pressure to actually just finish your syllabus that you actually do not really explore a lot with the, with the computing. With all the sports that you've got to do and all the other extramarital, you know that gets put on right at the back-burner because you're so busy doing your prep, your marking and then of course whatever else you do, then still run a family. So of course that is why I kind of haven't kept up with this, with the technology *per se*.

MR CHIZWINA: Which technology would you say you have used before? Like I know at Monash there are whiteboards, there is Moodle?

TEACHER D: Ja, listen, I came from a government school and there were some teachers who had whiteboards but that was also only in my 4 years, my last 4 years of teaching. When I first started we had overhead projectors with a transparency and I mean all my years of teaching I never, I preferred to have a board because you could make your point, because otherwise the kids are looking right up there, at the overhead projector, right up there and in fact the overhead projectors in those days, used to go to the biology people, to the science people, to the geography people, because you know they need to do maps and all that sort of thing. So I am, when it came around, they only had four say whiteboards to distribute and I

know that at Krugersdorp, where I taught now, when I left in 2014, they were bringing in smart boards, but it was literally only for, one per department. So if you had, if you had 11 maths teachers, which is what we had, because we were a school of about 1 500, it was a, it meant that only the heads of departments got a whiteboard. Do you follow? So it was a case of, you know, so I mean I didn't need it, so I just stuck to, I just stuck the black board, in fact the green board as it was called. You know it was not a, it was not the old black chalk board. Those are in fact nicer to work on than the green boards. Those old, old chalk boards are nicer to write on, you know.

MR CHIZWINA: So you'd say you are a teacher that favours like the whiteboard? What is your instructional style? Has your typical instructional style swayed you to adopt technology in your practice?

TEACHER D: Well in, at Monash, it's super, because you have got this visualiser. So you know it's almost like a projector but you are working there on what you are developing there and then are you with me? So it's almost, it's just basically, the visualiser has become the modern version of the whiteboard. I do not physically use the whiteboard in the classes any longer. When I first started here I did because I didn't know how to, I could never get the things, the things going and you know the system is quite slow very often. If the previous lecturer was on the computer console and then you wanted to change it to the, to the visualiser it sometimes took quite a bit of time. It's got a bit better over the years, ja.

MR CHIZWINA: Okay.

TEACHER D: So I'm definitely still more a "board and chalk" but here I use the visualiser and I develop what I need to teach.

MR CHIZWINA: How has being a ZHC1010 teacher influenced you to adopt technology teaching that could be used by you and all the other teachers in the unit?

TEACHER D: No, no

MR CHIZWINA: Because it is more like you say you're like a "chalk and whiteboard teacher."

TEACHER D: Ja a "chalk and talk." Ja, "chalk and talk" to teacher, ja.

MR CHIZWINA: Chalk and talk.

TEACHER D: Ja.

MR CHIZWINA: With regards to collaboration, who do you collaborate with? Why do you collaborate with the individual or individuals? How do you collaborate?

TEACHER D: Collaboration with my students or collaboration…

MR CHIZWINA: Amongst themselves, do you encourage them to collaborate…

TEACHER D: You know Sabelo, it's actually a bit difficult in the maths because in the maths we're actually under quite a lot of pressure to actually get through quite a lot of work in the 12 weeks that we need to. So there actually isn't, you know because I mean you have one lecture and then you've got the three tutorials, but you, we actually find that in the tutorials, you're actually covering the practical work of what was covered in the lecture. Or sometimes with Teacher B's course for instance, we actually, we actually land up teaching what he did not manage to cover in the lecture, because he's only got an hour. You know and I mean he has got this huge topic. So, you know, you try and consolidate A), what he's taught you in class and then apply it, because I mean that's actually what the courses are. So you're actually quite restricted from a time constraint point of view. Ja, so I'm not against collaboration but I haven't explored that with the students in that, in that there's just no time, within the classroom situation to actually do that.

MR CHIZWINA: Okay.

TEACHER D: Alright.

MR CHIZWINA: So like, do you find the using of technology can be able to provide a time for them to be able to collaborate?

TEACHER D: You know where I find it's fantastic, is you know here you have got the shared drive.

MR CHIZWINA: Hmm.

TEACHER D: Okay and of course now they have got Moodle at home and it's actually quite nice with the shared, with the shared drive, because you can say to your kids: "Alright, go to the shared drive, go to week 12, there's a prac (practical) exam on there what you need to do." You know so that's actually quite nice. So you don't have to go and show them. I mean you can show them there and then but it takes some time to get, to move from the

visualiser to the computer and *vice versa.* I mean that's where this whole system is actually really quite nice and of course the fact that they, they've got all their slides from the lecture, is on the computer and on Moodle, so they can get that at home. So I mean that is really, really nice.

MR CHIZWINA: Do you ever refer them to maybe some other like sites where they can learn maths?

TEACHER D: Hmm.

MR CHIZWINA: If they don't understand?

TEACHER D: You know what Sabelo, our students that come in are generally quite weak, if, in mathematics, if they didn't, if they were of a higher calibre they wouldn't be doing the foundation programme. So we're sitting with kids who are coming into the system, a large majority of them have only done possibly, what's it called? O-level maths and I know within the schools, within the South African schooling system, they've done literacy and literacy, I don't know if you remember, if you're familiar with higher grade and standard grade maths. It is even way below standard grade. You know, so you, you're actually dealing with a level of, of child that has actually, you know you are catering for the middle masses that didn't quite just make it in order to get into mathematics to do whatever they need to do BCom or whatever and then you're dealing with the bottom end of this, the spectrum. So you need, you know, you need to consolidate at the level of teaching that you need to get through.

MR CHIZWINA: Okay.

TEACHER D: Alright?

MR CHIZWINA: Like, for now, what is your opinion about the teaching of maths? Teachers in like, for example, who are studying to become, the students are studying to become teachers, should they be given some like, in service training on how to use technology in the teaching of maths?

TEACHER D: In service, you mean the students teaching mathematics…

MR CHIZWINA: So…

TEACHER D: Or all students?

MR CHIZWINA: Let's say someone who is in Teacher's College…

TEACHER D: Ja?

MR CHIZWINA: Who wants to become a teacher, do you think that they should be given like in service training?

TEACHER D: I mean, I think they should. I mean, I think, I mean I have learned everything here from just asking in the poor old Department: "You know what I do next? What do I do next?" You know, ja absolutely, you know, but you know what it is. Also technology changes so quickly. You know in the old, you know the old, the old cellphones were this size. Now the cellphones are this size and you can get your emails on there and you can get… You know the technology changes so quickly and I must be honest. My husband is a CA and we, he was writing his own software. So I went back to college basically because I never did any bookkeeping. So I actually went back and I did high school accountancy, because I know how to programme. Okay and we used to programme on basic, but you know, I didn't understand the basics of business. I didn't understand the general ledger. I didn't understand a cash book. I didn't understand a balance sheet. So I went back to actually teach myself that and in 84 when they brought in the, ag the IBM PC for the first time, you know and everything went onto the DOS system, I mean after that I had my kids and then I just had so many other things to do that I just didn't keep up with the technology. So the technology side is actually more my problem. It's my fault, the institution or whatever, but ja, I definitely think they need to be taught, they really need to be taught something, but you know it will be outdated in 3 years time.

