Does the chalkboard still hold its own against modern technology in teaching mathematics? A case study

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ABSTRACT

The purpose of this case study is to explore the integration of technology into teaching at a mathematics department at a large South African University. Both quantitative and qualitative data were collected from staff teaching undergraduate mathematics. The study shows that many staff members feel that chalkboards are still more suitable than technology for teaching mathematics. This finding supports the idea of a strong subject culture. Age does not emerge as a determinant for preference of either technology or the chalkboard, although gender and academic qualifications do. Subject culture is strongly rooted under the male members of staff, while female staff members feel more positive towards the use of technology in teaching. Use of chalkboards has decreased significantly over the past 10 years, while the use of modern technologies has increased accordingly. Teaching of large groups has necessitated the use of technology in the classroom. Despite the strong subject culture, a shift in attitude towards technology use in teaching is noticed and there is a definite trend of moving towards using new technologies.

KEYWORDS: Undergraduate mathematics, technology, chalkboard, attitudes and beliefs

1. Introduction

The university where this study is based is a large research intensive university and, as most South African universities, has a high student-to-staff ratio. The mathematics department at this university is one of the largest in the country. Classes are often large, with 300 and more students in a class common at first year level. Lectures are conducted in traditional lecture halls housing more than 500 students. Teaching of large groups has in some way necessitated the use of digital technology (such as tablet PCs and data projectors) in classrooms as the visibility of the class of chalkboards in front becomes problematic for students sitting at the back.

The study reports on a 10-year period 2003–2013. In 2003 technology that allowed for interactive teaching, such as tablet PCs and interactive boards, was costly and not widely available. As new technologies were developed and the cost of these technologies decreased, the use of modern, digital, interactive technology for teaching mathematics has become more feasible over the last decade. By 2013 most of the lecturing halls at the university had

been equipped with data projectors, making the use of computers, tablet PCs and other electronic devices such as iPads for teaching in classrooms possible. The question arises, with newer technologies available, which technologies are preferred and used by staff members teaching mathematics.

2. Research aims

The first aim of this research is to determine the attitudes and beliefs towards the use of technology for teaching mathematics held by the staff, and which attributes of the staff members moderate these attitudes and beliefs. A second aim is to determine the preferred mode of technology usage and how the technology is used for teaching undergraduate mathematics at the mathematics department under discussion, and how this has changed over a 10-year period. The study does not intend to evaluate the quality of teaching, nor seeks to suggest that teaching with the use of digital technology is necessarily superior to teaching without technology.

3. Literature review

In a recent survey by Borba, Askar, Engelbrecht, Gadanidis, Llinares and Sánchez Aguilar [1], the authors identified five sub-areas of research in blended learning, mobile technologies, massive open online courses (MOOCs), digital libraries and designing learning objects, collaborative learning using digital technology, and teacher training using blended learning. Maclaren [2] conducted a study in which he investigated how using tablet PCs can transform traditional pedagogy. McMullen, Oates and Thomas [3] integrated digital technologies into a large calculus course. Another recent book on mathematics education in Australasia [4] contains an entire chapter on research on using technology in mathematics teaching over recent years.

So research on using technology in mathematics education abounds. However, most of this research is on the use of technology by students and less on the use of technology by teachers.

Chalkboards (and whiteboards) are still a common tool for teaching mathematics at universities and schools [5,6]. In their international study Artemeva and Fox [7] found that the central pedagogical style of undergraduate mathematics teaching is a multimodal approach using 'writing out a mathematical narrative on the board while talking aloud' (p. 345), referred to as 'chalk talk'. They postulate that this teaching style can be highly complex, as apart from the text and symbols written on the board which communicates the mathematical language to the students, amongst others, lecturers often verbalize and talk about what they are writing, use gestures to indicate relationships, use pauses for reflection, and ask students questions. Chalk talk exposes students to the thinking, practices, and procedures of the mathematics [7]. Friedland, Knipping, Rojas and Tapia [8] argue that

> … teaching with a chalkboard is like thinking aloud, making clear for the students all the different steps involved in a proof or in the construction of a diagram. (p. 17)

Mathematics problems and their solutions should be delivered in real time [9] as students

> … need to be shown step by step how to work out a problem, and how to write down a solution in a clear and precise, mathematically correct way. Students need to learn mathematical explanation. [10, p. 231]

Writing on a board slows down the lecturer to a pace that students can comprehend, as everything must be written down in class and diagrams must be drawn, especially in subjects such as mathematics, chemistry, physics and other sciences [7,8]. Ressler [11] maintains that chalkboards are also reliable, easy to use and text remains visible to students after the teacher has moved on to a new topic.

