Perceptions and needs of South African Mathematics teachers concerning their use of technology for instruction

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Although many South African teachers have access to the internet, they often refrain from using available online resources to improve the quality of their own teaching. In an attempt to promote Mathematics teachers' effective use of online resources, we developed a web-based platform. This article reports on the first phase of a broader project that focuses on Mathematics teachers' perceptions about and needs for utilising technology in the classroom. Twenty-two teachers participated in this mixed-method pilot study. To obtain qualitative data, we facilitated a Participatory Reflection and Action (PRA) workshop and for the quantitative part of our study, we implemented a questionnaire. The Unified Theory of Acceptance and Use of Technology (UTAUT) were selected for the theoretical framework. With regard to effort expectancy, participating teachers found the use of technology overwhelming, resulting in a need for further training. No evidence was found of social influence affecting the participants' acceptance of technology. The participants proved to have access to sufficient equipment. However, their perceptions of their own limited skills weighed heavier than external facilitating conditions. As a result, participating teachers were hesitant to utilise technology in their teaching.

Keywords: internet; mathematics education; online; quality material; resources; teachers' perceptions; technology; UTAUT

Introduction
Mathematics education is one of the national priorities in South Africa. This fact is highlighted in the executive summary of the National Development Plan (NDP), and indicates the demand for an increase in the number of students achieving above 50% in Literacy and Mathematics, respectively (National Planning Commission, Department of the Presidency, Republic of South Africa, 2012). After two decades of democracy in South Africa, the legacy of inferior mathematics education offered to the majority of learners in the years of apartheid is still prevalent in most public schools. In the recently released results of the Trends in International Mathematics and Science Study (TIMSS) 2011, South Africa was, as in the case of similar studies in the past, placed among the poorest performing participating countries (Spaull, 2013).

Some of the current critical challenges faced by teachers in South Africa and many other countries with emerging and developing economies, relates to their own lack of mathematical content knowledge, and the skills required to apply what they know in the classroom. According to Rowland and Ruthven (2011), it is generally agreed that the quality of teaching depends on the knowledge the teacher brings to the classroom. In this regard, the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) III study (2012) indicates that many South African Mathematics teachers have a limited understanding of the curriculum content they are required to teach. The discourse regarding potential solutions to the mathematics crisis in South Africa often raises questions about the possible nature and format of additional support for teachers that may have a positive impact on their professional development.

Rationale for the Study
The International Telecommunications Union (ITU, 2014) estimates that there will be approximately three billion internet users by the end of 2014, with two thirds of those users residing in developing countries (Stephens, 2015). These three billion internet users account for 40% of the world population, with more or less one out of three people from developing countries being connected to the internet (ITU, 2014).Worldwide internet usage increased dramatically from 14 million (0.3% of the world population) in 1993 to 1.75 billion

(25.6% of the world population) in 2009 (internet Live Stats.com, 2014). Internet users in developing countries are estimated to have doubled in five years from 0.974 billion in 2009, to 1.9 billion in 2014 (ITU, 2014). Against the background of society being intertwined with technology, Keitel (1997) argues that it has become easier to find technological solutions for problems, rather than searching for non-technological solutions.

With an enormous amount of information available on the internet, the current challenge is not only to find information, but also to effectively filter available information, with the purpose of selecting relevant, credible and quality information (Brin & Page, 1998). This vast web-based reservoir of quality mathematics resource materials may be of great value to practising teachers in South Africa. However, despite technology becoming increasingly available to teachers, they often do not make optimal use of technology for teaching and learning purposes. Research indicates that "although teachers in schools show great interest and motivation to learn about the potential of Information Communication Technology (ICT), in practice, use of ICT is relatively low and it is focused on a narrow range of applications" (Sime & Priestley, 2005:131). Similarly, Howie and Blignaut (2009) found that only 18% of Grade Eight Mathematics teachers use technology in teaching and learning activities, with the main uses of technology related to administration and processes of monitoring learners' feedback.

Rapid demographic, social and political changes in many emerging economies now demand a technology friendly teaching environment, but many of these countries, including South Africa, are still struggling with a series of socio-economic problems that are deeply entrenched in the social fibre of these countries: teacher shortages in some disciplines, such as science and mathematics, poorly or under-qualified teachers, lack of infrastructure, packed classrooms, crushing poverty, social and political inequity, etc.) (Kapur & Sharma, 2013; Trucano, Iglesias & Hawkins, 2012). These harsh ground challenges, amidst the reality of resource-strained environments, are increasingly forcing emerging economies to find alternatives to conventional teaching methods in the classroom. While the global debate on technology use in education thus continues, many developing countries, particularly in Latin America and Asia, are exploring the use of ICT devices in the classroom. Against this background, the following question can be asked: if technology is so widely used in society in general, why don't South African Mathematics teachers make optimal use of technology for teaching and learning?

Contextualisation of the Study

In an attempt to promote the effective use of online resources by Mathematics teachers, we are currently undertaking a funded research project[i] that focuses on the development of a Mathematics Information and Distribution Hub (MIDHub), which will provide teachers with quality online content, where the aim of our research is to determine the extent to which such a web-based platform can support practicing Mathematics teachers in South Africa. This paper reports on the first phase of the broader research project and focuses on the perceptions, needs and expectations of participating Mathematics teachers with regard to their use of technology in the classroom. The results as presented in this paper provided the required baseline information for our development of the MIDHub platform.