MR CHIZWINA: Okay.

TEACHER D: But it's got to be meaningful. It is all very well having all the gadgets. It's like I mean all these private schools, the one just here Maragon. I know their Standard 6's, last year, their Grade 8's all got, they all got iPads. I mean they are hell of expensive. Okay and I mean I had a friend of mine who was teaching there for the first time. Well, she was, she was, she has been teaching with me and she, moved across there. And she says: "Oh, my God" and then they would drop the things and then she says at the end of the day there's actually no harm in working with pen and paper. You know it's all very well working on your, on your iPad and that but you know when it comes to real mathematics, you need to be able to actually do the doing, what is important from a mathematical point of view.

MR CHIZWINA: Outside, outside of your teaching what other gadgets do you play around with?

TEACHER D: What other?

MR CHIZWINA: What other, like…

TEACHER D: Gadgets?

MR CHIZWINA: Technology, do you play with?

TEACHER D: Do I play with? No oh, God no…

MR CHIZWINA: Does your use of technology outside of lectures and tutorials influence you to try the technology in the classroom? If yes why? If no, why not?

TEACHER D: I'm too busy socialising. Ja, man listen, I must cook, I must wash. Hey, I'm running, I have got a life. I actually don't, I actually don't, look I message, you know on my cellphone but I mean it is not like that my cellphone is attached day and night to me.

MR CHIZWINA: Hmm.

TEACHER D: You know, ja no and I mean, and I do not like playing computer games. That's…

MR CHIZWINA: Well…

TEACHER D: A younger generation.

MR CHIZWINA: So do you think that wouldn't you like maybe should

try and use messaging to teach maths?

TEACHER D: If I could see, if someone could show me how effective it is, yes, then I would use it.

MR CHIZWINA: Can technology be joined with other instructional methods of teaching mathematics? If yes, in which ways? If no, why not?

TEACHER D: You know if somebody, if somebody showed me how effective it is, ja, then I would, could use it, but I have not been shown that. I'm not, I'm not convinced that it's any better than my piece of paper and my pen and talking and discussing and going through. We

want to draw a cubic graft, what do we have to do? Look at the thing. Look at the graph. Look at the shade. You look at the cut on the vertical axes. Look at the cut on the horizontal axes. Do you know what I'm saying, that development, it's the talking, the doing and the understanding.

MR CHIZWINA: And the video games, wouldn't you not like see as…

TEACHER D: You see I don't do video games so I, but I mean if I was shown that there is, that there's something nice then yes, but whether you would get the same, if it's as effective, I don't, I don't know, I wouldn't, if someone could show me how to, you know, a game, then possibly I would look at it, yes, absolutely.

MR CHIZWINA: How has senior Management at Monash been supportive to teachers in process of using technology in teaching mathematics?

TEACHER D: You know, when I started here Sabelo, yoh, I felt like I had a half an eyeball above the level of the water, because I was trying to get to grips with the content, which was slightly different. I mean it was economic mathematics. Okay, I'm not trained in economics at all. You know, so it was a learning curve for me there and I must say I found it quite daunting. I must be honest with you, I suppose, apart from the IT people, helping you when you're stuck, I must actually say no, because everybody is so busy doing their own teaching. I mean I, when I started here that year, Teacher B had like five classes, he was full on. So he was teaching from 09:00 until 13:00 and I was lucky to see him at lunchtime and just ask him the problems that I had. I mean it just, he was, he was stretched from a teaching point of view. Do you follow? So he couldn't really sit down: "Now you do this and you do that or you can play here and you can play there." And then the other bit I've just learned sort of as I have been here longer and longer, you know, but I must be quite honest with you. I would say actually no, but I've also been under a time constraint myself because I have been so busy trying to, trying to actually get to grips with the, with the work, that you know what you're teaching and doing, that I have not had the time to actually maybe go to IT or find someone to sit and do the thing. Do you follow what I am saying, but I mean amongst my own colleagues, Teacher E has been quite helpful but that's just getting around the shared drive and do this, do, that, do that, do that. You know, I mean she was quite good with that, but in that first year when I was here, oh, I tell you, I really felt like a, I really, I really felt like I was sinking, just because, because Teacher B was just stretched. He was teaching five classes flat out and I was just fortunate that Teacher E, also had just one class, teaching with Teacher B

and then I had about three. So at least you know she showed me how to get around on the shared drive. How to look for the stuff, du-du, du-du, du-du, but it's also just, it's just about, it's also just using the stuff and the experience. Alright?

MR CHIZWINA: But now you are able to use, to create PowerPoint slides?

TEACHER D: No, no, no I can't do PowerPoint, no I do not know that. I do not know that.

MR CHIZWINA: Okay,

TEACHER D: No.

MR CHIZWINA: And Moodle?

TEACHER D: Moodle, I'm getting my way around there, but I'm not, I'm not proficient enough to actually put something on and put something off. My computer skills are very…

MR CHIZWINA: So you…

TEACHER D: Down.

MR CHIZWINA: Never tried to have like, something like create like a video and put it up on Moodle, you wouldn't think of…

TEACHER D: No, because I don't how to do it, I actually don't know how to do it. I don't know how to put stuff on. That is why, Sabelo, when, you know Teacher E has been off now and they wanted me to run the course and I said: "I'm not going to run the course" because I said I'm not familiar of how to put things on the system and take them off and you know create files and all that. I do not know how to do all that stuff.

MR CHIZWINA: Have you experienced the use of technology in the teaching of mathematics? If yes, what did you gain from this experience or what did you understand about the use of technology? If no, what would you expect to learn if given an opportunity?

TEACHER D: Ja, listen, ja I mean, Teacher B does it, Teacher E does it you know where they go on to what they've got on the thing and they've got these slides and all that. I mean, I attend, I've attended all of Teacher B's lectures and I've attended all of Teacher E, whoever I'm teaching with, Teacher E's lectures, because it's just easier for a teaching point of view, because you can see where the emphasis is in the thing for your own students. Yes, you know, you can see where they have put PowerPoint's on and all the rest of it, you know, but I

mean you've really got to know your, you've got to really know your way around without making a donkey of yourself in front of all the students, because if you don't know how to get to the different things.

MR CHIZWINA: Okay. So like, what would you like, if you have got to go to a class like that with technology, what would you expect from that, turning from that experience?

TEACHER D: What do I expect?

MR CHIZWINA: Hmm?

TEACHER D: Well I suppose I would be entertained, you know, I mean because it's different, but I mean, I mean Professor Michael has done that very nice. He's prepared his own slides for Teacher E's courses. You know which he then makes available for the kids on the computer, you know and on Moodle in fact. You know, for that day and it's actually really nice because you can, you know you, you know everything is right there whereas I'm more of a teacher, I'm not a lecturer. I'm more of a teacher. I actually tackle the problem and then we work through that.