However, the use of chalk talk pedagogy does not exclude the use of modern digital technologies. The chalkboard and dry whiteboard inspired the development of technologies such as electronic blackboards and interactive whiteboards.

Electronic boards offer many of the advantages of using chalkboards, together with the advantages of modern technology, such as saving, printing or sharing the material written on the board [12]. Unfortunately, this technology is costly and not widely installed.

On some university campuses, the only common technology installed in lecture rooms is a standard PC connected to a digital data projector [2]. Although non-interactive computer technologies, such as *PowerPoint* presentations that use prepared slides, can be used on standard PCs and are widely used in modern lectures, Loch and Donovan [9] question the effectiveness of these technologies for the teaching of mathematics. Although slides can be prepared for mathematics, it is time consuming and solutions prepared beforehand allow little flexibility in the classroom [5] and often the pace of lectures delivered with prepared slides is too fast for students [2,7]. Where an interactive learning approach is used, the lecturer develops a solution from scratch and students can contribute to a particular path, but this aspect is lost when everything is prepared before the lecture begins [10]. Limited flexibility of a presentation often results in passive learning, as the presentation cannot be adjusted according to students' reactions, and this loss of modality impact the development of mathematical thinking severely [2].

A tablet PC and stylus, connected to a projector, offer a blend between chalkboard teaching and electronic slides. Freehand notes can be created (e.g. in Windows Journal), or existing files can be annotated (e.g. *MS Word* files, *PowerPoints* or PDFs). Mathematical software and handwriting recognition software can be used on a tablet PC.

Fister and McCarthy [13] and Olivier [14] identified some of the advantages of using a tablet PC for teaching mathematics. The ability to create a document that includes the lesson outline and allows the lecturer to fill in details as the class progresses is seen as a major advantage. It is then also possible to save these class notes and make them available on the internet afterwards or to revisit it at a later stage. Other advantages include improved class interaction due to eye-contact, greater responsiveness from the lecturer [14] and the ability to use different colours and highlighting to enhance notes made by the lecturer [13]. Also, when using *Math Journal* (software that includes handwriting recognition) equations can be solved and algebraic manipulations carried out. According to Fister and McCarthy [13], the ability to save class notes, and making them available to students on the internet, has had the most significant impact. This feature allows students to learn more effectively, focusing their attention on the classroom activities and not on note taking.

Galligan et al. [5] argue that although the tablet PC can be used to write step by step solutions to problems in class, incorporating suggestions by students, once it has been written,

the solution becomes static, like solutions in textbooks. Using the recording capabilities of a tablet PC allows the solution and lecturer's explanations to be captured as they are writing it and these recordings can be made available to students via the learning management system (LMS). According to Galligan et al. [5] this practice did not cause class attendance to decrease, although Yoon and Sneddon [15] found that this feature did impact students' class attendance.

Like tablet PCs, mobile tablet technologies such as the *Apple iPad* and *Samsung Galaxy* tablets can also be used for teaching purposes. Manuguerra and Petocz [16] describe their experiences using the *iPad* for various purposes in teaching at a university that offers courses to both face-to-face and distance students. Most of the advantages described by them concur with the advantages of the tablet PC.

In their case study on teaching an online mathematics course using pen-based technology, Karal, Kokoc, Colak and Yalcin [17] advocate the necessity of using digital ink technology and related technologies (such as the tablet PC) to 'display concepts, symbols, and solution process steps' synchronously (p. 333) and to achieve a good level of interaction between lecturer and students.

Loch and Donovan [9] describe mixed experiences with tablet technologies. As benefits of tablet technology can be outweighed by technical issues, Loch and Donovan suggest that the

> … lecturer's competency and dexterity with the tablet is a key factor in the successful teaching with this tool. (p. 5)

Anderson, Anderson, McDowell and Simon [18] also warn that when using new technology in the classroom, there is a risk that 'the technology becomes a distraction rather than a complement' (p. T2G-18) and that legible handwriting, attention to pen colour and contrast with background, cluttering of slides and displaying the slides long enough for students to comprehend the material are critical factors to the clarity of slides when using systems such as *Classroom Presenter* on a tablet PC.

In spite of its tremendous potential, the presence of technology in classrooms does not automatically enhance teaching and learning – it can even impede learning if not used appropriately [19]. According to Loch [10], teachers often use new technology in the same way as the older technologies, and not to its full potential, due to user's lack of knowledge and comfort of familiarity. Maclaren [2] cites reliability of new technology as a critical factor affecting adoption.

