Journal of Research, Policy & Practice of Teachers &
Teacher Education
Vol. 3, No. 1, June 2013, 36-46

Mathematics lecturer's values and their choice of technology for their instruction in one university in Malaysia

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With the current rise in popularity in using technology to enhance the students' learning experience, mathematics lecturers are pressured to incorporate technology in their instructional design. The situation becomes problematic when many of these lecturers' learning experiences have a limited exposure to teaching and learning technology. To compound this decision making further, technology tools offered to lecturers' are numerous in terms of functions and forms. This study focuses on how mathematics lecturers' in one university in Malaysia decide on what technology to use and what are the factors that are involved in their decision-making. This study presents the narrative of five mid-career mathematics lecturers and how they meaningfully selected, used technology and incorporated technology into their instructional designs. The evidence in this study suggests that lecturers' decision on what technology they use in their instructional design tend to be in an ad-hoc manner and above all it is their belief in mathematics that appears to predict their utilization of technology. The finding of this study is valuable in guiding organizations and individuals who are interested to incorporate technology in designing mathematics instruction.

Keywords: Instructional design; mathematics education; educational technology.

Introduction

Mathematics has always been considered as an important element in any curriculum. Mathematics is always viewed as a cornerstone of most curricular experience for developing students' quantitative world view. This ability is generally considered an asset among employers. Ismail and Awang (2008) indicate that Malaysians tend to gravitate towards tertiary courses with a mathematical element to improve their odds at employability. Rose and Betts (2001) conducted an extensive study on income and mathematics competency. In their study, they found a gap of eight thousand dollars annually between students who have done up to calculus. Factoring inflation this number now must have quadrupled by now. Bishop (2004) argued that students and their parents believe that the future success in their careers is determined by their mastery of mathematics.

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This phenomenon comes with its own contesting issues. On one hand mathematics has always been taught in universities due to its constant need. On the other hand this phenomenon also attracts many students who lack an intrinsic drive or the fundamentals in mathematics to participate meaningfully in mathematical academic work. One likely consequence of this is it has led to a stretching of the teaching resources and undermining the quality of learning. To overcome some of these issues many institution look towards technology. It is believed that integrating technology can improve understanding of mathematics (Roblyer, 2006). Many in the teaching industry particularly administrators tend to believe that technology could magnify one's teaching effort. Technology can capture teacher effort, multiplied it and can be re-channeled time and time again.

Many institutions in Malaysia are in the midst of investing tens of millions in technology to support this idea of blended learning, hoping it would enhance the teaching and learning experience of the learners. Many governments have initiated global investment in technology to improve teaching and learning in schools and colleges. For example in the United Kingdom, the government spending on educational technology in 2008-09 in the UK was £2.5bn (Nut, 2010), in the United States, the expenditure on K-12 schools and higher education institutions was $6 billion and $4.7 billion respectively in 2009 (Nut, 2010) and in New Zealand, the government spends over $ 410 million every year on school technology infrastructure (Johnson, Calvert & Raggert 2009).

The investment in technology to support a technological blended learning is heavy and most importantly, it is taking up resources from other forms of support that could enhance the students learning experience. Along with this, the marketplace is filled with technological tools and devices that are competing to have their presence felt in the classroom. These devices are marketed to the lecturers and institutions as a silver bullet that can solve the entire teaching and learning predicament.

The problem statement

There has been much research done on how lecturers use technology in their instructional designed and its effectiveness (Manches, O'Malley, & Benford, 2010). Studies done by Matsuda (2008), Horibe & Underwood, (2009), Isik & Tarim, (2009) and Mueller (2009) have presented evidence how technology has enhanced the learning outcome of students. However, little work has been done on how lecturers go about choosing these technologies and how they justify their choice. This study intends to investigate how mathematics lecturers select their technology for their instructional design and what are the factors that they consider in incorporate technology in their instructional design for their students learning experience to be meaningful.

Literature review

According to Harris, Mishra, & Koehler (2009) meaningful integration of technology must consider three aspects; namely the technology, pedagogy and content. For the integration to be successful and sustainable, the use of technology must be meaningful and congruent to the pedagogical needs. Margaret Niess (2011) provided an extensive review on a dynamic framework for describing teachers' knowledge required for designing, implementing, and evaluating curriculum and instruction with technology. In reality, many uses of technology for instruction can be distracting, disruptive, or altogether ineffective if they are not produced with the individualized cognitive needs of the target learner in mind (Mayer, 2009). Lecturers must always consider the impact of technology has on the cognitive processes of students (Kennedy & Deshler, 2010). The using of technology in teaching and

learning mathematics is crucial, but what is more important is, how technology is incorporated in the instructional design.