MR CHIZWINA: Okay, in your, in your teaching experience, have you ever once tried to use technology? Like let us say maybe you have found something somewhere and then have you ever tried to bring it into the classroom?

TEACHER D: No, I have not, because we, A), we didn't have computers. Alright I'm talking now before I was here. Okay, we didn't have computers in the class. I think that's getting better and better in the South African schooling the system as well. You know, I mean what we have always worked with are calculators, to the detriment of the students, because they come into, they come into Grade 10. They're now 16, they are going to turn 16 that year and if you asked them a ⅓ and a ¼, they would take out a calculator and work it out. They will not work it out like you, well you are even younger than I am. I will take a piece of paper, find a common nominate and work that out, but of course the problem is in Grade 10 I now expect them to work out ½ x plus a ⅓ x and of course they can't use a calculator, because we're dealing with unknowns and you know, they haven't got that proficiency because they are so dependent on this, on this machine. But I mean at, certainly at the senior level you've always have the, you've always have had your calculator and I mean with the new statistics that has come in, you know, you've got to use, you've got to use a standard

deviation and put your stuff onto the, onto the machine, you know, your tables, so that you can then square the item to do, to work out your standard deviation and your variance and all that sort of things. Ja, but computers as such, I haven't physically used, in my ordinary teaching at school because we didn't have computers in the class.

MR CHIZWINA: Okay and at Monash do you see like students using technology for…

TEACHER D: Oh, all the time, they use their iPads. They are so good with their iPads. They really are. I mean I see that in the lectures. I sit in on Professor Michael's lecture and the kids are sitting there and they've got the slides all there. They've got everything there, because he's already posted his lecture for the day on the, on the, you know, the slides on Moodle and on the shared drive. You know so they're sitting there with their little iPads and they've got it all in front of them. It is actually quite fantastic, but whether they're taking it all in is a different thing, because you know you sometimes also have to do something and that's what I also find actually with, with Teacher A, sometimes with the slides. Everything was slides but then you know he will explain the stuff, but sometimes when it's handwritten and you develop it, you actually remember it far better, than when you just see the slide being put up. You know it's not like in economics, when you look at the reason for the failure of the business, or whatever, you know point 1, point 2, point 3, point 4. You know in mathematics a lot of it is actually developing your concept, you know and it's sometimes better than actually saying: "Alright, now what do we do from here to there? Let's look. Let's go from there to this step. What are we doing now" and you move on like that.

MR CHIZWINA: So…

TEACHER D: Rather than a slide, rather than a slide.

MR CHIZWINA: So you do not like, find like, let's say like for example, if

you have to do have video…

TEACHER D: Ja.

MR CHIZWINA: Where you show that whole…

TEACHER D: Yes.

MR CHIZWINA: To be effective or you need that interaction? Do you think that the students would actually learn if they are just given those videos or they should actually come to class and see the whole process of coming, of finding a solution?

TEACHER D: I think the students, I think the… Look, if there's a video, then they, obviously they don't have to come to class, but I think sometimes it's actually… Look I would say the video would back up, but I think initially, to do the development, is still, is still better than seeing the video cold. You know if they see the development in the class and then they have the video as a back-up, in case they've missed something. Do you follow what I am saying, but listen, it's debatable. I, you know that's something you'll have to find out in your, in your research. I still think that the actual, the actual teaching part, is where you actually impart your knowledge to a certain extent.

MR CHIZWINA: Do you feel that your knowledge of technology is sufficient for you identify and adopt technology?

TEACHER D: No, no, no, I think my maths is pretty good. You know my maths background and because I have taught, I have taught for so long. You know, the fact that I'm not totally *au fait* with getting around on the systems and I am and the students are quite, are great, because I tell them: "Listen, I cannot get from here to there." At the beginning I always used to ask them and they used to help me out, you know, but from a point of view, of teaching the mathematics, no, definitely not.

MR CHIZWINA: From your experience and beliefs, do you think that technology is beneficial in the teaching of mathematics? If yes why? If not, what are the reasons?

TEACHER D: Sabelo, I can't answer that question. You know I've got no, I've got no report back, I just think from a point of view, of accessing, it's fantastic. I mean they don't have to walk around, they don't have to walk around with notes and notes and arch lever files of files of notes. I mean they've actually got everything there. Week 1, they've got all the lecture notes there. Week 2, they've got all the lecture notes there. Do you know what I am saying?

MR CHIZWINA: Hmm.

TEACHER D: They just can open it up. Whether it is as effective as what we had, when we were students, where we just had these notes, it's debatable, but I mean I just think it's great,

you know, how they can access the stuff at any particular stage. I mean, like for instance, all the exercises, are on the shared drive or on Moodle. Okay and the answers as well. Okay, so it's wonderful for them. I always say to the kids: "All you need to do is just print out the exercises because then you've got a hard paper and then you can tick off as you're going along, the ones you can do and the ones that you cannot do." You can't do that on the, well I suppose you can do it to a certain extent, but you know then the machine is not working and it takes, it's quite, what I do find with the students is very often, if they've got their iPads, on sites here, for some reasons, it's quite slow. I don't know whether it has to do with the Wi-Fi or what, but it takes quite some time to, for them to get into the stuff. Whereas if I've got this exercise sheet here, alright, I could do number 1, I could do number 6, I could do number 10. "Can I please have some help with number 8?" It's there, its right there. I can see what you have done and what needs to be done.

MR CHIZWINA: Okay, is it possible like, for you to be able to combine technology with other methods of teaching, of teaching maths?

TEACHER D: I am sure there could be. You know I just need to be, I just need to be convinced that it's quicker than what I am doing presently. You know…

MR CHIZWINA: Can technology be joined with other instructional methods of teaching mathematics? If yes, in which ways? If no, why not? Like for example the iPad, do you think that the iPad could be combined with how you teach maths?

TEACHER D: Whether it is going to be more effective is the, is the other problem. Sabelo, I suppose, I suppose if you knew your way around it would be, but then I've got to expect every student to have an iPad, which some of them still don't have. I mean there are a lot of students here that, you know, they still have to have access to the shared drive, and all the rest of it. You know, I think you know, if all the students are on the same level then it is fine. I mean that's why I just worked at a normal government school and I mean we certainly didn't have computers in our, in our classrooms. You know, so, you're sort of limited. I mean even the marks we did long hand, in a mark book, I mean its bloody crazy.

MR CHIZWINA: So if any decision has to be influenced by that, that the

students have access to that resources?

TEACHER D: Ja, ja absolutely. I think…

MR CHIZWINA: Does the accessibility of technology at Monash allow you to adopt technology in your Practice? If so, how? If not, explain why?

TEACHER D: That's absolutely, that's priority number 1 and you know if, if out of 5 students, 2 have got iPads you cannot just teach on an iPad if 3 of the students haven't got access to that. You know, you've got to, you've got to cater for everybody and not everybody is in that league to actually have an iPad.

MR CHIZWINA: Even if they have the iPads they might not be able to use them for maths?