Several other factors that affect successful integration of technology into teaching have been identified in the literature reviewed, including lack of and access to technology [20,21], basic computer skills of teachers [20–22], fear of change and fear of technology [22,23], lack of technology-supported pedagogical knowledge [20] time constraints [20], availability of technological support [2,22], beliefs and attitudes towards technology [20] and subject culture [24].

The use of a chalkboard seems to be strongly rooted in the subject culture of mathematics, as Greiffenhagen [6] states 'Blackboards are of almost iconic status in mathematics' (p. 505). Maclaren [2] claims that mathematics lecturers are reluctant to give up the use of writing boards. He also argues that lecturers will use pedagogies in their teaching that are most likely those in which they themselves were successful in learning (p. 23), so if a lecturer succeeded in learning with chalk talk, they are more likely to use it as a lecturer.

The *unified theory of acceptance and use of technology* (UTAUT) [25] aims to explain user intentions and usage behaviour of information systems. The theory identifies four constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions) as core determinants to explain user intent and behaviour, while gender, age, experience, and voluntariness of use moderate the impact of the four key determinants. According to the UTAUT:

- the influence of performance expectancy on behavioural intention will be stronger for men, and particularly for younger men. (p. 450)
- the influence of effort expectancy on behavioural intention will be stronger for women, particularly younger women, and particularly at early stages of experience. (p. 450)
- the influence of social influence on behavioural intention will be stronger for women, particularly older women, particularly in mandatory settings in the early stages of experience. (p. 453)
- the influence of facilitating conditions on usage will be stronger for older workers, particularly with increasing experience. (pp. 454–455)

Therefore, according to the UTAUT, personal attributes of an individual, such as age and gender, has an influence on the acceptance and use of technology, especially in their place of work.

Institutional factors also play a role in the teaching pedagogies and technologies lecturers use, as both the management of class room technologies and the timetabling system are often centralized with standard equipment [2]. Hannan [26] found that new technologies may be introduced into large institutions where research is regarded as more important than teaching, in order to free up more time for staff from the burden of teaching, but also from assessing with traditional assessment methods. At institutions where teaching and learning are of higher priority, he found that innovations are undertaken, often resulting in rewards for those involved, enhancing the reputation of a course, department or institution.

It can be seen from the literature that there are various factors that affects the implementation and use of technology in different situations. For the purpose of this study, the technologies referred to in 'teaching with technology' refer to the any digital technology, such as the standard PC, tablet PC or other tablet technologies, and digital overhead projectors, used in class in conjunction with digital data projectors, in contrast to traditional chalkboard or whiteboard technology or the traditional overhead projector.

4. Research design and methodology

In order to determine the attitudes and beliefs towards technology for teaching undergraduate mathematics, as well as the preferred use of technology, a survey using a pen and paper questionnaire, was conducted at the mathematics department of the South African university in question. The staff in the department, at the time of the data collection, consisted of 77 staff members, from assistant lectures to emeritus professor, 48 of which were appointed to lecture undergraduate mathematics. Of these 33 (68.75%) are male, and 15 (31.25%) are female. They are all pure and applied mathematics lecturers, although a few of them have a research interest in mathematics education.

The questionnaire was designed by the researcher and contained 25 questions divided into four sections, namely demographical information, use of technology in the classroom, use of technology outside the classroom, and attitudes towards technology. The questionnaire was piloted with a small number of lecturers and relatively few changes were made. In order to ensure a good return rate the questionnaire was kept as short as possible to encourage the lecturing staff to complete the questionnaire, although it included a number of open-ended questions in order to collect qualitative data. This article reports only the responses to questions about the use of technology in the classroom and the attitudes held by the participants towards technology.

Participation was encouraged – however, completion of the questionnaire was voluntary. A total of 48 questionnaires were distributed and of these 32 questionnaires were returned, giving a response rate of 66.67%. Analysis by gender, age, academic qualification and post level showed that in general the respondents are representative of the undergraduate teaching staff in question.

Participants were encouraged to be honest in their replies. However, some of the responses relied on the memory of the participants and it was not possible to verify this information. As this study is in the form of a case study, findings should not be generalized to other departments or universities. Ethical clearance for this study was applied for and received by the Ethics Committee of the relevant faculty at the university.

In the questionnaire, respondents had to indicate whether they strongly agree, agree, feel neutral, disagree or strongly disagree with given statements. In order to analyze the results statistically, we grouped respondents who strongly agreed with those who agreed and those who disagreed with respondents who strongly disagreed, while the respondents who felt neutral about a statement were ignored. Since the sample is small, we used Fischer's exact test to judge about the statistical significance of results.