The MIDHub study was preceded by a related ongoing study by the FirstRand Foundation (FRF) chair based at the Nelson Mandela Metropolitan University (NMMU) in Port Elizabeth, that focuses on the integrated off-line digital resources to assist with the teaching and learning of mathematics. As part of the preceding study, digital teaching and learning resources and teaching equipment were provided to all practising Grade 10 to 12 Mathematics teachers in 10 participating schools, in a resource-constrained urban environment. Training included a one-year professional skills development programme that focused on curriculum content was offered to participating teachers. This was followed by regular professional learning community sessions, during which participating teachers received basic technology training.

Research Aims

It is not only the quantity of available information that is problematic for Mathematics teachers, but also the quality of the information from which they are able to choose. Teachers do not always have the time and expertise to search and screen the millions of internet sources for suitable quality material. This line of argumentation emphasises the need for pre-packaged support to Mathematics teachers, especially for those teachers who may be hampered by limited content knowledge. Our aim with the MIDHub project is to address this need by establishing a mobile online database that can support teachers in dealing with the challenge of selecting suitable information from a range of potential resources. To this end, we have initiated and introduced a supportive delivery hub (MIDHub) that provides easy and quick access to relevant curriculum aligned material and quality instructional resources for Mathematics teachers.

As part of our efforts to design and establish MIDHub, we first investigated the perceptions of 22 high school Mathematics teachers concerning their needs, beliefs and practices for using technology in the classroom. This paper therefore reports on the perceptions against which the MIDHub platform was subsequently developed. MIDHub is currently being implemented in 10 schools in the Eastern Cape province of South Africa, in a resource-constrained environment. However, the development, format and implement-ation of the MIDHub platform do not fall within the scope of this paper.

The primary research question underlying this paper is: *what are the perceptions, current practices and support needs of Mathematics teachers for using technology in the classroom in a resource-constrained school setting?* In order to address this research question, the following secondary questions guided our investigation:

- What are the general views about the use of technology by Mathematics teachers?
- What are the technical abilities of teachers when using technology in the classroom?
- Which challenges do Mathematics teachers in a resource-constrained school setting experience in using technology?
- Which existing factors support Mathematics teachers in their use of technology in the class-room?
- What additional knowledge, skills and support are required by teachers to optimally use technology for instruction?

Theoretical Framework

The UTAUT model produced by Venkatesh, Morris, Davis, GB and Davis, FD (2003) was selected as our theoretical framework (Figure 1), as it could explain human behaviour in the context of technology use, based on the underlying principles of the model. According to the UTAUT model, four constructs will influence people's intention to use technology, namely performance expectancy, effort expectancy, social influence, and facilitating conditions (Venkatesh et al., 2003). These four categories correspond well with the categories of barriers for technology integration in teaching and learning, as identified by Hew and Brush (2007).
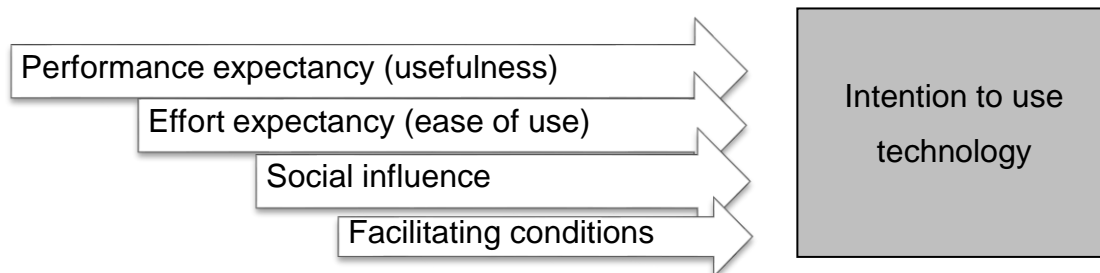

Figure 1 Unified theory of acceptance and use of technology (UTAUT)

Performance expectancy
Venkatesh et al. (2003) define *performance expect-ancy* as the extent to which people believe that the use of technology will assist them in enhancing their job performance. Performance expectancy is related to the following five constructs from various underlying models: *perceived usefulness*, *extrinsic motivation*, *job-fit*, *relative advantage*, and *outcome expectations*. Taylor and Todd (1995) define *perceived usefulness* as the belief that mak-ing use of technology will increase performance. Similarly, Davis (1989a) and Davis, Bagozzi and Warshaw (1989b) define *perceived usefulness* as the extent to which someone believes that utilising a specific system within an organisational context will improve job performance. *Extrinsic motivation* involves the driving force behind behaviour (such as using technology for teaching and learning) due

to the belief that it will assist the user to benefit from this behaviour (Venkatesh & Speier, 1999). *Relative advantage* is described as the extent to which a new idea is thought to be better than its predecessor (Moore & Benbasat, 1991). Finally, *outcome expectations* describe the tendency of people to prefer to assume behaviour that is perceived to effect positive results than behaviour that they do not believe to be beneficial in enhancing their performance (Compeau & Higgins, 1995; Venkatesh et al., 2003). In their study, Venkatesh et al. (2003) found the performance construct to be the strongest predictor of intention in both intentional and compulsory situations. In terms of this study, *performance expectancy* is regarded as the extent to which Mathematics teachers believe that using online instructional resources will assist them in improving their

teaching and/or learning of mathematics in the classroom.

Effort expectancy

Effort expectancy relates to a person's perceived ease of use of technology (Venkatesh et al., 2003). The three constructs associated *with effort expectancy* are: *perceived ease of use*, *complexity*, and *ease of use* (Venkatesh et al., 2003). *Perceived ease of use* is defined as the extent to which someone believes that using a specific system will be effortless (Davis, 1989a; Davis et al., 1989b). According to Venkatesh and Davis (2000), *perceived ease of use* will influence *perceived usefulness*, since performance can be enhanced by systems that require little effort to use. In contrast to ease of use, Rogers (1983:238-239) defines *complexity* as "the degree to which an innovation is perceived as relatively difficult to understand and use". Venkatesh et al. (2003) indicate significant similarities between the *effort expectancy* constructs in both intentional and compulsory situations; however, with extensive and continued use of technology, *effort expectancy* becomes less significant. *Effort expectancy* in this study refers to Mathematics teachers' *perceived ease of use* when utilizing online instructional resources.