TEACHER D: Ja, I have not been shown how to use them, to be quite honest with you. I need a younger teacher to show me, their way around.

MR CHIZWINA: Do you think in-service learning in the use of technology could assist in technology adoption?

TEACHER D: I need somebody younger than me, much younger than me, who is familiar and who has had, who's been quite proficient. You know you need your, you need your, you need a certain amount, you need a level of success, when you teach. You need to know that at the end of a 45 minute period or at the end of a 40 minute period, when the kids go out your class, you need to say to yourself: "Alright, I have had an 80% success rate in my lesson." If the kids are saying: "Listen, I didn't get that." Then you know tomorrow you've actually got to back pedal and re-teach. You haven't been successful in your teaching method are you with me? So if you have got, if you have got technology, that can make it easier, then by all means, one uses it, but then everybody has got to have access to it. Now having one computer and you have got 35 kids in the class, like you have at the normal schools, listen, there is just not, there is just no way on with that.

MR CHIZWINA: In what ways does time affect your decisions to adopt or not to adopt technology?

TEACHER D: You mean presently here at Monash?

MR CHIZWINA: Yes, yes.

TEACHER D: No, no, no.

MR CHIZWINA: So you find that you spend more time on preparations…

TEACHER D: Ja, preparation and that, ja.

MR CHIZWINA: So the time…

TEACHER D: Ja.

MR CHIZWINA: To learn the technology…

TEACHER D: Ja.

MR CHIZWINA: It is not there?

TEACHER D: Ja, no and look, you know, at the end of the day, as a sessional, you actually only get paid for the hours that you teach.

MR CHIZWINA: Okay.

TEACHER D: You know that's also the other big thing.

MR CHIZWINA: What barriers affect your ability to use technology in your practice at MSA? Do these barriers hinder your ability to adopt technology?

TEACHER D: What other barriers?

MR CHIZWINA: Ja.

TEACHER D: I think your biggest barrier is the fact that the kids are coming, whether it is from a disadvantaged background, although I think that the students here, generally, comes from quite a privileged background. You know, but the fact that they come from a disadvantaged background in that their maths is quite poor. So you keep on having to go back. You know, Sabelo, when, Johnny will bear me out, when they set things out, and they give them:

$$y = 4x^2$$

and we ask them to differentiate that, then they, alright. Say:

$$\frac{4}{x^2}$$

So then they will write it as:

$$y = \frac{4}{x^2}$$

They are then supposed to write it as:

$$4x^{-2}$$

And then what are you asking, to differentiate, which is divide the, x and then they just write down anything. You know:

$$y = \frac{4}{x^2} = 4x^{-2}$$

And they will, and then, all of a sudden, in the middle of all that they'll have the:

$$x$$

So they're not, they haven't been shown how to set things out. So here you are at University, having to show them how to set things out that should have been taught to them at school level. Do you follow? So that's why I say that a lot of the kids come from very disadvantaged backgrounds, from a point of view of mathematics, mathematical knowledge.

MR CHIZWINA: So you…

TEACHER D: And I find that very challenging.

MR CHIZWINA: So you also find that maybe some of the, like for example, let's say you want to use an iPad, for maths, they might struggle with that? Like for example how to use the, how to be able to write the functions on an iPad?

TEACHER D: Ja, ja, you know it's, ja, you know, for what we need for our course here, I don't think we actually need to have a, we need to get the, they need to pass the mathematics so that they can actually get into whatever field of study they want to and Sabelo, I must just add, that it's been actually quite nice, with me, having taught here, semester 1, 3 years ago. Those, a lot of those kids, who I thought were really weak students, are now in their 2nd year, this year, at, here at Monash and you know, you bump into them and they are actually doing quite nicely. So you know, I'm, you know they'd managed just to scrape through in that foundation programme and yet they are managing doing their Bazeko (?) course or whatever.

So that's actually quite nice, you know, it's just this getting over this hurdle, so that they can get into University.

MR CHIZWINA: So like now, having them to use a tool are you not creating another hurdle for them?

TEACHER D: Listen, I think the kids are far more, *au fait*, I think they are so much more *au fait* with technology than what we are. I mean give the kids a new cellphone, they'll have it sorted it you know in a, within a day. God, give it to us, give me a new cellphone it will take me the better of 6 months until I can actually function with it properly, but I mean that's just, because they can play with it the whole time.

MR CHIZWINA: In your opinion would owning a device for example an Ipad influence you to try and use it for teaching and learning ? If so, how? If not, why not?

TEACHER D: If I had an iPad, I would try and see what I can do, but I mean you know, I've also got a, I have got to have somebody there, just to give me, show me, hold my hand and show me a little bit: "You can do this. You can go into this." I mean, like I know with Google, you have got search engines. I'm getting good, I'm getting better every day do you follow?

MR CHIZWINA: Yes.

TEACHER D: You know and it's just to have the time to be able to look at it and to be able to source the stuff. That's actually, it's more a time effort, a time thing than anything else.

MR CHIZWINA: So the device requires time and requires assistance…

TEACHER D: Ja.

MR CHIZWINA: For you to consider using it in the classroom?

TEACHER D: Ja, hmm, hmm basically, that's, it in a nutshell, well done. Ja, absolutely, in my case, yes.

MR CHIZWINA: With regards to collaboration, who do you collaborate with? Why do you collaborate with the individual or individuals? How do you collaborate?

TEACHER D: Do we collaborate? Well we've got, we do collaborate but I mean we see what is on Moodle. We see what is on the shared drive and for instance, it was Teacher E's

birthday yesterday so phoned her and she says: "Do not forget about the video." She make videos for her maths, for her summer semester. So you know, ja, I tell the others: "Listen it's on, it's on the shared drive but it's on, it is on the semester, semester 1's hmm, the semester 1 outfits." Ja, so we do collaborate, but I mean you know just to see what it is.

MR CHIZWINA: Okay.

TEACHER D: Ja, ja, I share, we share that information. If that is what you want to know.

MR CHIZWINA: Okay.

TEACHER D: Ja.

MR CHIZWINA: Has anyone ever brought something that you could try to use in the classroom?

TEACHER D: Listen, no, well I mean, in this case yes, we, you know I've have told everybody to just to have a look at it. I mean I've seen the videos, they really are nice and I mean she's just done them because that summer semester, 12 weeks gets shortened into, into 6 weeks. You know, so you know she, that's why she made the videos, so that the kids could actually look at the stuff, but I mean as such, no and I think also, and I'll be honest with you, I just think that your full time people are actually, are actually overloaded with classes to teach. I mean Teacher B hasn't got the time to actually sit with me and because he's got such a full timetable that he's so busy teaching, you know, and then his only bit of spare time is his lunch hour. Then he's got this old bat here, asking him all sorts of questions, but that's, that's the reality of it. I mean, when I started here, if it was not for Teacher E, I would've been floundering and only because she was teaching with me. She had one class with me and I had three and we were all teaching with Teacher B, Teacher B you know the semester 1, okay. So as I was doing my preparations and that I used to give her the solutions and that, because she hadn't taught it for about 5 or 6 years, you know and Teacher B had changed the course quite considerably, you know, from what she was used to 5 or 8 years back, you know, but and I mean it was terrible because Teacher B taught literally, had five classes from 09:00 until 13:00 and then still classes afterwards. So it was just only the lunch hour, shame and the poor guy, he wants to now go and visit his friends and I'm desperate just to ask him a 5 minute question there, you know and it, you know, it was actually a problem in my very 1st year here, you know.