5. Results and discussion

Although a staff member may have a positive attitude towards technology in general, subject culture may deter the staff member from integrating technology into his/her teaching [24]. In order to determine the attitudes and beliefs of the participants towards the use of technology with respect to teaching mathematics, participants were asked whether they agree or disagree with a number of statements. Two of these statements were 'Mathematics is a discipline that lends itself to the use of technology for teaching' (statement 1) and 'Even with modern technology available, I still believe that the best way to teach mathematics is the use of a chalkboard' (statement 2). Figure 1, Table 1 and Figure 2 show the relative frequencies of the responses to this statement.

Figure 1 shows that only 19.4% of respondents disagree with the statement that mathematics as a discipline lends itself to the use of technology for teaching. Although more respondents agree (or strongly agree) with the statement than those who disagree (or

Table 1. Mathematics is a discipline that lends itself to the use of technology for teaching.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
3	9	12	3	3

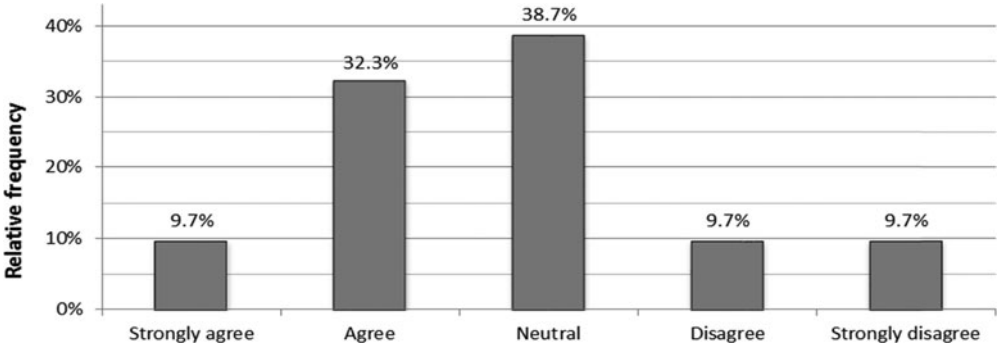

Figure 1. Mathematics is a discipline that lends itself to the use of technology for teaching.

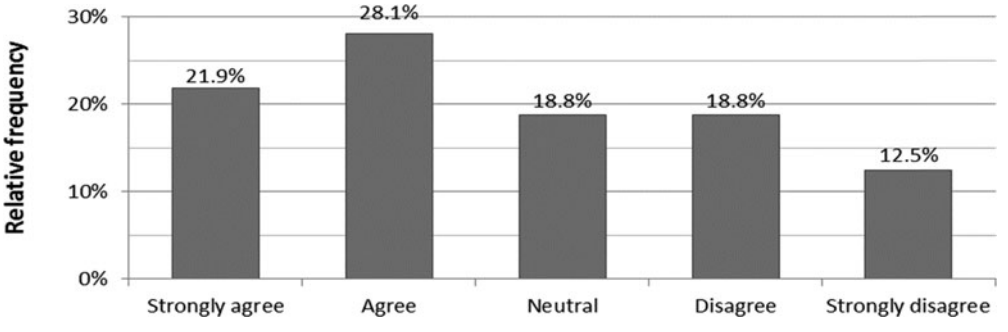

Figure 2. Even with modern technology available, I still believe that the best way to teach mathematics is the use of a chalkboard.

strongly disagree), the difference is not statistically significant ($p = 0.054$). It is therefore interesting to see in Figure 2, regardless of their response to the first statement, that 50% of the respondents agree (or strongly agree) with this statement that the chalkboard is the best way to teach mathematics, while 31.3% disagree (or strongly disagree). Also here the difference is not statistically significant ($p = 0.13$). The UTAUT defines performance expectancy, one of the key determinants, as 'the degree to which an individual believes that using the system will help him or her to attain gains in job performance' [25]. Even though they do not disagree that technology can be used to teach mathematics, a group of approximately 50% of the lecturers still believe that using the chalkboard is the best way of teaching mathematics and that technology will not improve their teaching (increase their performance expectancy). Clearly, the minority, less than a third of the respondents, are willing to concede to technologies other than the chalkboard, while half of the respondents still believe that the chalkboard is more suitable than technology for teaching mathematics. Although not statistically significant, this finding seems to support the idea that a subject culture still exists amongst the staff members of this department.

An attempt was made to determine whether the age and gender of the staff members have an impact on their preference on teaching technology.

Figure 3 represents the breakdown of the responses to statement 2 according to respondents' age groups.