Social influence

Social influence refers to an individual's view of what other people who are significant to him/her, think about his/her use of technology (Venkatesh et al., 2003). The three constructs stemming from related theories are *subjective norm*, *social factors*, and *image* (Venkatesh et al., 2003). Fishbein and Ajzen (1975, cited in Venkatesh et al., 2003:428) define subjective norm as a "person's perception that most people who are important to him think he should or should not perform the behaviour in question". Similarly, Ajzen (1991) defines *subjective norm* as an individual's perception of social pressure with regard to whether to carry out certain behaviour or not. Taylor and Todd (1995) refer to subjective norm as *social influence*. Similarly, Triandis (1979), cited in Thompson, Higgins and Howell (1991:126), refers to "the individual's internalization [sic] of the reference groups' subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations".

Regarding image, the concept implies social approval that can be described as the extent to which the use of new technology is perceived as promoting a person's status in his/her social circle (Moore & Benbasat, 1991). In comparing different models, Venkatesh et al. (2003) indicate that *social influence* is a predictor of intentional use of technology only when the use is not voluntary. *Social influence* in this study is defined as

Mathematics teachers' opinions about what people who are significant to them (such as school principals, heads of departments or subject heads, the FirstRand Foundation (FRF) team, colleagues and the school governing body) think about their use of online instructional resources.

Facilitating conditions

Facilitating conditions explain the level of a person's perception that organisational and technical infrastructure exists to support the use of technology (Venkatesh et al., 2003). The three constructs from underlying theories that relate to *facilitating conditions* are *perceived behavioural control*, *facilitating conditions*, and *compatibility*. *Perceived behavioural control* is defined as the perceived ease or difficulty associated with an individual's carrying out of particular behaviour (Ajzen, 1991). A positive correlation exists between perceived behavioural control and specific behavior when a person believes that s/he is capable of executing the behaviour concerned (Ajzen, 1991). According to Taylor and Todd (1995), *perceived behavioural control* will influence *behavioural intention*, which will in turn influence the actual behavior that occurs. They also argue that in a computer utilisation context, user support is an example of a facilitating condition that can affect computer use. *Compatibility* refers to the extent to which new technology is perceived as complying with prospective users' current values, needs and previous experiences (Moore & Benbasat, 1991). In their study, Venkatesh et al. (2003) found *facilitating conditions* not to have a considerable influence *on behavioural intention* in terms of the UTAUT model. *Facilitating conditions* in this study are therefore defined as the level of Mathematics teachers' perceptions that organisational and technical infrastructure (such as resources, knowledge/skills and technical support) will facilitate their use of online instructional resources.

Behavioural intention

The first four constructs (i.e. *performance expectancy*, *effort expectancy*, *social influence*, and *facilitating conditions*) of the UTAUT model are hypothesised to determine *behavioural intention* (Venkatesh et al., 2003). In this study, *behavioural intention* implies Mathematics teachers' intention to use online instructional resources. *Facilitation conditions* and *behavioural intention* will predict and explain the actual use of technology. Even though the UTAUT model explains general users' intention to use technology without specifically referring to teachers' use of technology, we applied the model to our study in our attempt to understand the factors that will influence teachers' intention to use online instructional resources.

Research Methodology

In this study, we adopted a convergent mixed methods approach, thereby capitalising on the benefits implied by both quantitative and qualitative research (Creswell, 2014). In identifying and selecting participants, we combined convenience and purposeful sampling strategies. As the 22 teachers who participated in this study formed part of the preceding FRF study, we could conveniently access them. In identifying potential participants, we were thus driven by the possibility of this cohort of teachers being a useful source to benchmark and establish the technology needs profile of Mathematics teachers who teach in resource-constrained settings in public schools in South Africa. After sampling the 10 FRF-related high schools in the Eastern Cape, we relied on the following selection criteria to purposefully select 22 teachers from the pool of potential participants (Patton, 2002):

- Participants had to be high school Mathematics teachers in resource-constrained school settings from among the group of FRF-related schools;
- Participants had to attend a colloquium in the Nelson Mandela Metropolitan area on 19 and 20 September 2014 (Pinelodge, Port Elizabeth), during which data collection took place;
- Participants had to provide informed consent for their participation in the project.

For the quantitative part of our study we implemented a structured, self-administered questionnaire. In constructing the questionnaire, we were guided by the categories stipulated in the UTAUT model framework (Venkatesh et al., 2003). Questionnaire items were clustered in sub-sections to allow for the measuring of various dimensions pertaining to the usage of ICT, such as respondents' personal view of ICT in general and in an educational environment in particular; a self-assessment of their ICT skills; respondents' needs for training and skills development in the field of ICT, as well as personal and structural factors that negatively impact upon respondents' usage of ICT. The questionnaire mainly made use of structured measuring items, although a few open-ended items were included as a means to further clarify some of the responses to closed-ended items. The data was analysed by means of the Statistical Package for the Social Sciences (SPSS), software version 22.0. Sample characteristics were confined to univariate descriptions and frequency distributions, as the relatively small size of the sample did not allow for the use of inferential statistical methods or the employment of multiple regression in the data analyses.