MR CHIZWINA: So what are your final thoughts regarding how technology should be used in the teaching of maths? Do you think that, how do you think that it should be approached? What would you think is going to be the best way that technology can have a play in the teaching of maths, especially in the classroom?

TEACHER D: It can be an aid, because you can access all sorts of, there's that Khan Academy and all that. You can access those videos, but you know, at the end of the day, you need to concentrate on what you, what you are here for. You are here to teach, so that these students can get into 1st year Varsity. So you also want to teach them to the best of your ability and if that item of technology helps them, then well and good, but sometimes do they really need an iPad to pass maths 101, or maths 1017? I do not think so, except for accessing the stuff, alright?

MR CHIZWINA: Okay.

TEACHER D: Alright?

MR CHIZWINA: Okay, alright. Thank you for your time.

INTERVIEWER: MR SABELO CHIZWINA

INTERVIEWEE: TEACHER E

MR CHIZWINA: How long have you been teaching mathematics?

TEACHER E: Sjoe, approximately 30 years I would say.

MR CHIZWINA: Okay and what made you like choose to become, a maths teacher?

TEACHER E: Because I'm passionate about mathematics.

MR CHIZWINA: Okay.

TEACHER E: I think I can make, I can teach other people to, that it will also become easy to them.

MR CHIZWINA: Okay and at Monash, how long have you been teaching at Monash for?

TEACHER E: Since 2005.

MR CHIZWINA: Okay and before you came to Monash, like were you teaching in a formal school or University?

TEACHER E: Yes, I've taught, before I came to Monash I taught at St Stithians at the boys' and the girls' college and before that I taught at Ferndale High School and Randburg Hoërskool. That is about it, yes.

MR CHIZWINA: So it was in the field of pure match?

TEACHER E: Not in Randburg, there I taught science, but in Ferndale and St Stithians, I taught pure maths, yes.

MR CHIZWINA: Okay, With regards to technology, have you ever considered using it?

TEACHER E: Just repeat that question again?

MR CHIZWINA: Have you ever used technology or wanted you could try using technology in a classroom?

TEACHER E: Have I?

MR CHIZWINA: Ever considered using technology?

TEACHER E: Have I ever considered using technology…

MR CHIZWINA: Yes.

TEACHER E: Okay, it depends on what kind of a technology it is, because as it is we are using computers and we are using the smart boards which I really enjoyed, but that is still just, it's, you know it's not like, because I believe anyone who wants to learn about maths must put, they must use the technology. It's not really me, because the maths already exists in my mind. It must start to exist in their minds. So it must be something that they must be able to use, so when I use a smart board it is as if I use a whiteboard or a blackboard. It's simply that I can then save what I've said.

MR CHIZWINA: Ja.

TEACHER E: And use it later on, which is in the case of mathematics, it is no good, because a sum that you've done must not be there already when a student looks at it. You must have, you must develop the sum. You must not, the student mustn't look at the end product. The student must look at the beginning product. So technology, we use it but it's not really of any, it doesn't make it better, in the way that, you know, a whiteboard works, because I like to start it again.

MR CHIZWINA: Yes, alright.

TEACHER E: That is, that's not really helping…

MR CHIZWINA: Do you…

TEACHER E: But…

MR CHIZWINA: Hmm.

TEACHER E: The truth is a student must actually see the beginning of the sum and not the end of the sum. So by saving that on the, using the smart boards, I was privileged enough to be able to use those venues with the smart boards and the fantastic equipment there. I learned how to use them and I really liked it, just because it's, just because it's new and it's exciting to use it, but really for mathematics, as long as you've got a whiteboard and you can wipe it off, it is as good or a good blackboard, and you can wipe it off, a blackboard is messy, it is exciting to use the smart board, but it's not really that you have to have it.

MR CHIZWINA: Okay, so you, do you think that your experience influences whether you would adopt technology or not, for example like maybe if you have used it before do you think that having used it before it allows you, or it makes you want to use it again to teach maths?

TEACHER E: Yes, only because you know, it's like having an iPad. It's nice having it but you don't really need it, you can use a computer. What, I try to say is, it's nice to use the smart board. It's nice to have the technology but I can teach exactly as much as what I'm teaching on all of this technology, I can teach on a piece of paper.

MR CHIZWINA: Okay.

TEACHER E: We can come later to where I've done other work where technology helps me, but talking about the way that I can use it in the classroom, a whiteboard, or a smart board or a blackboard, it does not really matter. When we come to things like that I have saved on the computer where the student can go back to it. You know it's so much easier to carry a computer around than to carry a whole lot of books around. You know the book has got the same in it as what the computer has got, where I saved the textbook, on an eBook, you know that's an eBook, with all the answers on it and a textbook with all the answers. It's the same thing, it's just easier to work from the computer.

MR CHIZWINA: Okay.

TEACHER E: Hmm.

MR CHIZWINA: So as a Unit Co-ordinator for mathematics, how has this position influenced you to adopt technology in your teaching and also the other mathematics teachers?

TEACHER E: Yes, I would like them to use the technology, because then I can communicate more easily to everyone. You know, if everyone is on track with the technology, you know, if everyone knows where to go and look for something and where to find it and how to use it, it obviously makes it easier, yes.

MR CHIZWINA: Okay, like how can you describe, how do you like teach maths? What is your teaching, instructional style?

TEACHER E: Okay, obviously if you start a new section, the students, some students might know a little bit about it, but some students would, it would be the first for them to learn about that topic. Then you will have an introduction and say you would open up the context to them and you will teach them some theory and then you will show them the kind of questions that will arise from there. Once you've shown them the kind of questions that will come from there, then I would actually like students to practise by themselves. As I say, before, I have said before it, maths is something which you've got to do yourself. I can't get into somebody's brain and put it together. They've got to look what I have done and then they've got to do it themselves. Ultimately when they write that exam, they are on their own.

MR CHIZWINA: Has your typical instructional style swayed you to adopt technology in your practice?

TEACHER E: No. They must have the confidence that they have seen things like that before, they have tried it, they know how to do it. It's not recalling back facts. It's a skill that they've mastered, how to do those sums. I call it sums. Let's call it problems or whatever, but by doing it for a student, you don't allow them to become mature in their own thinking. They have to do it themselves. So therefore, I like to teach for a little while, open up the context to them, but then they've got to do it themselves and then I will go students and say: "Show me what you are doing" and I will look and see what they've been doing and say, ¾ through the lesson then I will go back to the smart board, or whiteboard or whatever

way and I will then pick a few of the sums that they've done and show them that the most common errors that they've made and discuss that again.