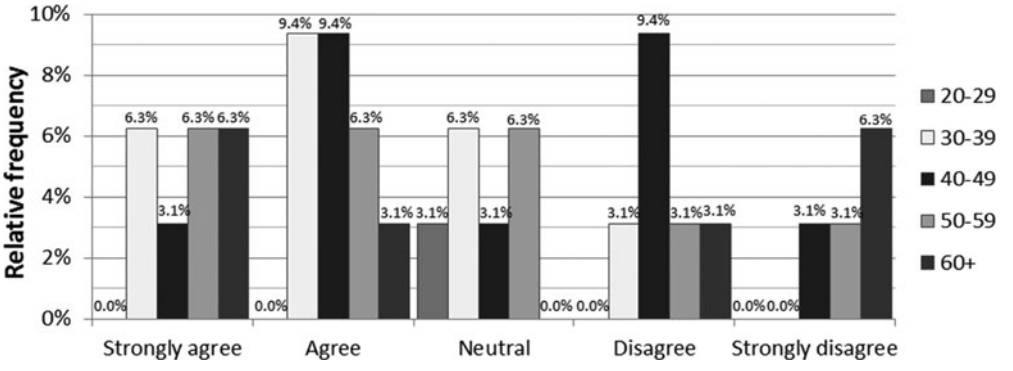

Figure 3. Even with modern technology available, I still believe that the best way to teach mathematics is the use of a chalkboard – by age groups (relative to total number of respondents).

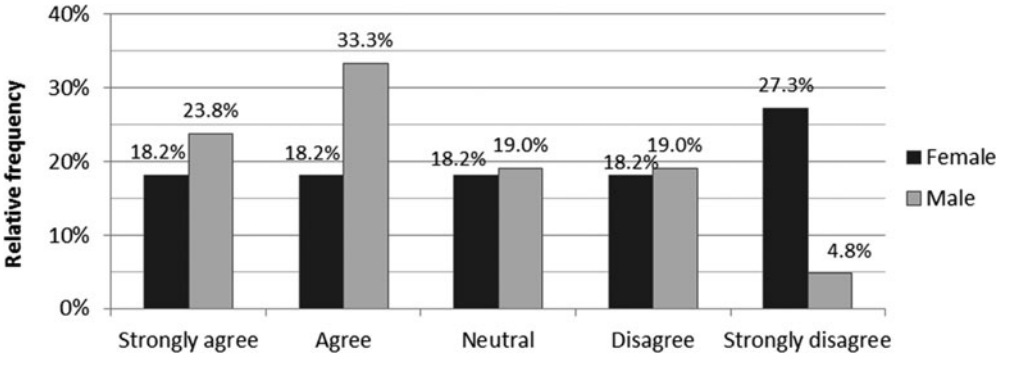

Figure 4. Even with modern technology available, I still believe that the best way to teach mathematics is the use of a chalkboard – by gender.

Results show that the correlation between the age groups and agreement to the statement that the chalkboard is still the best way to teach mathematics is weak (correlation coefficient $r = 0.12$). Prensky [27] describes the generation born after 1985 and growing up surrounded by digital technology, as *digital natives*, and those born before 1985 are referred to as *digital immigrants*. With the exception of one, the respondents fall into the latter category, and while some of them have 'immigrated' into the digital world, others have not – age does not seem to play a role here. The numbers in this comparison are too small to do a statistical comparison.

Although the UTAUT found age to be a moderator in the acceptance and use of technology, age does not emerge in these results as a moderator on the preference for the chalkboard over technology. A strong subject culture, as well as the belief that mathematics is a discipline that lends itself to the use of technology for teaching, is prevalent amongst all the age groups.

Figure 4 suggests that gender is indicative in the responses to this statement as relatively more males (57.1%) than females (36.4%) agree with the statement 'Even with modern technology available, I still believe that the best way to teach mathematics is the use of a chalkboard,' and relatively more females (45.5%) than males (23.8%) disagree with the statement. Gender therefore emerges as a moderator on the preference for technology over the