To obtain qualitative data, we facilitated a two-hour PRA-based workshop (Chambers, 2008). For this purpose, teachers were requested to discuss a range of questions in small groups of four teachers per group, capturing their ideas and perceptions on posters. The different small groups reported back to the larger group, following discussions of each question. Figure 2 provides an example of the PRA-based activities that we facilitated.
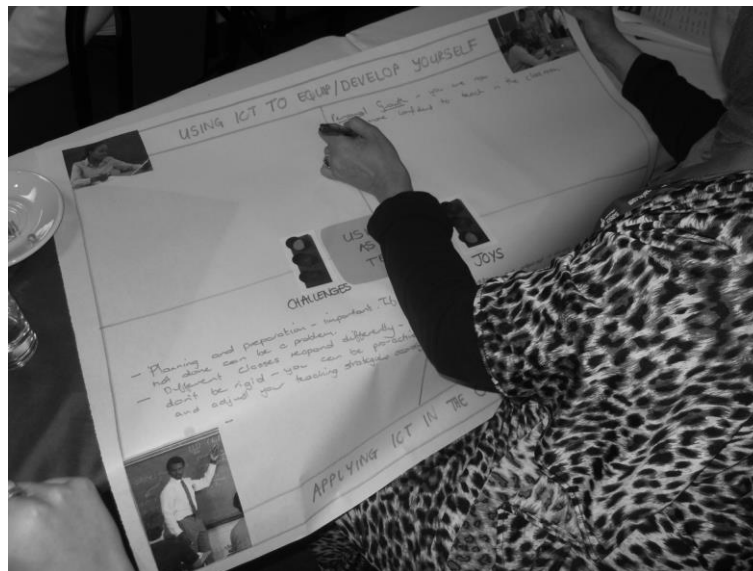

Figure 2 PRA-based activity 1, 19 September 2014

The following prompts were used for the PRA-based discussions:

1. How do you use technology as a Mathematics teacher, to (i) equip/develop yourself; (ii) to enhance your teaching?
2. Which challenges do you experience regarding the use of technology in the classroom?
3. Which resources are available to you, in terms of knowledge, skills and technical support?

4. What do you require more of in terms of knowledge, skills and technical support?
5. How can the proposed MIDHub platform support Mathematics teachers in using technology in the classroom?

For the purpose of this article, we focus on the data generated during the discussion of the first four questions. In support of the PRA-based activity that we facilitated, we utilised observation-as-context-of-interaction (Angrosino & Mays de Pérez, 2000), visual techniques (photographs and posters) and field notes (Patton, 2002). We audio-recorded and transcribed all PRA-based discussions and report-backs. For data analysis, we implemented thematic inductive analysis (Creswell, 2014). Two researchers analysed the data independently. After reviewing all qualitative data, initial categories were identified. During a second round of review, the researchers grouped ideas that belonged together, thereby structuring the analysis according to themes and related subthemes. The incidences that the various themes and subthemes occurred were noted in order to be able to rank the emerged themes when comparing this to the quantitative data that was obtained.

In order to enhance the rigour of the study, and in support of trustworthiness and reliability of the findings, the qualitative data was therefore analysed separately by two researchers before comparing their analyses to finalise the themes that emerged. Differences were discussed with a third researcher, thereby reaching an agreement. In this manner, we attempted to ensure intercoder reliability as proposed by Miles and Huberman (1994). Triangulation of the quantitative and qualitative data occurred following the separate processes of quantitative and qualitative analysis.

In terms of research ethics, we obtained permission to conduct research from the institutions involved in the project. After meeting the participants, we informed them of the purpose and progress of the project, and what would be expected of them during data generation sessions. Benefits of the project were pointed out and potential risks were mentioned. Throughout the process, we respected the privacy of the participants and adhered to the guidelines associated with confidentiality and anonymity. We relied on our relationship of trust with the participants, and participants were well aware of the option to withdraw from the study if and whenever they wished to do so (Patton, 2002).

Results
All participating teachers held a minimum of a Bachelor degree, with the majority of them having 19 years or more experience in teaching secondary school learners ($n = 17$). All of them indicated that they had access to a computer both at home and in the classroom; however, as indicated in Figure 3, the majority did not have internet "in class" and "at home" at the time of data collection.
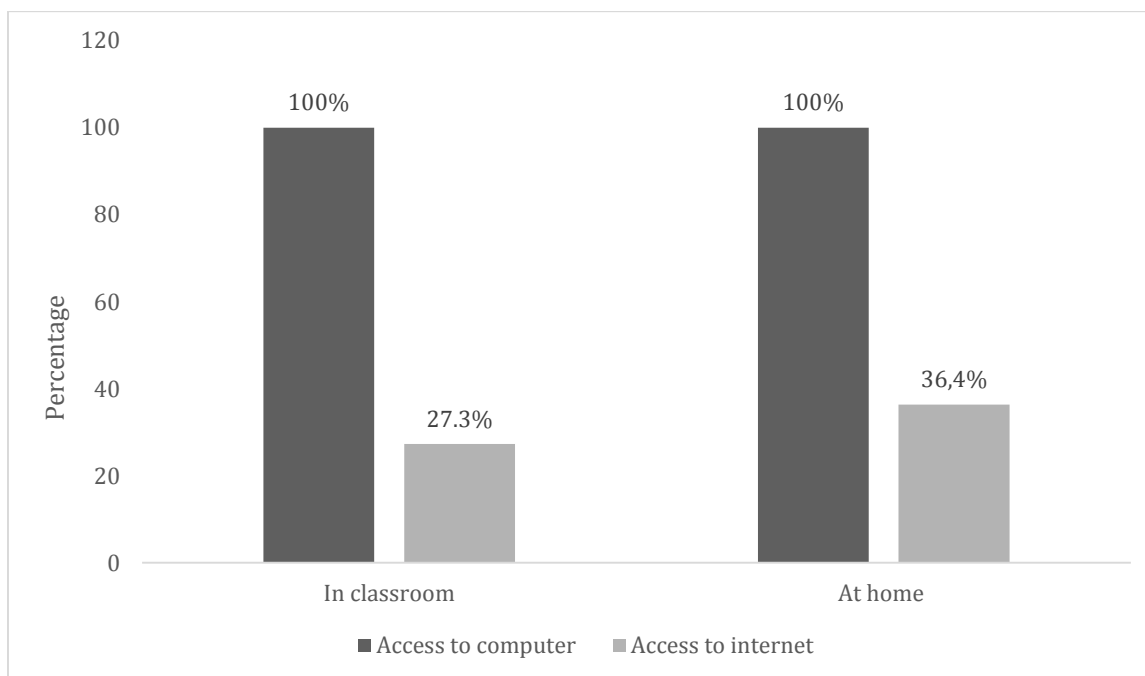