MR CHIZWINA: Okay. Do you think in-service learning in the use of technology could assist in technology adoption? Do you think that you should have those workshops where you are taught how to use maybe for example iPads, in the use of, in the teaching of maths?

TEACHER E: Yes, it, yes, there can be workshops to teach them how to use an iPad but that will still not teach them how to do mathematics. It's simply how to, to learn how to use the instrument or whatever they've got in front of them but that will not teach them how to do mathematics at all. So there is a place for that kind of workshop but it's not going to take away, you know, working with maths is like problem solving. The instrument can't make it easier for you.

MR CHIZWINA: Okay, okay.

TEACHER E: Hmm.

MR CHIZWINA: Does your use of technology outside of lectures and tutorials influence you to try the technology in the classroom? If yes why? If no, why not?

TEACHER E: Hmm.

MR CHIZWINA: Because I'm looking at the videos that you created so I was thinking, I was thinking maybe you have done videos before, so that's where you got the idea to record those videos.

TEACHER E: I had no experience about that before. Sabelo, just repeat that question again for me.

MR CHIZWINA: Okay, do you feel the time you spend using technology outside that classroom might influence you, how you use technology to teach maths?

TEACHER E: Okay, the time that I have spent outside, let me, you know maybe I won't answer that question directly to you.

MR CHIZWINA: Yes.

TEACHER E: The reason why I have started that was because we have not, it was for the summer semester, it was not for something else and we were given less time to teach the

same amount of content to the students and I was quite sure that the way, that the brain deals with mathematics is you need to have time and I only saw the students twice a week, instead of say 3 or 4 times a week. I have seen them for 5 hours during that time, its 2, 2, let me just quickly think about it. Ja, it was 5 hours. So it was quite a long time that I have seen them but it was only 2 days and for mathematics you need to engage with mathematics every day. It's like food that you eat. You cannot just eat twice a week, you've got to and that's the way you need to do it. So, I realised that when I leave the students, students do not have the responsibility to go back to the maths. Or they will think: "Oh, the teacher is away, what I can do now? I am helpless and I cannot, you know, what am I going to do?" Then I decided, but there is an easy way of being close to your student. Create a video and make sure that they can watch this video and then you are with your student even on a Sunday or a Saturday when they, when it's, you know, when there aren't any lessons and that is why I created that.

MR CHIZWINA: Hmm.

TEACHER E: So that they can look at it at any time they want to. I was fortunate, by the fact that we have a video camera and we are quite familiar with it, but I had to try many ways of doing it and that took me a long time to get that right. I tried to work that the camera will only photograph it over my shoulder on a piece of paper, but then my hand was in the way and that didn't work and I tried several ways. Then eventually, I realised, that I've got to do it like in a classroom and I had a little room with a whiteboard and we set up the video camera in such a way that it could photograph me and the whiteboard and whatever I was saying. It is a good quality video camera and that's the way we did it and yes, so I think it was a good thing that I could do that and I, I've heard people talking of it that they wanted to do it, but I knew that I can't, I did go to the University and I did ask them whether they could do it for me. They came up with lots and lots and lots of ideas but every time there was a problem, and a problem, and a problem and I thought: "You know, I can't wait for them, it will never happen and it has not happened." That is why I did my own thing.

MR CHIZWINA: How has senior Management at Monash been supportive to teachers in process of using technology in the teaching of mathematics?

TEACHER E: Not that kind of technology. No, well they, I went to Estelle and she then had to go to Australia and then she had to go and find out, you know it was endless problems. So, I thought that's not how I am going to do it, because it will, my students will fail because the 6 weeks of the summer semester will be gone and nothing, you know they will still be busy

working out how to do it. You know, so I realised soon, soon, I can't rely on them. I am sorry to say that but…

MR CHIZWINA: Okay.

TEACHER E: Ja.

MR CHIZWINA: Have you experienced the use of technology in the teaching of mathematics? If yes, what did you gain from this experience or what did you understand about the use of technology? If no, what would you expect to learn if given an opportunity?

TEACHER E: No, no.

MR CHIZWINA: You've never attended one?

TEACHER E: No, no, no, no, no you know I would watch on TV…

MR CHIZWINA: Hmm.

TEACHER E: Where and it was one of my, one of my colleagues that I've worked with, that people will phone in with questions and then on the TV, you know SABC whatever, the lady will listen to the question, write it on the board and then explain it and yes. So it was more or less what I have seen, is what my students saw from my videos, a lady standing in front of a board explaining it, a short question.

MR CHIZWINA: And what did you learn from that experience?

TEACHER E: I just, from that experience that I've seen on the TV, is that it can be done, you know. So I copied that, but it was, I didn't think in the beginning to copy that. It just happened that that was the best way it worked out.

MR CHIZWINA: Okay.

TEACHER E: But you know, talking about that, I know somebody from MTN and they want to put together, on a, they want, in Africa they want to put together like, issue the students with iPads but it wouldn't be an iPad of Apple or any of these Tablets. It would be just a Tablet for teaching and give them this kind of concept, teaching them different units or modules or subjects. So, but I haven't seen any of that. I just know it's an idea of somebody, but whether they've gone as far as that, I do not know, because there's, you know I know

education is very important but they've, you know there are people starving, so why having a Tablet when you need a bread.

MR CHIZWINA: Ja that's…

TEACHER E: Ja.

MR CHIZWINA: True.

TEACHER E: Ja.

MR CHIZWINA: So is there like any technology that you would want to use in your teaching that you feel like it would add value?

TEACHER E: That it will add value?

MR CHIZWINA: Ja.

TEACHER E: You know it takes me back and maybe you must talk to Teacher A.

MR CHIZWINA: Okay.

TEACHER E: You know the nature of mathematics is such a way that you've got to engage with mathematics. Say you are the student or I am the student, I need to take content, whether it's on a Tablet or whether it's in a book, or wherever. You know I mean, whether you get it in a book with paper pages, or whether you get it on digital you've got to take your pencil and a piece of paper and you must start to work out things. You can't just look at it, never, never. You can never just look at it and think it will just jump into your head. You've got to engage with it and only you can do it. You can't do it in groups. It doesn't work, because what happen in groups for instance and that, you know the cleverer one will grasp it quickly and will try to explain to the other and then the other ones never develop. It's only the cleverer one that then develops better and better. So it is a lonely subject. You sit by yourself and you do it. Technology can add to it, you know. Like I've given those videos to the students to look at, so what they have done is, they've looked at the video and look at the way the concepts have been put together. Then they must go back to the questions and try them one by one and then when they get stuck they can go back to the videos and say: "Oh what is the concept? Where do I miss it?" And I've seen the students sitting in the corridors and at, in empty venues and so on. On the ground they will sit with their computer, watching these videos and then next to them they will have a piece of paper and they will close the

video and start to do their examples and then they will open up again and look at these videos. What I can say about these videos is as the summer semester progressed and that was now 2 years ago, with the very 1st summer semester, halfway through the semester I said to somebody: "They expect us to have an 85% pass rate. I will be lucky if I get a 60% pass rate, because there is too much content and too little time." The students started to watch those videos as I released them and they were doing their work and we, all of us worked so very hard, because I still had to motivate them and say: "It is there, I'm not gone" over the weekends because I only saw them on a Thursday and a Friday. "I am with you on a Monday, Tuesday and a Wednesday. I'm just there in a video. Look at the videos. All of the work is there" and at the end of that semester my, my pass rate was not 85%, it was 94%.