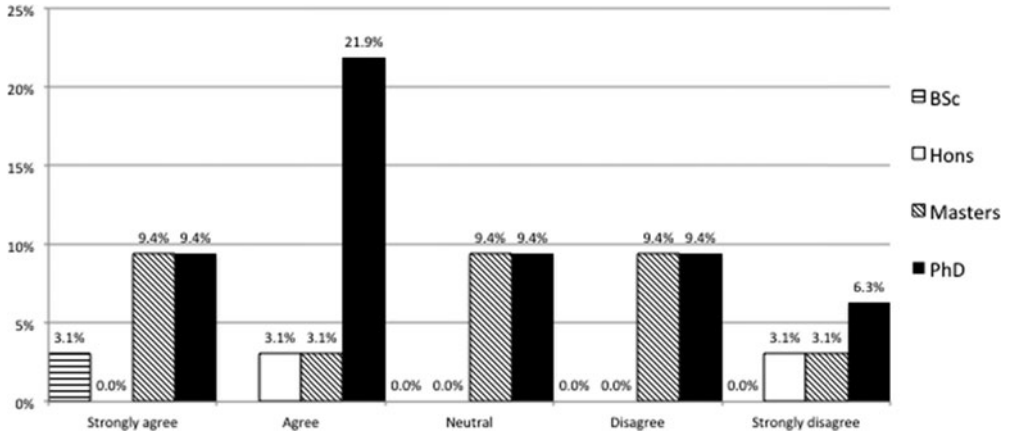

Figure 5. Even with modern technology available, I still believe that the best way to teach mathematics is the use of a chalkboard – by academic qualifications (relative to total number of respondents).

chalkboard for teaching. It appears that the subject culture is more strongly rooted under the male staff members, with more than half of them showing a preference for using the chalkboard. Although some of the female staff are also influenced by this subject culture, overwhelmingly more female staff feel positive towards the use of technology for teaching mathematics. The numbers in this comparison are too small to do any statistical comparison.

Since the teaching experience of the respondents correlates strongly to their ages, and the use of technology for teaching is mostly voluntary, these two variables were not used. Two other variables, academic qualification and teaching qualification were used instead.

Figure 5 shows that 10 of the 18 respondents (55.6%) holding a doctoral degree agree with the statement that the chalkboard is still the best way to teach mathematics, while only four of the 11 respondents (36.4%) holding a masters' degree agree with this statement. As the number of respondents holding a BSc or honours degree is so low, no deductions are made from their responses and no statistical comparison would be valid.

Academic qualifications are found to be a moderator of preference. The higher the qualification, the stronger is the belief in the chalkboard for teaching. Although this is not an unexpected finding, the fact that leadership is situated amongst higher qualified staff members may be a deterrent for promoting technology for teaching.

It can be seen in Figure 6 that more respondents holding a teaching qualification (54.6%) agree with the statement than disagree (36.4%) and accordingly, relatively more respondents that do not hold a teaching qualification agree (47.6%) with the statement than disagree (28.6%). Therefore, not holding a teaching qualification indicates a stronger preference for using chalkboards over technology for teaching mathematics. Again, the numbers seen in this comparison were too small to test for statistical significance.

In order to determine the change in use of teaching technologies over the 10-year period, participants were asked to indicate approximately what percentage of teaching time during a semester they spent using the different types of technologies in 2013, as compared to 2003. The use of technology for teaching undergraduate mathematics has changed significantly over the 10 years, as can be seen by comparing Figures 7 and 8.

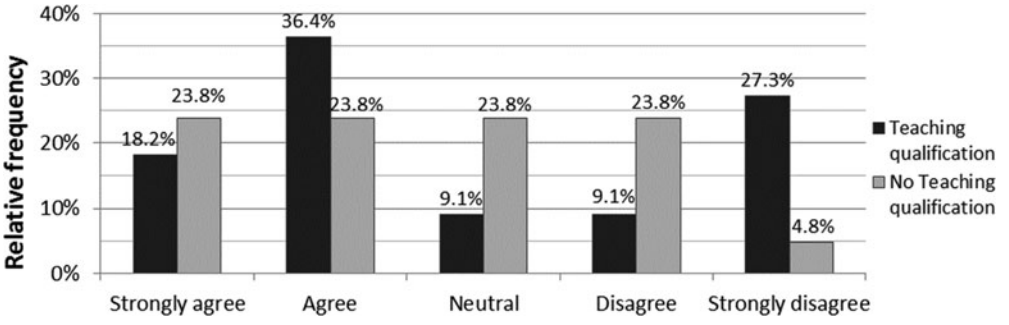

Figure 6. Even with modern technology available, I still believe that the best way to teach mathematics is the use of a chalkboard – by teaching qualification.