Figure 3 Percentage of teachers who have access to a computer and internet at home and in the classroom

Teachers' General View on the Use of Technology in the Mathematics Classroom

All teachers indicated positive views regarding the use of technology in mathematics instruction. On a five-point Likert scale, 86.4% strongly agreed, and 13.6% agreed that technology can be a great asset in the classroom, as captured in Table 1. They expressed excitement about the introduction of new technologies in teaching, yet at the same time, almost 73% admitted that they found the field of ICT overwhelming.

Teachers were in agreement that using technology in the classroom could improve both teaching and learning. In support of the results captured in Table 1, teachers identified several benefits that they associated with the use of technology in the classroom during the PRA-based workshop. Participants distinguished between benefits for teachers and perceived benefits for learners. Regarding the former, they viewed improved teacher efficiency (e.g. using Excel for capturing and reporting marks), the possibility of saving time (yet only when skilled to implement technology) and an increased ability to explain complex concepts, as potential benefits that teachers could experience when implementing technology in the classroom. Regarding the perceived benefits for learners, they believed that learners could profit from the creation of more opportunities for participation and interaction that could promote understanding, visualisation and interest in Mathematics. Figure 4 provides a summary of some of the benefits (right-hand side) and challenges experienced by the participants.

Despite their overall positive view, teachers experienced the field of technology as overwhelming, with 40.9% strongly agreeing and 31.8% agreeing with this statement. Data that was generated during the PRA-based workshop confirms this view. In their discussions, participating teachers also mentioned that the use of technology requires a paradigm shift by teachers. In explaining this perception, they highlighted the need for teachers to move their preference away from traditional methods of teaching, to an approach that would incorporate change and modern trends.

Table 1 General view of technology

| Statement	Strongly agree (%)	Agree (%)	Uncertain (%)	Disagree (%)	Strongly disagree (%)
I love all forms of technology; it adds great value to my life	72.7	27.3	-	-	-
I find the field of technology overwhelming	40.9	31.8	4.5	22.7	-
Technology can be a great asset in my classroom	86.4	13.6	-	-	-
I would love to learn more about the role of technology in teaching	86.4	13.6	-	-	-
I am excited about the introduction of new technologies in teaching	86.4	13.6	-	-	-
Using technology improves my classroom instruction	54.5	45.5	-	-	-
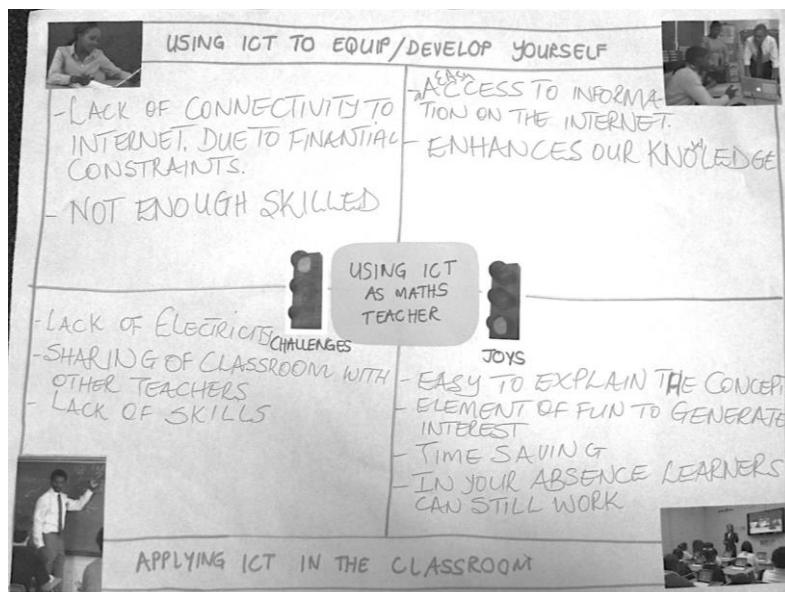
Figure 4 Benefits and challenges of using technology in the classroom

Teachers' Current Use of Technology during Mathematics Instruction

When asked about the frequency with which they needed to used their laptop/computer for a number of specified activities in the 12-month period preceding data collection, participating teachers referred to using technology for instructional purposes, both during lesson preparation and in completing administrative tasks. Table 2 shows that almost all of the participating teachers (95.2%) used their computers/laptops on either a weekly or a daily basis at their school for teaching purposes. This represents the highest frequency of usage for all the listed activities. All the teachers indicated using GeoGebra (mathematics dynamic software) when teaching: 15% on a daily basis, 30% weekly, and 35% monthly. However, a rather large number of teachers (20%) indicated that their use of GeoGebra was limited to a mere few times per year.