MR CHIZWINA: Okay, so what did you learnt from that experience of creating the videos and giving the students the videos?

TEACHER E: What I have learnt is that you must still tell them the videos are there, they won't use it, they forget they are there. A student is, you know, but when they become nervous then they, they all fall back on the videos and the videos were short. So it didn't bore them. They had, they didn't need to go and look for and run through a long piece of thing and see: "It's is not that." I named each of those videos and they were about say 5 minutes or less or maybe at the, maybe 7 minutes, but they were really very short. So they could go to the exact video, just look at that. So I've learnt it works. That is, you know, that is what I can say, but you know still, that technology, simply the teacher is still doing the old fashioned work of teaching and then it's simply that the teacher is not in the classroom. The teacher is now on the computer with the student.

MR CHIZWINA: Okay.

TEACHER E: Do you know what I mean?

MR CHIZWINA: Yes, yes.

TEACHER E: Ja, so the teacher is still the old fashioned teacher, but I can be at my house and the student can be in his room and he can have me on his laptop and he can look at the old fashioned lesson, because I haven't had a smart board when I did this. It was a simple whiteboard, a small whiteboard where I did the sums. You know I have made lots of mistakes with it and then I had to start again. You realise that you are not professional, you pull your face. You know, I did it absolutely on my own. I had no help. I had to control the,

you know the switching on and the switching off. So I do not want to look at those videos because they irritate me when I look at myself and see I've pulled my face or whatever, but I think when the student watches it they are in real need of looking at the content of the video, you know, to what I am saying there and they don't mind about the person who is pulling the face or whatever.

MR CHIZWINA: Does the accessibility of technology at Monash allow you to adopt technology in your Practice? If so, how? If not, explain why?

TEACHER E: I don't think they have got that video thing.

MR CHIZWINA: Okay.

TEACHER E: Because there are people who say and I've spoken now to Professors at RAU and they're going to do the very same thing and they're going to do it in accountancy, but I, I do not know how long you need to, how long such a video will be, because I know it works very well if they are not very long, but I don't know how it is going to work at UJ. I don't know whether since Monash has got the facilities now. I don't know. I know that Professor Du Toit, he's in accountancy there as Monash, he was talking about it even before I did it and I thought: "You know if, you know the, the schools are much more important than us", well however they think so. So you know we stand at the end of the road. We won't be able to use all these fancy things and the schools are, well you know I don't really want to put it in that way, but we are inferior to, so I thought I can't ask them. They must first do the thing and I did my very humble thing and it worked.

MR CHIZWINA: Okay, so it wasn't about Monash, it just, it was dependent on you that you, you had an idea and you felt that you had to ensure that the videos are created and they were going to be used. So it wasn't really, you never relied on Monash, you decided on…

TEACHER E: No, I never relied on Monash. Well I tried, but it didn't worked. You know, remember I asked Estelle and then she said they've got to find out and whatever. Once I have did, once I've done them, I went back to, and that was last year and they explained to me how to put it on Google Drive, these little videos of mine, but you know what, I haven't done it yet. When I get back I must, because these things, as, and as I have said that the video camera is actually of a very high quality, but I saw that I couldn't record it on high definition because then it's, the files were too big and I couldn't get it on to the website or not website, onto the drive. I couldn't get it onto the drive. So I had to change the videos to

standard, how do you say, high definition, standard definition and but maybe I, if I put it on Google Drive. I think it's Google Drive, Google something, then I can put it onto there and the students can watch it, because I couldn't put it on Moodle, it was also too big for Google. So I could only put it onto the subject drive and every semester, I've got a problem getting them from the subject drive. Even my computer was not big enough, the memory of my computer was not big enough to store all those videos.

MR CHIZWINA: Okay, do you think that, like the technology, the students finds it beneficial or they still prefer the old fashioned teacher in the classroom approach?

TEACHER E: Sabelo, just repeat that again.

MR CHIZWINA: From your experience and beliefs, do you think that technology is beneficial in the teaching of mathematics? If yes why? If not, what are the reasons?

TEACHER E: Only this thing where I say, I can be available to the student, when he's at home. I say that can be beneficial, but the way the brain was created by God that we cannot change and the way that the brain deals with mathematics, that you can't change. The nature of mathematics that you've got to deal with it yourself, and sit and engage with it, that you can't change. So, yes, technology can help but it is a very specific technology you know. It's, you know, I typed mathematics. I cannot expect the students to go and sit and type mathematics. It will take them forever. You need to sit and take a piece of pen, paper and a pencil and scribble down notes. It's not like, something like in the olden days, where you had shorthand, where you can write something quick- quick and or type quick-quick. These things doesn't work like that. It's a, you've got to go according to the nature of mathematics.

MR CHIZWINA: Okay. Is it possible, like for you as a maths teacher, is it possible to combine technology with other methods of teaching in the classroom, for example, is it possible maybe for you to use technology in your assessments…

TEACHER E: Yes, you can use technology in assessments. It is just very, you know I can't see the time that you spent on doing that because also if you've got a bank of questions, it takes a long time, student's gets use to the questions. You know, there's only so many questions that you can ask. So it takes very, very long to think out these things and the moment you start with multiple choice, students, you don't see where they've gone wrong, that's not really the point.

MR CHIZWINA: Okay.

TEACHER E: You see. So and I, you can use it, yes, you can. You can use multiple choice. Students again, for assessments reasons, you want to know where the student has gone wrong, you can't see that. I have tried multiple choice in my life, at Monash.

MR CHIZWINA: Hmm.

TEACHER E: It's an easy way of marking.

MR CHIZWINA: Hmm.

TEACHER E: And if the computer can do it, but you're not working in favour of education.

MR CHIZWINA: Okay.

TEACHER E: If education is important to you and not yourself, you can use multiple choice but then education is not important.

MR CHIZWINA: Okay, in the classroom itself is it possible like, for technology to be used? Is there, do you find like maybe for example during the tutorial there can be an opportunity to introduce technology or to use technology?

TEACHER E: Technology is not helping in the nature of mathematics. You know because I need to see the, the thinking process of a student. I can't see it with technology.

MR CHIZWINA: Okay, okay, so like maybe wouldn't technology, like for example enable your students maybe to be able to ask questions, during the tutorial, or you, you don't see it working?

TEACHER E: No, no, it won't work. It won't work, no.

MR CHIZWINA: Hmm.