The effective preparation of teachers in the use of educational technology has been extensively discussed by researchers in the past few years (Koehler & Mishra, 2008; Liang, Walls, Hicks, Clayton, & Yang, 2006; Settlage, Odom, JL. &Pedersen, 2004; Smerdon et al., 2000). Questions such as how to teach a subject with technology in a pedagogically appropriate way and how to develop the knowledge base to design and implement technology-infused lessons in education are often raised (Kirschner &c Sellinger, 2003).

Findings from a recent meta-analysis indicated that technological laced instruction was positively related to student achievement (Yesilyurt, 2010). Further, the use of computer-based manipulative has significantly improved mathematical understanding in younger students (Manches, O'Malley, & Benford, 2010). Studies done by Matsuda (2008), Horibe & Underwood, (2009), Isik & Tarim, (2009) and Mueller (2009) have all reported that students thinking, real-world connections between classroom material and practical experiences, cooperative learning and students' self-efficacy beliefs are positively correlated with meaningful technological embedded learning environment. These results suggest that it is critical to consider the effects of instructional methods and students' perception when designing strategies for mathematics teaching and learning. "An analysis of the effects of computers for mathematics learning indicated that students expressed positive attitudes about mathematics and showed an increased number of learning behaviours" (Reed, Drijvers, & Kirschner, 2010).

An effective curriculum that is facilitating the use of technological tools should link instructional approaches and learning outcomes to the goals of the lesson (Koszalka & Ganesan, 2004). According to Niess (2005), learning activities should take into account student needs, the content being taught, and other contextual variables. However, researchers in this field have long recognized, the presence of technology is no guarantee of meaningful improvement in teaching and learning. All too many institutions have invested heavily on technology but have seen only superficial changes in practice or outcomes (Mehta & Fine, 2012). Schramm (1977, 273), "learning seems to be affected more by what is delivered than by the delivery medium."

There are evidences in research that indicate technology acceptance is more complex than originally thought, (Taylor & Todd, 1995b; Thompson, Compeau & Higgins, 2006; Ball & Levy, 2008). The beliefs a teacher holds about mathematics has a significant impact on the teaching and learning that occurs in the classroom setting (Grootenboer, 2008; Taylor & Bailey, 2011). The prevailing assumption is that available technology can and should change what mathematics is taught and how it is learned (Kersaint, Horton, Stohl, & Garofalo, 2003).

It is important to recognize that the use of technology has brought about a degree of positive influence in teaching and learning particularly in Mathematics (Rogers, 2006), (Eggert, 2005) & (Williams, 2010). Research has indicated that only carefully planned integration of technology would guarantee a meaningful learning experience. In this study the focus on how the lecturers go about this crucial integration. What are the factors that they consider when they integrate technology into the instructional design?

Methodology

The evidence for this study is generated using a hermeneutic phenomenology methodology. This method was chosen above all for its appropriateness for this study. Phenomenology is a human science where the participant and the researcher engage in a discussion to reveal the meaning of a phenomenon as it is understood by the participant (van Manen, 1990).

While traditional phenomenology focuses on the fundamental description of the phenomenon, hermeneutic phenomenology enables the interpretation of the description. For the purposes of this study, the researcher sought commonalities and themes arising from the descriptions. The purpose of this hermeneutic phenomenological study was not to determine the gaps in the participants' understanding in the use of technology in instructional design but to describe and interpret how the participants employed them in their own practice.

It was proposed that 10 full-time mathematics lecturers who employ blended teaching be interviewed for this study. Volunteers were sought through an email sent to all mathematics lecturers from the university. The email explained the research and the role of the participants. The lecturers were to contact me directly to volunteer to participate. Once the lecturer responded to the initial email, a short questionnaire was sent to the lecturer requesting basic demographic data, such as year of subject, level of education, teaching level, age, sex, and a brief description of the technology that they are engaged in their teaching. The plan was to number and categorize these surveys in order to randomly select the participants. However, only 5 lecturers fulfilled the criteria of facilitating a blended teaching class with at least five years of teaching experience. This, of course, represents an extremely low response rate. It was not the aim of this study to draw a representative sample to generalize findings to a larger population. Data collection was carried out between September 2012 and November 2012. The interviews lasted between 30 minutes and an hour and a half, with an average length of approximately 40 minutes. All interviews were recorded and transcribed.