Computers were also regularly used at home to prepare for school work, with almost 86% of the respondents using their computers to prepare for school work on either a daily (47.6%) or a weekly (38.1%) basis. The majority of the teachers who participated indicated that they used Microsoft Word (MSWord) to prepare lessons and Excel to capture marks. In this regard, almost all (95%) of the teachers reportedly used Excel and 68.4% used MS Word at least once a month. Less frequent activities involved the use of computers for creating PowerPoint presentations and doing internet searches. Half of the teachers indicated that, when it comes to PowerPoint presentations, they only used their computers a few times per year, or not at all. One in every three participants (35%) did not use their computers for internet searches at all, and 10% did so only a few times per year. These results correlate well with the 28.6% of participating teachers who indicated that they regarded their internet usage and PowerPoint presentation skills (23.8%) as poorer than those of their learners, thus pointing towards the possible existence of a generation gap between some teachers and learners, as far as certain technological skills are concerned.

Table 2 Frequency of computer usage for specified activities

Purpose	Activity	Never (%)	A few times per year (%)	Monthly (%)	Weekly (%)	Daily (%)
Teaching	At school with projector to teach	-	4.8	-	47.6	47.6
Teaching	Using GeoGebra	-	20.0	35.0	30.0	15.0
Teaching	Creating presentations (PowerPoint)	30.1	20.0	25.0	20.0	5.0
Admin	Capturing marks	5.0	5.0	55.0	20.0	15.0
Preparation	Internet search	35.0	10.0	20.0	15.0	20.0
Preparation	Word-processing activities	15.8	15.8	10.5	15.8	42.1

Challenges Experienced by Teachers

During the PRA-based activity, the participating teachers identified several external and internal challenges that potentially kept them from regularly using technology during mathematics instruction. Externally, unreliable electricity supply, classroom migration and the burden of connecting at the beginning of each period, as well as time limitations in terms of both preparation and teaching time, were regarded as inhibiting factors. In addition, several teachers referred to problems pertaining to subject content as their reason for not implementing technology, or to the fact that the energy and effort required to teach "difficult" classes left no room for innovation and new approaches.

Internally, teachers experienced their perceived lack of sufficient computer and software skills, and their hesitance (in some cases even resistance) to move from traditional teaching to technology-supported teaching, as factors that had a negative effect on their use of technology in the classroom. One of the participants stated that "it is difficult to find good quality material that suits my learning style". Figure 5 captures the teachers' ideas about the challenges they face, as identified by one of the small groups during the PRA-based activity.

The quantitative data revealed two primary challenges that the teachers experienced, namely that the internet was perceived as being too slow and that there was too much material to be covered in the curriculum. More than 50% of the respondents were of the opinion that their personal use of technology in teaching was hampered by a slow internet (either to some extent or to a large extent), while almost one third of the teachers confirmed that, to a large extent, the vast amount of curriculum content had a negative effect on their personal use of technology in teaching. Table 3 summarises these and other challenges related to the use of technology in the classroom, as identified by the participating teachers.

Table 3 Challenges related to the use of technology in the classroom

		Affected to a large extent (%)	Affected to some extent (%)	Affected to a small extent (%)	Not affected at all (%)
1.	I lack computer skills	-	22.7	31.8	45.5
2.	I am not interested in using technology for teaching purposes	5.0	-	20.0	75.0
3.	Personal aversion to technology as teaching medium	-	23.8	28.6	47.6
4.	Insufficient technical support for teachers	9.1	18.2	9.1	63.6
5.	It is too difficult to integrate technology use into the curriculum	-	18.2	22.7	59.1
6.	I am not in favour of the use of technology in my classes	-	4.5	18.2	77.3
7.	Internet is too slow	19.0	33.3	19.0	28.6
8.	There is too much material to cover in the curriculum	31.8	9.1	13.6	45.5

Existing and Potential Factors that could Support Teachers' Use of Technology in their Classrooms
Despite certain challenges deterring teachers from implementing technology in mathematics instruction, participants were aware of certain resources, knowledge and skills that were already available to them and that could support them in using technology. They were also asked to identify further needs in these areas.

Concerning the resources already available to them, participants mentioned that their involvement in the FRF project implied access to equipment (e.g. laptops, data projectors and projection screens), as well as software (e.g. videos and emulator), during PRA-based discussions. In addition, they were able to identify their existing knowledge and basic computer skills (e.g. in MS Word) as factors that would support their use of technology. These perceptions are most probably related to the training they underwent as part of the FRF initiative. Teachers were also requested to indicate whether they had participated in any ICT related professional skills development in the two years prior to the survey. The results shown in Figure 5 suggest that a relatively small proportion of them had attended professional development courses.
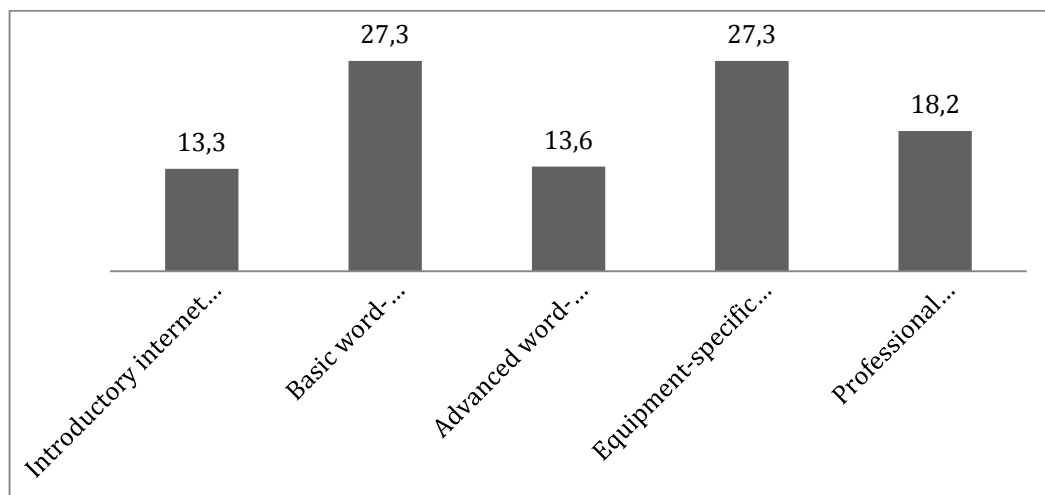

