Using the Internet in Teaching Mathematics in Primary School

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This paper arises from a larger study that aims to investigate how primary school teachers use the Internet for teacher professional development and for teaching mathematics. Through compilation of interview data and classroom observations from one primary teacher, it was found that this teacher uses technology and particularly the Internet as an integral component of her daily mathematics teaching, and regards the Internet as vital to her teaching style. This report provides an examination of the way this teacher integrates the Internet into her mathematics teaching, reasons to use the Internet in teaching mathematics, the benefits for students, and how this approach aligns the intent of the new Queensland mathematics syllabus. The results are discussed in the light of new learning in New Times.

Background

'New Times' is a term commonly used to describe contemporary society, and our ever-changing, increasingly digitised world. New times are characterised by new ways of learning, primarily through use of the Internet (Kerry, 2000; Moor & Zazkis, 2000). The Internet allows learners to ask questions or share ideas with teachers and friends via electronic mail (James, 2001), to do hands-on activities using Internet-based manipulatives (Crawford, 2003), to engage in collaborative-projects with other students in different countries (James, 2001), to collaborate in discussion forums (Yang, 2002), to ask questions directly of experts, or to obtain primary resources (Kerry, 2000). All of these are new ways of learning unknown less than two decades ago. With the Internet, activities which previously required students to be physically present in the classroom can now be done virtually without attending classrooms (Bellon, 2002; Foster, 2003).

Internet access has significantly increased in recent years. In 1999, Becker (1999) found that over 90% of schools in the USA had become connected to the Internet. In 2001, the Australian Bureau of Statistics (ABS) reported on the availability of Internet access in Australian households, stating that almost 40% of homes had Internet connection, and that their data suggested this figure would rise significantly in the future.

With the impact of technology in new times, standard competencies previously required for life are continuously changing. In new times, basic knowledge, such as the ability to count, or to read, is no longer enough (Zevenbergen, 2004). The type of skills required include critical thinking skills, problem solving skills, the ability to evaluate information and make informed judgements, communication skills (such as being able to presents ideas and to share experiences), proficiency in using technology (being familiar with a range of technologies and being able to use them), team work skills or being able to collaborate with other people to achieve common goals (e.g. James, 2001; Motwane, 2003; Queensland Government, 2002; Stacey, 1997; Zevenbergen, 2004).

In new times, schools must be responsive to the new demands of technology, to match the needs of learners, and to look at learning in new ways (e.g. multidimensional and not linear approaches in learning). Schools are one of the institutions that have primary responsibility for preparing students to succeed in this increasingly complex world (Australian Council of Deans of Education Inc., 2003; Queensland Government, 2002; James, 2001; Kerry, 2000).

New Times requires new ways of dealing with increasing amounts of information, and new ways of transforming information into knowledge. Teachers necessarily play a key role in these processes. New times require new roles for teachers. The promise of new times for learners of mathematics is that technology may provide new pathways for successful learning. To consider the new role of the teacher in new times, it is beneficial to explore 'old' approaches to mathematics teaching, and to overview literature pertaining to reform approaches to mathematics teaching and learning.

Mathematics Teaching

Teaching as a transmission process. A teacher who believes that information can be transmitted to students' heads often employs lecture methods in the teaching of mathematics. These teachers usually stand up in front of the class, writing formulas on the board, and providing several examples for practising the formula. Teachers then give students many exercises for practice and expect students to memorize the formula (Boaler, 1996; Wedde, Breuer & Hüvelmeyer, 2003).Yet several studies have described the detrimental effects of this approach for students (e.g. Glazer, 2001; Boaler, 1996). Because of a tendency for teachers to expect students to memorise a lot of facts that may not necessarily make sense to them, and asking students to listen and practise many exercises in preparation for a test, many students come to the conclusion that mathematics is either about right or wrong, it is unrelated to real life, or it is only appropriate for smart students (Goos, 1999; Boaler, 1996). Generally speaking, this transmission view is not relevant to new times. In an age of fast information (accessed via the Internet) teachers are no longer the main sources of information. This means that, on the one hand, it is very possible that what teachers have planned to teach, some students have already understood better by accessing information themselves. On the other hand, what teachers might have prepared in a very well-structured form cannot guarantee that it will be easily understood by students, particularly those who do not have the pre-requisite knowledge. Further, if transmission is a viable teaching approach, it means that the role of teachers might be replaced by technology in terms of being a transmitter which might offer very structured instruction. For example, a lot of drill and practice can be readily done through the Internet, and a lot of visualisations are available to explain particular concepts. However, technology on its own cannot change educational practices (Wiske, Sick, & Wirsig, 2001).