The method of data collection was in-depth, semi-structured interviews of the 5 mathematics lecturers. The interviews were digitally recorded, transcribed, and sent back to the participants for verification. Once the interview data were validated by the participants, the process of reduction began. In analysing the data, the hermeneutic phenomenologist is searching for the hidden meaning behind the text (Maggs-Rapport, 2001). I reviewed them line-by-line and highlighted significant passages such as quotations, sentences, and words. The data were then grouped by clustering statements and passages into themes or units of meaning.

Results

The five mathematics lecturers interviewed for this study used technology for a variety of reasons and purpose. The data appear to indicate that: Not all lecturers in this study could justify the use of a particular technology from a pedagogical point of view. Their decision on selecting particular tool was more of by chance rather that filling in a gap in their practice or enhancing a particular part of their practice. The evidence also seems to indicate that lecturers were more inclined to choose technology based on their beliefs and values they have in mathematics.

Analysis

The lecturers were asked about the kind of training they went through, how they were prepared to teach mathematics in an effective manner and to what extend are they successful in achieving his. They were also asked about whether they felt confident about using technology and they considered themselves as technologically savvy.

The response was as follows:

Lecturer 1	… Yes, I have received formal training in teaching, and the university regularly offers programs and workshops on teaching methods. … Pedagogy is important. … I believe if you focus on the evaluation of the ideas (maths) then you can't go wrong… At the end of the day it is all about how bad the student wants it. Yes, for the most part I do consider my well inform when it comes to using technology.
Lecturer 2	Yes, I am formally trained. I attended courses on teaching and pedagogy when I was a student and now in the university as professional development. Pedagogy is important but I feel it is very important at the school level… At the tertiary level the emphasis on more on content, there is a lot to learn and very little time. … I have been doing this for about 10 years now; I must be doing something right… I use IT everyday, I guess I know enough to get things done.
Lecturer 3	I do spend some time trying to keep up with the development in the teaching of mathematics… I did receive formal training in teaching and learning … Some things are useful, not like the time when I went to college. (Lack of emphasis on learning) … But at the end of the day it is all about how hard the student want it. There is no easy way to learn maths. Yes, I consider my self sufficiently informed about IT and technological savvy.
Lecturer 4	I have a diploma in education. I find something very relevant, but most of it I have figured it out myself… Maths is very objective you either know or you don't. If you are passionate about this subject and you have the right foundation that there is no problem in teaching and learning maths. No issues with technology
Lecturer 5	When I started at this university, I had to attend lots of workshop and training on pedagogy… I have spent a lot of time in finding relevant examples to get the students excited. … You see calculus is boring to many of my students, so if my examples are interesting like the thing to with war and reproduction the students have fun solving them. The students must have the relevant background to do well, otherwise they can cope. Whatever can be said and done at the end of the day the students must be able to prove it on a test… yes a paper and pencil test….

The lecturers in this study indicate that they were all formally trained in teaching and view themselves of having sufficient knowledge in technology. The evidence in this study appears to indicate that the mathematics lecturers who participated in this study seem to project a perception that mathematics education is about content mastery and student desire. Their responses tend to indicate that they see their job at transmitting ideas and knowledge as their dominant teaching practice (Kim, 2011). They also have the opinion that understanding mathematics is largely to do with student participation and involvement. The data also seem to indicate these five lecturers see understanding of mathematics in a linear development as akin to an assembly line, they see prerequisite knowledge as a predictor of the students' success. It is crucial to them that students acquire ideas sequential as it underpins understanding of mathematics as a whole.

When lecturers were then asked what are the main technology that they used for teaching?