Figure 5 Proportion of participants who attended skills development courses

Teachers indicated the need for more advanced and specialised computer-related knowledge and software skills on, for example, the use of GeoGebra and PowerPoint, and conducting internet searches. On a more general level, they indicated the need for greater exposure to technology-integrated teaching approaches and relevant curriculum-based online resources during PRA-based discussions. They mentioned the potential value to them of observing teachers or watching videos of technology-based lessons being presented. Although not specifically related to the use of technology, several participating teachers indicated the need for specialised knowledge on child development and the effective teaching of adolescents. This need can be related to the challenge experienced by teachers in maintaining discipline in their classrooms.

Figure 6 shows the survey results regarding the need for further training in selected areas of skills development as identified by the teachers.

A large proportion (81.8%) of the teachers expressed a need for further training in areas such as advanced word processing and the virtual learning environment, as well as communication with online communities (mailing lists, twitter, blogs) for professional discussions with other teachers (72.7%). These expressed needs should be viewed in light of the fact that almost 40% of the participating teachers also indicated that they had never used online discussion forums in the past. The fact that more than two thirds of the teachers indicated a need for introductory courses on using the internet is therefore not surprising, considering that almost 62% were of the opinion that their internet skills were either at the same level or poorer than those of the learners in their schools.
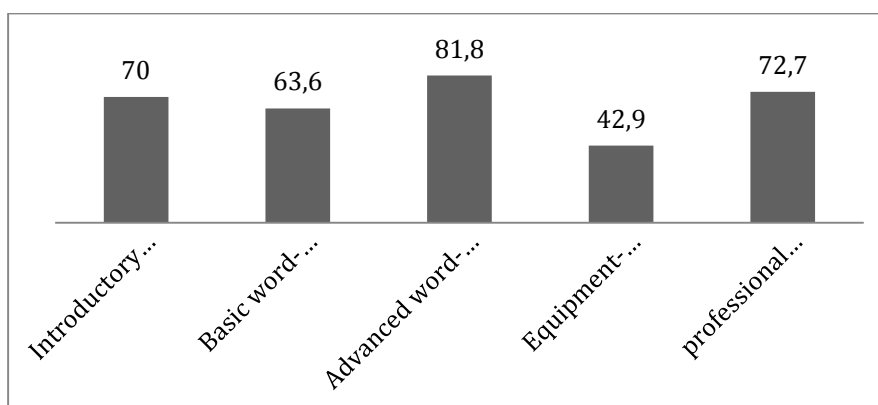

Figure 6 Need for further training in selected areas of skills development

In addition to the aforementioned needs, teachers referred to infrastructure and practical issues that could support them in using technology in the classroom. More specifically, they voiced the need for each teacher to be placed in a fixed and secure classroom, equipped with technology and stable internet connections. In their view, such resources and safe classrooms could save time and provide an environment where it would be easier to provide technology-assisted teaching. When discussing technical support as a factor that could promote the use of technology in the classroom, participants indicated the need to have easy access to content-specific information on the internet, e.g. instruction videos, international resources, previous examination papers, GeoGebra sketches and workbooks. They emphasised a need to support all grades in terms of content that relates to the current school curriculum (Curriculum Assessment Policy Statements).

Discussion

Much of what has been published on emerging trends in technology use in education relates to experiences and observations in industrialised countries (Trucano et al., 2012). The boom in the information technology sector of the past decade or more, however, has gradually, yet persistently, seeped into the lives of those in developing countries as well. Huge amounts of money have been invested in equipping schools with computer-based technologies worldwide, but there is little evidence of the effective use of these technologies for instruction. Research about the acceptance and effective use of technology by Mathematics teachers to improve teaching is therefore relevant for both developing and developed countries.

In order to design the MIDHub database that consists of filtered and structured relevant online resources for teaching mathematics, it was important to understand teachers' perceptions, needs and practices related to their use of technology for instruction. To this end, we used the UTAUT model to organise and interpret the results. Even though this model focuses on technology use in general, our study narrowed the focus to Mathematics teachers' perceptions, needs and use of technology for instruction.

In terms of this study, *performance expectancy* relates to the extent to which Mathematics teachers believe that using online instructional resources will assist them in improving their teaching and/or learning of mathematics in the classroom. Participating teachers expressed positive sentiments about using technology in the classroom. They apparently believe that the use of technology will result in teachers being more effective, and that it will increase levels of student participation, understanding, visualisation, interest and interaction. Venkatesh et al. (2003) found the performance construct to be the strongest predictor of intention in both intentional and compulsory situations.