TEACHER E: No, I can't see that technology will help them. You know if we, if we become, the kind of, say, not in the classroom, if the student needs to work away from home and it all depends on a student, then we will have to make use of technology, but then they, you know then they're away from me. So, I would say in a classroom with maths students it's about, it's about maths and there the student must learn the maths, what, technology is not going to make him understand better.

MR CHIZWINA: Okay. In what ways does time affect your decisions to adopt or not to adopt technology? Do you have enough time to spend on learning about new technologies?

TEACHER E: No.

MR CHIZWINA: Create…

TEACHER E: No, no, no…

MR CHIZWINA: The videos?

TEACHER E: No, time, you know, if I think about technology, let me put it this way. Maths, the way that we teach it at Universities and whatever, has already been created, that is, it's not new content. Maths is age old, you know it comes from 1200's, 1400's, 1600's. There is a little bit of new mathematics but it is such complicated stuff. So all I can really do is to present it in a different way, using technology.

MR CHIZWINA: Ja.

TEACHER E: But if you think what I've said in the past, to present it differently, you, a student mustn't see from the beginning, the end. A student, you must develop like it's a whole development. Yes, I can use PowerPoint and show, but it's really, if one goes to lectures that Teacher B has got, it's so wonderful to watch him. He will have, on the one screen, he will have the content typed out, but on the other screen he will work with a visualiser and he will develop it in handwriting, the thought processes of how the whole problem, you know, is set out. So, no, I don't think that, ja...

MR CHIZWINA: Okay.

TEACHER E: It's a very difficult thing. Maths has got its own ways and technology is not really going to make a big difference on how maths is working.

MR CHIZWINA: What barriers affect your ability to use technology in your practice at MSA? Do these barriers hinder your ability to adopt technology?

TEACHER E: Hmm, Sabelo, just repeat that question again…

MR CHIZWINA: Okay.

TEACHER E: I will not answer that one now…

MR CHIZWINA: Do you feel that your knowledge of technology is sufficient for you identify and adopt technology?

TEACHER E: No. Technology, to teach the contents, I do not know where technology can help me teach it better

MR CHIZWINA: What barriers do you think exists with regards to using technology in your teaching, the teaching of maths?

TEACHER E: Hmm, what barriers?

MR CHIZWINA: Ja.

TEACHER E: It is, the barriers, is what maths is. Maths, you know if I think where do, I want to use technology, it's to make the learning process easier.

MR CHIZWINA: Can technology be joined with other instructional methods of teaching mathematics? If yes, in which ways? If no, why not?

TEACHER E: But it won't and to make the assessment easier, but what do I want to achieve by assessment. I need to see whether the child, the student understands it and using technology is not going to help me understand that better, it won't. Technology, to teach the contents, I do not know where technology can help me teach it better. I've explained to you why that, the technology that I've used was only to replace me, when they don't see me, but it's not helping in the process of making the student understand those concepts better. You know technology to me is simply replacing the book with digital information and I can't see that. I can't see that technology can do that in the, in the classroom.

MR CHIZWINA: In your opinion would owning a device for example an Ipad influence you to try and use it for teaching and learning ? If so, how? If not, why not? Do you think having an iPad influences you to be able to use an iPad in the teaching of maths?

TEACHER E: Owning an iPad does it, again, do I think owning an iPad will help me using an iPad in…

MR CHIZWINA: To influence you to use it in your teaching?

TEACHER E: No, no, no, sorry. Everyone who wants an iPad is not going to get it, no, no, because I'm telling you at the, I have bought myself an iPad or I received one as a gift lately,

it's not going… I haven't, I have actually, because the iPad, okay, a computer has got all these programs that I can set up a document. Now I have gone to the iStore and I have asked them whether I can have words on it and whatever and they've given me similar things that I can have on the iPad, but as I said to you, to type mathematics is not easy.

MR CHIZWINA: Yes.

TEACHER E: It is a very, very, it takes a lot of time to type it. It's not just, you know, a quick sentence that you write. It's a complicated thing to do. You get used to it, you know. It's easy to do it once you know how to do it, but it takes a long time to write it. Now if a student can draw a square root easily why will they go to click, click, click, click and then they've only got a square root, you know.

MR CHIZWINA: Yes.

TEACHER E: Where you can do it with one stroke, you can draw a square root and by the computer it takes you a long time to get there. No, no, by having an iPad I see that the students have got it in the classrooms but it's only to know where the, I am in the textbook or instead of, to know where the questions are, you know. They download it as a, I think as a PDF or whatever, they look at it and it's on their screen and they just read it off there, but on the other hand they could've gone to a computer and they could've, it saves some paper, yes, but you know, on the other hand it doesn't really makes things more, it doesn't help them with their thinking process.

MR CHIZWINA: Okay, right. The last two questions, okay.

TEACHER E: Hmm.

MR CHIZWINA: With regards to collaboration, who do you collaborate with? Why do you collaborate with the individual or individuals? How do you collaborate?

TEACHER E: Yes, I have, you know, for instance with Teacher D. I have shown her, you know, how to use these things and we've worked together and it's easy to say you know: "Go and look there and there", but it is just another way of storage, technology…

MR CHIZWINA: Yes.

TEACHER E: For mathematics. I stored it here, it's easy, then you go and look at it, I don't need to send a courier up to Monash and say: "This is, there's an exam that I have set" you know to Frikkie or whatever by press of a button there it is. Do I answer your question?

MR CHIZWINA: Yes, yes.

TEACHER E: Ja, so, you know, when Teacher E came there 2 years, or 3 years ago, it was lovely to have another student, because she was like a student of mine and she was and I showed her lots of things. How you do this and how you do that and so on, but that doesn't really, you know it's simply another way of storage, you know.

MR CHIZWINA: Yes, yes.

TEACHER E: It didn't help with the teaching of maths, except that there the stuff is and you can use it from there, but it didn't help the method how to teach maths, the method of teaching maths hasn't changed.

MR CHIZWINA: Okay. What about in the schools, are there any people that you, sometimes you discuss using technology in the teaching of maths?

TEACHER E: No, not really, except with Rakesh

MR CHIZWINA: Right.

TEACHER E: But you know he's, he's more on the stats side, so I think you must ask Teacher B about that.

MR CHIZWINA: Okay, right.

TEACHER E: Ja.

MR CHIZWINA: Okay, finally, what would you say about technology, using technology in the teaching of maths? Your overall, your overall, what you tell someone? What would you advice people, or what is your own opinion on the use of technology in the teaching of maths?

TEACHER E: What would I say?

MR CHIZWINA: Ja.

TEACHER E: Okay, I would say that maths is the most important thing that you must think of and not technology. If technology can help you, yes, but you must always think that what do, you want to achieve. If you want to achieve high marks and you want to achieve that the students know what is, what it's all about…

MR CHIZWINA: Hmm.

TEACHER E: Then the students must engage with the mathematics themselves, one by one and for that, they need to go and sit still in a quiet place, with a pencil and a piece of paper and they must study mathematics and do mathematics. If there's a video that they can watch, they can do it but that won't and no technology will help them understand maths. They've got to do it themselves.

MR CHIZWINA: Ok