Lecturer 1	I do a lot of things differently, I think the one main thing is using technology, like power point helping me present ideas quicker … this is also good because at the end I will pass it on to the students they save time copying…. … I teach statistics… the spreadsheet software like Excel is very essential to my teaching… it allows to arrive at the solution quicker… I allow students to explore the possibilities
Lecturer 2	I use the clicker in my class; in fact I kind of use it a lot. Helps me to keep track of the student understanding…. …about two times a lecture.
Lecturer 3	My lecturer theatre is fitted with the lecture capture system; I use it every time I lecture… I encourage my student to review the parts that they feel that they are weak in.
Lecturer 4	I don't feel comfortable with a lot of this, in my son's class the teacher uses an interactive board… I think at that level it is important to engage students … but at my level I believe that the student should be engaged by the ideas I use a (regular) white board in class, I find writing and talking in real time makes my teaching more effective… when I do this simultaneously I get the timing right. … I do encourage my student to take a picture of the white board… and also pictures of their assignment to email me for help.
Lecturer 5	I use graphing software to show how some function looks like… I also use some videos from MIT and other universities as an alternative to my lecture. … and the students can watch these videos again and again until they get it.

The main technology that the lecturers in this study were, lecture capture system, audience response system, videos, presentation software and some graphing software/tools. In the interviews, it appears that the lecturers overwhelming only talked about using technology to present their ideas. The lecturers in this study appear to leverage on technology as a transmit tool. Two of the five lectures on the other hand have explored further, Lecturer 2 in this study used technology to gauge his students' understanding and to regulate his teaching and Lecturer 1 used technology to apply mathematical ideas in a more authentic context. The lecturers on the whole felt that the student benefited from their use of technology by not having to transcribe or take down notes, and put their efforts in participating and paying attention in the class. On the whole the lecturers saw technology playing a role in increasing the effectiveness in transmitting content.

The five lecturers were asked how they went about choosing these technologies that they incorporated in the instructional design. They responded:

Lecturer 1	I use a quite a few apps and Excel, usually what happens is the students come to with this thing… If I feel it is appropriate that I advertise them to the rest of the class and I may use it in my teaching… … Usually it's on plotting a graph and such…
Lecturer 2	I attended a professional development training and saw the trainer using the clicker. … When I used it, I found it was engaging… I decided to try it in my class.
Lecturer 3	My university invested in this lecture capture system, I decided to give it a shout.
Lecturer 4	Normally I use the LMS provided by the university to circulate materials and assignments. … It is a university policy I think…
Lecturer 5	When I was in grad school I used the particular graphing tool, I find it useful… I incorporated it into my teaching. … I sometimes feel my English pronunciation is not that good … using these videos by other lecturers could help my students.

The data seem to indicate that most lecturers in this study employ technology in an ad hoc manner.

Lecturers in this study appear to demonstrate they don't see technology as a precision tool to solve a pedagogical problem. The evidence in this study indicates that technology is used to supplement their teaching rather than drive their teaching. The lecturers did not identify a gap in their practice and then actively sought a technological solution. The evidence seems to indicate that, the only exception to this is Lecturer 5. Lecturer 5's response seems to indicate that she has consciously incorporated technology to compensate for a predispose condition that she had identified. She sees herself as am having an issue with communicating with her students, particularly with a spoken English. She actively sought ought videos of prominent lecturers to incorporate them in her instructional design.

When that five lecturers were asked how have they modified their teaching practice after incorporating technology, their response was as follows:

Lecturer 1	Not much, I think a lot of these things happen naturally, I really don't have a big plan I use them as I see fit. But I have changed my content, the complexity of my question particularly in statistics has increased. With technology I can give bigger data set.
Lecturer 2	The clicker is good when the response is not good I repeat myself. I use it to keep track of myself.
Lecturer 3	I have considered doing anything differently, I have to think about it….
Lecturer 4	Not really, unlike other subject mathematics is fundamentally a thinking subject. No technology will help me with this. Students must practice and learn to solve the problem … that is the only way to learn mathematics.
Lecturer 5	I find it hard to say how different. Sometimes I make the students watch videos and later I use the graphing software to help students to visualize, otherwise they may have difficulty visualizing a function.

The evidence in the study indicates the lecturers did not radically adopt technology and change their teaching practice. For the most part these lecturers have taken a conservative approach in adopting technology in their teaching and learning practice. They seem to hold strong to a traditional face-to-face delivery model as their preferred choice of teaching. The evidence in the study seems to indicate that for the most part lecturers are not convinced that technology is has change teaching substantively. It is still used to complement their teaching.