*Teaching as a constructive proces*s. The traditional view of teaching provides a limited view of teachers as transmitters of knowledge. In contrast, teachers as facilitators would help students to construct their own knowledge. As facilitators, teachers position students at the centre of activities, taking into account what students already know and what they expect to learn from teachers in classrooms. Such approaches are widely accepted as a means to reform the teaching and learning of mathematics (e.g. Boaler,1998; NCTM, 2000; Wood, Cobb & Yackel, 1991).Student-centred approaches advocate that teachers position students as partners in the learning process, taking opportunities for when students can be informants or experts in certain sub topics. Although a seemingly simple approach to mathematics teaching, many research studies have shown that getting teachers to reform their teaching style is not an easy task (e.g. Boaler, 1998; Borko, 2004). To develop innovative teaching requires a huge amount of effort from teachers. Often, teachers, especially those who acknowledge the limitation of traditional mathematics teaching, have found it difficult even though they have a willingness to change (Borko, 2004).

Methodology

The paper reports on a small part of an ethnographic study, namely a case of an expert teacher Fida (pseudonym) in teaching mathematics with the Internet in a primary school. Her participation in this study was fully voluntarily. My focus in this part of the study was to begin to answer the following questions: In what ways does the teacher use the Internet in teaching mathematics and how does she organise students when teaching using the Internet?; Why does she use the Internet in teaching mathematics?; What are the impacts of mathematics teaching using the Internet on students' learning?; and, To what extent is utilisation of the Internet relevant with the new mathematics syllabus in Queensland?

Prior to classroom observations taking place, the teacher completed several questionnaires, providing information about her professional background, how she uses the Internet for professional development and for teaching and learning mathematics. The researcher spent two weeks in this teacher's classroom. Informal interviews with the teacher were held on several occasions, to clarify her responses to questionnaire items, and to verify my perceptions of what I had observed. The researcher also accessed the Internet to find the teacher's favourite websites, as listed in its Bookmark. E-mail communication was a part of the data collection method, and this occurred both during and after the fieldwork. Videotaped lessons also assisted in completion of the fieldnotes. Data analysis occurred through sifting the rich corpus of material to produce a profile of this 'expert' teacher in using the Internet for teaching and professional development.

Results

Description of Fida's Classroom

The most noticeable thing about Fida's classroom is its crowded feel. There is little space for students or the teacher to move. The class is very open with no doors, and many people pass the classroom via the verandah. Voices from other classrooms can be heard and people that pass the classroom can be seen by the students. The tables in the classroom are arranged in three long strips with desks facing each other. Four other desks are on the verandah and were usually used for small group teaching.

In Fida's classroom with 26 students, there are only 6 computers, and only 2 of these are connected to the Internet. The computers are in the corner of the classroom, and in this position, they can be monitored by the teacher while she is helping other students.

Classroom Setting

In the classroom, the Internet is integrated into Fida's daily teaching including in mathematics. She stated that she prefers having access to the Internet as a part of the classroom setting instead of in a laboratory setting as it enables her and her students to use it whenever required for learning in the classroom. However, Fida emphasized that she regards the Internet as just a tool for learning, and not as a focus.

From the questionnaire, it was found that Fida uses various organisational settings when teaching mathematics with the Internet, namely small groups, individual rotations, whole class introductions, and paired work. From the observations over two weeks, two different settings were seen, namely individual rotation and paired work. It was also

observed that occasionally, without any instruction from the teacher, a group of three or four students would spontaneously form as they became involved in a discussion about material found on the Internet, or when they were helping each other to solve problems. On several occasions, some students had a turn at the Internet as a reward for finishing selected tasks. Fida explained that this was for individual extension. On another occasion, a student went to use the Internet of his own accord whilst his other friends were watching a video.

Internet Activities in the Classroom

From the time the Internet has been available in Fida's classroom, she has used it for mathematics teaching. The first implementation was for mathematical research, as she wrote in her e-mail:

> The earliest I used the Internet for student maths research was in 2000 where the students were looking for situations where they would 'work' mathematically (they were looking for jobs with maths). During this investigation they discovered a host of maths activities and resources and quizzes and the dreaded worksheets online. But not a lot about occupations for mathematicians. However they did begin to discuss the nature of maths skills and understandings and why they needed them.

Fida said that she used the Internet for a range of classroom activities, including direct access to learning objects and manipulatives, exploring investigations by students, comparing and communicating ideas with others. She also uses the Internet to find research on mathematical ideas, to explore lesson ideas, unit ideas and also for access to community resources and excursion activities. During the classroom observation period, five examples of Internet activities in mathematics teaching were seen, namely: Lego Box Game, Fido Puzzle, virtual manipulatives for Geometry, and Google Search. In the following paragraphs, each of these will be briefly described in terms of what they look like, the mathematical concepts involved and how these activities engaged the students.