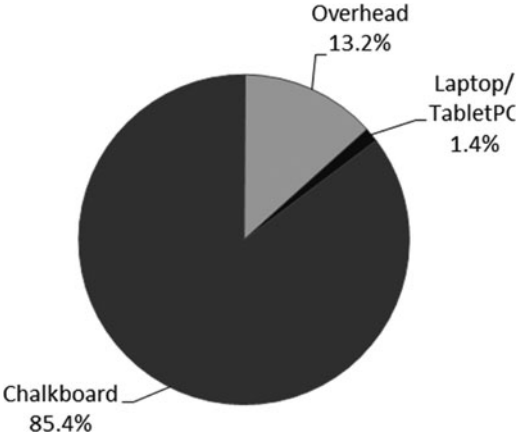

Figure 7. Use of technology – 2003

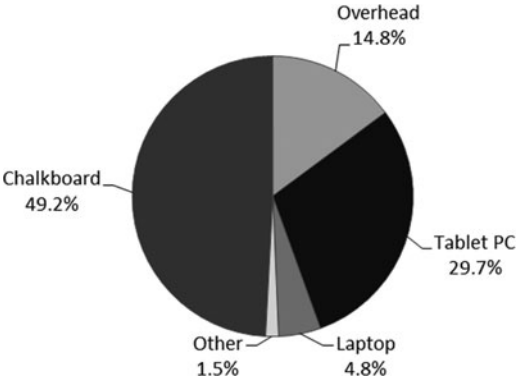

Figure 8. Use of technology – 2013

From Figures 7 and 8, according to the respondents, use of the chalkboard has decreased dramatically from 85.4% to 49.2%. Large classes, together with the availability of newer interactive technologies, can possibly explain this decrease as the use of tablet PCs has increased to 29.7% of the teaching time. The use of overhead projectors remains more or

less the same – from 13.2% in 2003 to 14.8% in 2013. However, it is not necessarily the same respondents who still use the overhead projectors. Some of the teachers who used overhead projectors in 2003 have now adopted the use of tablet PCs, while some of those who only (mostly) used the chalkboard in 2003, have since started using the overhead projectors. None of the 32 respondents use a mobile tablet (such as iPad) for teaching purposes.

From the results, it is clear that use of the chalkboard is still preferred by half the respondents. In answer to questions on how and/or why they use the technology they do, various reasons were given by respondents why they do *not* use modern technology, or why they prefer the use of a chalkboard. Many of these reasons concur with the reasons found in the literature.

The following is a summary of the reasons given by the respondents:

- Better communication of mathematical ideas
- Better pacing of the lecture
- Student-lecturer interaction and the opportunity for student-generated responses and concerns
- Time constraints: time that it takes to master new technology and time that it takes to prepare for lectures
- Mistakes are spotted more easily on the chalkboard
- Having multiple chalkboards on which important theory can remain visible
- Cost, availability and reliability of technology
- Lack of training
- A strong belief that mathematics is not a subject that lends itself towards the use of technology for teaching:

> The teaching of mathematics is an inherently low-tech activity. It can be supplemented by well-chosen high-tech interventions, but the basic process is fundamentally low-tech. There needs to be a distinction between technology that we might decide to use because we think it is effective, and technology that we consider bad but would be forced to use, because of aberrations in the teaching/learning environment, e.g. 300+ students in one room, chalkboard not clearly visible, etc. (Respondent 01)

- The nature of the mathematics course taught

> I teach pure maths with proof – technology won't cement properly the arguments. Students say they do not feel the math. (Respondent 30)

Some of the responses suggest a perception (misconception) that using technology for teaching necessarily implies the use of non-interactive technology, such as prepared *PowerPoint* presentations as described by Galligan et al. [5] and Loch [10]. Pacing of lectures, mistakes not spotted, no opportunity for student-generated responses and time required to prepare quality slides are all issues that relate to prepared slides and solutions, and do not take the attributes of a mobile tablet or tablet PC into consideration. Tablet PCs at its most basic level can be used instead of a chalkboard, without any change in pedagogy or teaching style.

It can clearly be seen from Figures 7 and 8 that the use of tablet PCs and data projectors for teaching undergraduate mathematics has increased significantly since 2003. The first tablet PC used for lecturing purposes in the mathematics department at the university was acquired in 2003 by a faculty member using her own research fund, and through her own initiative. Her enthusiasm about the advantages of the tablet PC inspired a number of fellow faculty members to follow her example.

Nine female and four male respondents indicated the use of tablet PCs. Of these, eight indicated that they use it 90% or more of their teaching time.