Effort expectancy in this study implies Mathematics teachers' *perceived ease* of use in using

online instructional resources. With regard to *effort expectancy*, participating teachers found the use of technology "overwhelming". This experience can be linked to limited confidence in their own technology-related knowledge and skills, which – according to the participants – included only basic knowledge and skills. A strong desire thus exists among the participants for further development and advanced training in technological skills. Thompson et al. (1991) hypothesise that there is a negative correlation between the perceived and the actual difficulty of using a computer. This implies that when people perceive technology as difficult to use, they will not adopt or use it. This may be a possible reason why Howie and Blignaut (2009) found the integration of technology by Mathematics teachers in South Africa to be very low.

Social influence in this study relates to Mathematics teachers' perceptions of what significant people (e.g. their principals, heads of departments or subject heads, colleagues and the school governing body) think about their use of technology for instruction. We did not find any evidence that *social influence* affected the participants' use and acceptance of technology in any way. This may be ascribed to the fact that the participating schools had not as yet prioritised the optimal use of technology in their classrooms. In their study, Raman, Don, Khalid, Hussin, Omar and Ghani (2014) explored teachers' acceptance of smart boards, and also found that *social influence* did not play a significant role in teachers' intention to use smart boards. A possible reason for this is that teachers still act relatively independently and autonomously in their own classrooms. In comparing different models, Venkatesh et al. (2003) found *social influence* to be irrelevant to the intentional use of technology, but significant whenever the use of technology was compulsory.

Facilitating conditions refer to the level of a person's perception that organisational and technical infrastructure exists to support the use of technology (Venkatesh et al., 2003). With regard to *facilitating conditions* for using technology in the classroom, the identified external and internal conditions were seemingly not supportive of one another. Externally, the participants had access to sufficient equipment, electricity and infrastructure (even though not always in ideal conditions). Internally, on the other hand, teachers' perceptions that their own knowledge and skills were limited, seemingly weighed heavier than external facilitating conditions. According to the UTAUT model, *behaviour intention* predicts *actual behaviour*. However, the latter is greatly influenced by whether or not a person believes that s/he is capable of executing the behaviour. In this study, *actual behaviour* is defined as Mathematics teachers' actual use of technology for instruction. Perceived behavioural control is one of the constructs that directly influence *behavioural intention*, which subsequently influences behaviour (Taylor & Todd, 1995). As a result, participating teachers were hesitant to employ technology in their teaching, despite their recognition of the potential value of adopting such an approach. The findings of the current study are indicated in Figure 7.
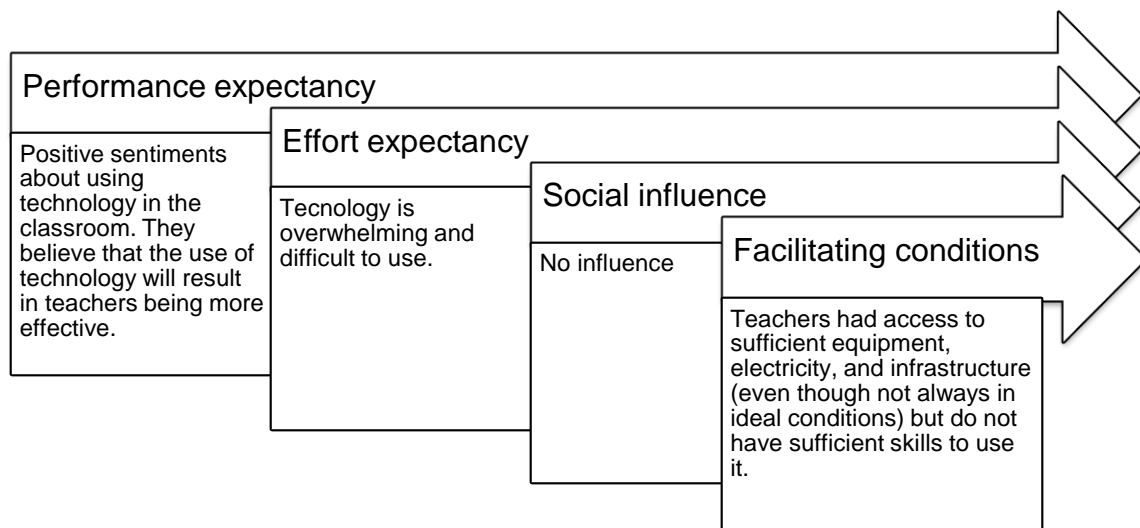

Figure 7 Application of UTAUT model

Conclusion

A critical challenge faced by South Africa and many other countries with emerging economies is Mathematics teachers' lack of content and pedagogical knowledge. The discourse about possible solutions to this problem often revolves around technology solutions. However, despite mobile phones and computers being increasingly available in emerging economies, teachers often do not make optimal use of technology for teaching and learning purposes (Howie & Blignaut, 2009; Sime & Priestley, 2005). Considering the availability of technology and the limited use made of it, the question remains as to why South African Mathematics teachers do not use technology optimally for instruction? This also raises questions about Mathematics teachers' perceptions, current practices and support needs, with regard to the use of technology for instruction.

The current study found that although, on a personal level, participating teachers embraced technology and believed that it could improve instruction, they often refrained from using available online resources to improve the quality of their own teaching. Participants had access to appropriate equipment and infrastructure (though not always in ideal conditions), but nevertheless found the use of technology overwhelming. A strong need for further training was therefore identified among the participants. Teachers' perceptions that their own knowledge and skills were limited, seemingly weighed heavier than externally supportive facilitating conditions. As a result, participating teachers were hesitant to utilise technology in their teaching, even though they realised its potential value. Structural and technical limitations tend to have a greater impact than personal preferences when it comes to factors that have a negative impact on teachers' use of technology.

Notes

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