Lego box game. (http://www.lego.com/eng/create/activities/junkbot2/default.asp) In the Legobox game, the player needs to find a way to build bridges by moving the coloured bricks which enables the junkbox to collect all the rubbish. This is a virtual Lego game where the player is expected to have the least number of movements to finish the task; the better the strategies, the less number of movements there will be. According to Fida, this game is a tool to engage students to think mathematically, because there are many different mathematical concepts involved in this game. As she explained, 'the Lego Box Game, is about spatial concepts and patterning and number and shapes, … working mathematically on problem solving.'

Fida also explained that this game was valuable in promoting discussion among students. This can be confirmed during the observation period, as students were seen working together, discussing strategies, and using a range of approaches to reach the goal and the next level. A certain amount of friendly competition was also seen as those who had reached higher levels wanted to share their solution strategies, but also to remain the leaders in terms of levels reached.

Fido puzzle. (http://www.digicc.com/fido/) The Fido puzzle is an interactive game where the computer will read the user's mind. Fida described the relationship between the game and the mathematical concepts:

> …with the Fido puzzle, it is to do with operations, a lot of operations, computation, and then the students discuss the different ways of doing calculations and why that would give them the right answer. It takes a lot of deep math thinking to understand how … They must always have accurate

methods of computation…accuracy, estimating, and metacognition…'

Through the observation I saw two pairs of students very excited how the computer could know the number they were hiding. A pair of students was thrilled when they found that the computer was wrong and they reported to the teacher proudly that they could win. In fact, they did the wrong computation. They went back to check their computation after the teacher said that the computer is never wrong. At another time, I saw a student being helped by his peer. With the Fido Puzzle, it appeared that students were learning a lot about computation in an engaging and motivating virtual game situation that required them to reflect upon their own thinking and calculation strategies.

Geometry (http://illuminations.nctm.org/) This website, which is provided by NCTM, allows students to explore the properties of various geometric solids, such as the number of faces, edges, and vertices. The teacher can also formulate his/her own questions to suit the students' age and ability. When using this site with the students, it was observed that the students were constructing geometric shapes out of play dough, and them comparing their creation with those displayed on this Internet site. The link to the Internet shapes assisted students to look at the features of their own shapes, and to make them more accurate.

Google search. (http://www.google.com/) During the observational period, students undertook a Google Search, which wasn't particularly related to a maths lesson, but was required by the students for their research project in which mathematics was integrated. The project required students to examine the size of certain animals, the geography and so on. Students sometimes went to computers to access the Internet by themselves and asked the teacher for help in selecting the information. The teacher encouraged the students to read the descriptions under subheadings of listed websites to find the information that might be of value to them.

From the questionnaire and interview data, it was found that Google searching is also usually used when the students did mathematical research. As Fida stated, 'With research it could be any mathematical concepts that they have identified, that they need to research'. Fida gave a further example of when the students were researching mathematical jokes, an activity suggested by the students themselves.

> One day, they said they wanted to find math jokes, so they did Google searching and there are a huge number of sites that are related to math jokes and then they pick up one that they thought really funny. This activity actually turned out to be a really valuable learning experience, they had to explain what the math in the jokes was and why it was funny. This gave me a real insight into their understanding of particular mathematics concepts.

Teacher's Reasons for Using the Internet in Mathematics Teaching

Three main reasons for using the Internet in Fida's mathematics teaching were identified, namely (1) to achieve her mathematics teaching objectives that mathematics is everywhere, a great tool to solve daily problems as well as mathematics can support cooperation/collaboration, (2) to facilitate student' learning, and (3) the belief of the important for students to have a good understanding and skill in using ICT.

Fida explained that Internet activities, for example, problem solving, math research, virtual hands-on activities, will help students gain the three objectives above. Furthermore, aligning with her philosophical beliefs about teaching and learning mathematics and individual learners (as examined in Patahuddin & Dole, 2006), she views the Internet as assisting her to act as a facilitator, particularly in engaging learners in their own learning. As

she stated

> I often find that I can engage them into some appropriate math learning related to what I am teaching, using the Internet. … Whereas normally, being the facilitator without the Internet is quite hard because you are there and you've got a whole class in front of you, and you can't often have a focus or enough focus … to keep the children discussing. Whereas, I find the Internet very good for sustaining kids' discussions and focus.

Also, as a facilitator, she has found it easier to cater to diversity, and to build mathematical knowledge and processes for students, as described in the following quotations.

> …you can offer extensions through the Internet. If you have children that are extra gifted who want to go into something a little further than the rest of the class… On the other side, I have used it a lot for those students who can't necessarily engage in the math that I am teaching… so often there are Internet activities or resources that will engage them.