In response to questions on how and/or why they use the technology they do, it can be seen that reasons why lecturers increasingly choose to use a tablet PC for teaching vary. Reasons concur with some of the advantages cited by Olivier [14] or Fister and McCarthy [13]. The following is a summary of the reasons given by the respondents:

- Ability to prepare material before the class and annotating this on the tablet PC

> One can prepare certain material beforehand. More versatile in class. Clean. Always facing the class. Can adjust size of letters. (Respondent 09)

- Ability to save the notes made by the lecturer in class for future use, and uploading it on the LMS:

> I get to share notes with students on clickUP [LMS] and have them on computer for future use. (Respondent 16)

- Use of colour to make lecture notes more interesting.
- Visibility in large venue halls with a large number of students:

> I use it because it allows students to see what I am doing; the venues do not lend themselves to chalk and talk anymore. (Respondent 13)

Visibility in large classes was indicated as a major reason why respondents use tablet PCs. Of the 13 respondents that indicated they use tablet PCs, six cited visibility as the only reason for using tablet PC and projector, but three others also included this reason as motivation.

- Feeling of empowerment and more control over classes when using a tablet PC:

> It's the way of the 21st century. It makes me bigger & better. (Respondent 22)

The ways in which respondents use the tablet PCs differ. Three levels of use could be distinguished from the questionnaires. At the most basic level, the tablet PC, together with the software *Windows Journal*, is used to write on instead of the chalkboard, without change in pedagogy or teaching style.

> As formerly with chalk, but on tablet. (Respondent 31)

On a next level, respondents prepare notes or slides beforehand and leave space to fill in and annotate in class (e.g. in *Windows Journal*).

> Use tablet & projector like overhead projector with pre-prepared 'slide' with space left for writing. (Respondent 24)

At the most advanced level respondents use a combination of different software, such as *PowerPoint* presentations, *Windows Journal*, videos and graphing software.

> I teach on a tablet PC using Windows Journal mainly. I intersperse with bits of PowerPoint, YouTube, etc. for visual effect & to make the lecture interesting. (Respondent 22)

The feature of the tablet PC to record writing on the screen together with the voice of the lecturer is not used by any of the respondents to record their lectures (although it is used to a limited extent to make and record videos (not in classroom) to upload onto the LMS for viewing by students).

Use of technology for lecturing purposes seems to be influenced by three factors: necessity, preference or beliefs and only to a very small extent, availability. Most lecturers who have requested a tablet PC, have been provided with one – only one respondent (who has only one year teaching experience) indicated that he/she uses the chalkboard and an overhead projector as he/she does not have access to other technologies.

A third of the respondents indicated that they would use technology differently in large and small classes. They mostly indicated that in large classes they would use more technology as visibility on the chalkboard becomes a problem. Therefore, the use of technology becomes a necessity (though it might not be a preference).

The majority of the respondents, however, choose their use of technology based on preference or beliefs, whether it is the chalkboard, overhead projector or a tablet PC. Subject culture seems to be a strong influence on these preferences – it prevails even among staff members who use tablet PCs. Almost half of these prefer to use the chalkboard instead of new technology when teaching small classes and only use the tablet PC as writing on the chalkboard is not always visible in large classes. On the other hand, the rest are convinced of the value of technologies that are suitable for teaching. They embrace the capabilities of the tablet PC, and explore ways to use it innovatively and not merely as a replacement of the chalkboard. They carry the belief that they are better and more efficient teachers using this technology.

6. Conclusion

The study shows that in 2003 staff members overwhelmingly preferred the chalkboard for teaching. Overhead projectors were also used, while the use of modern technology was practically non-existing. Ten years later the picture had changed dramatically. Use of the chalkboard decreased significantly, while the use of modern technologies, such as the tablet PC, has increased significantly. This is not an unexpected finding as teaching possibilities evolve over time and it stands to reason that staff members at a prominent South African university should keep up with the times as much as possible. The technologies used are chalkboard, overhead projector, laptops, tablet PCs and overhead cameras, often in combination. Despite this remarkable increase in technology usage for teaching, half of the teaching staff still prefers the use of a chalkboard to technology for teaching.

An unexpected finding was that age did not emerge as a moderator indicating a preference for the chalkboard over technology, although gender, academic qualification and teaching qualification emerged as moderators. The subject culture is strongly rooted under the male staff members, showing a preference for using the chalkboard, while overwhelmingly more female staff feel positive towards the use of technology for teaching mathematics. The subject culture also seems stronger rooted amongst those with higher academic qualifications, and also amongst those not holding a teaching qualification.

Since innovation in teaching using technologies tends to differ by subject, it is important to encourage innovation within a department or subject. Staff members should be encouraged to utilize the opportunities for the sharing of knowledge and proficient use of technologies already existing within the department. Mentoring could add a valuable dimension to this exchange.

Suggestions for further research include similar studies to be conducted at other South African universities, research about the perceptions of students with respect to the technologies, and research with respect to teaching pedagogies using technology.

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