Finally, this study wanted to ascertain how lecturers view technology in teaching and learning of mathematics. The lecturers were asked how they view technology and how technology will transform the teaching of mathematics. The researcher wanted to probe the views of lecturers whether they saw technology as an asset in teaching and learning of mathematical.

Lecturer 1	Technology is really important to me, it makes life easier… it really helps my students in finishing up their assignment. …I am able to more challenging question unlike before…. … the beauty of mathematics can be realized through its application
Lecturer 2	…now when they need, for example, to find the root of an equation…they don't think … they just go straight to the calculator and get the answer… they don't know how to factorise anymore! So I realize that these are the basic things we should know… and we should be able to do it without a calculator. Calculator alone is a simple device…when you talk about the apps that help you to

	plot a graph and all this thing… the students don't even know how to plot a graph and they become dependent on these handheld devices
Lecturer 3	Maths is a mental thing; it is all about doing it in your head. That is what makes this discipline so exciting and unique". … I am afraid that my students' future will hinder… like using Smartphone is not the same as knowing to write programming codes.
Lecturer 4	"things like graphing technology will only make students lazy and depended on it… …learning and mastering mathematics is not the same as getting the answer right…you can get the answer but yet be ignorant about it… … in engineering they use maths, we discover maths….
Lecturer 5	… I do use some technology to help my student learning process… the mark of a good mathematician is he does not need to use aids to figure things out".

Of the five lecturers interviewed, only one supports the idea that technology goes hand in hand in the teaching of mathematics. Four of the five lecturers were of the opinion that teaching mathematics with technology should be limited. These lecturers held a view that with the use of technology they were diluting the learners' learning experience.

Of the five lecturers, Lecturer 1 comes from an applied maths background. This gives him a unique perspective to the use of technology. He sees technology as liberating mathematical ideas from a pure theoretical perspective to a more functional purpose, he appears to associate technology as a medium where students can apply real world problem in a classroom setting. He is of the opinion that the beauty of mathematics lies in its functional value. He further elaborates that his objective in teaching is not to push so much for mastery of mathematics but appreciation and functional nature of mathematics. On the other hand lecturers with a pure mathematics background viewed technology for learning as a crutch particularly in the foundation years, only to be used sparingly. These lecturers seem to indicate the for the most part learning mathematics is about gaining a conceptual insight. It is their opinion the mathematics student must develop certain cognitive dexterity that allows them to manipulate these ideas mentally rather than relaying on technological aids.

This evidence is crucial for this study, the majority of the lecturers in the study felt that using technology to aid the learning experience will somewhat dilute their the students' ability to appreciate the purity of mathematics and obstruct the future learning. The evidence in the study indicates that mathematics lecturers' values and beliefs about what mathematics is, appears to determine how and what technology they adopt.

Discussion

In this study, the evidence seems to indicate that the driving force to the successful implication of technology for teaching and learning in the field of mathematics is governed by the lecturers' beliefs and value of mathematics. The lecturers who take the view of mathematics being perennial tend to belief that learners of mathematics must be challenged epistemologically. This group of lecturers tends to emphasize rigour and dexterity in their work. Their preferred pedagogy, tends to relay on knowledge transmission and abstract thinking; thus the technology is generally used minimally for presentation of ideas. The lecturers in this study tend to have the notion that technology may dilute the dexterity and rigorousness of mathematics. The evidence of this study indicates that lecturers' knowledge of technology is not the contributing factor to the quality and quantity of technology used in their instructional design, but the view they hold on the content that they are teaching. Baugh & Raymond (2003) provided evidence through their study that teachers' beliefs

about mathematics can have an impact on both their teaching and their students' beliefs about mathematics and their related teaching styles.

Lecturers who see the utility value of mathematics tend to promote pedagogy centred around technology and particularly lots of multimedia and simulation to aid teaching and learning. The evidence of the study tends to indicate that knowledge about technology does not necessarily lead to employment of technology. A person's beliefs and perception have more influence in determining how much technology they tend to employ in the teaching and learning activity. Looking ahead, this study points to the need for more longitudinal research on lecturers' beliefs and perception of their content, which becomes a predictor for expertise in the integration of technology. In particular, we see a need to investigate how the kinds of trajectories described in this study may, over time, fit within the many institutions e learning implementing goals. In addition to this policy on e-learning must reflect this notion and accommodate this range of diversity to optimize investment in relation to the teaching and learning needs.

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