Fida has also seen the relevance of the Internet and the importance of technology for her students' future lives, as reflected in the following conversation.

> Q: When the Internet first became available in the classroom, you started using it in teaching. You were continuously experimenting with the Internet. I am wondering why that was happen.
>
> A: When it became available in the classroom, it was an accessible tool for the children to choose to use. Also understanding and using ICT is an essential skill in today's society so students need the opportunity to develop these skills as soon as is applicable. But most of all I found the Internet a very useful/efficient way to stay up to date with current events, find teaching resources, research current issues and have contact with colleagues in other parts of Australia and the world.

Impacts on Student's Learning Process

Fida's experiences using the Internet in her teaching provided her with evidence that the uses of the Internet impact positively upon student's learning. Students are more engaged in learning, such as more active in asking questions/discussing ideas, they collaborate with others, students who normally do not engage become engaged with the teaching with the Internet, student who have extra needs have the opportunity to extend their maths learning, and students with learning disabilities have greater opportunity to engage with the concepts at greater depth and in a range of modes.

Some of these impacts were observed. It was quite often that students in the computer group were enthusiastic in learning. Many students were seen positively interacting with the Internet, for example, by using their hands to count, shaking of heads, responding orally when solving problems, asking questions to peers or to the teacher if at various times. In mathematical rotations, compared to other groups, the computer group were sent to focus on tasks quicker than non-computer groups and during the transition period in rotational activities, the movement from the non-computer group to computer group was more organised and quicker than the movement from non-computer group to computer group.

Relevancy between the Syllabus and Mathematics Teaching

In relation with the syllabus, Fida also explained that using the Internet in teaching mathematics is relevant because the new mathematics syllabus contains: (1) a high emphasis on the use of communicating technologies in teaching math, (2) a high emphasis on context links in real life: Computers and the Internet are very much part of life now, and many real life contexts are easily accessible on line" (3) a high emphasis on Thinking, Reasoning and Working Mathematically: "the Internet is a tool for research and assisting problem solving, accessing virtual manipulative sites", (4) building conceptual knowledge:

"The Internet provides a source of knowledge for exploring these, for example, algebra"; (5) extending concepts: "The Internet provides resources for exploring these, e.g., Chance and Data through access to ABS (Australian Bureau of Statistics) website", (6) Support Material on line: "The Internet provides easy access to these".

Discussion and Concluding Comments

New Ways of Learning

The case of Fida has given us evidence about new ways of learning by navigating the Internet. For example, with the Lego box, students were learning spatial concepts, problem solving, challenges and so on with virtual manipulatives. With the Fido puzzle, students interacted with the Internet, learning about computation. With the Google searching, students were doing research on self-selected or specified tasks. With the geometric sites, students explored virtually the properties of geometric solids. With the mathematical jokes research, students did research using the Internet, and this activity delighted the teacher as she saw that some students, who do not achieve well in mathematics, could explain the mathematical concepts involved in the jokes.

Initiatives for using the Internet sometimes came from students. The learning with the Internet during observation was rarely controlled by the teacher, as happened with students in the non-computer group. They were easily finding websites and directly used the Internet, then engaged with their own learning. Fida admitted that the way students interacted with the Internet was not how it at the beginning of the year, and that all students required specific assistance in using the Internet in class.

New Roles of the Teacher

From this study, it can be see that Fida's role in teaching mathematics is not one of being a transmitter or a centre of learning, but as a facilitator. She has taken advantage of the limited availability of the Internet connection in her classroom to support her in facilitating student's learning. She has created a list of educational websites in the computer Bookmark to help students find useful websites. Getting these websites was not an issue for her. These websites mostly come to her from her online professional discussions and sometimes from her students. Through using the Internet, she has found the means to more easily to engage students in learning and to cater to the various needs of different students. She has also noted that this learning provides opportunity for her students to collaborate with others. This case indicates that the Internet cannot replace the role of the teacher as facilitator, as she must set up the task, pose questions, provide appropriate websites, and give feedback.

New Demands in New Times and New math syllabus

It is widely accepted that we are facing new demands in these new times. Some skills (e.g. using technology effectively, evaluating and critically examining the huge quantities of information that we are bombarded with, and having adequate critical thinking to solve new problems) are crucial for living in this changing world. Fida has shown us how her teaching provided students with the opportunity to develop these skills. The teaching also demonstrated the uses of the Internet in facilitating the development of these skills.

As highlighted by Fida, that the emphasis in the new Queensland math syllabus is on communication technology, the contextualisation of mathematics problems, thinking, reasoning, and so on. My argument in this paper is that these syllabus objectives link directly to the educational potential of the Internet and its capacities as a source of information, a means for communication, and as a site for collaboration.

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