Australian Secondary School Teachers' Use of the Internet for Mathematics

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This paper reports preliminary findings on a study that investigates secondary school mathematics teachers' usage of the internet. A convenience sample of Mathematics teachers in Australia (N=63) was administered a questionnaire: the *Use of the Internet for Teaching Secondary School Mathematics Survey*. The paper discusses who uses the internet, how, and for what purpose, in teaching and learning mathematics.

Internationally, there are major efforts to produce resources on the World Wide Web for mathematics education. these include Math Forum (Drexel University, 1994), NRICH Online Maths Club (University of Cambridge, 1996), EdNA Online (Education Network Commonwealth of Australia, 2003), and National Library of Virtual Manipulatives (Utah State University, 2003). However, the uptake of the internet as a resource for mathematics education in schools has been slow. Studies (Becker, 1999) conducted in the United States on the use of the internet for different subject disciplines showed that Mathematics teachers have sharply lower measures of internet use and perceived value of the internet compared with high school teachers of other academic subjects such as Science, Social Studies and English. There are brief descriptions of Australian teachers' use of the internet in conjunction with studies on the use of Information and Communications Technology in several case studies (eg. Barnes & Loong, 2003). The data from these studies shows that mathematics teachers in the three year *Discovery School Project* lag behind teachers of LOTE, Special Education, English, Computing, SOSE and Technology in providing less than the mean number of lessons using the World Wide Web. Apart from these general studies, there is a paucity of literature on how Australian mathematics teachers use the internet in secondary school mathematics.

Pedagogical Use of the Internet in the Mathematics Classroom

Studies (eg. Gerber & Shuell, 1998; Idris, 1999) conducted on the use of the internet in the mathematics classroom have primarily focused on hyperlinked characteristics of the web to access information. "Resource based learning" was a traditional pedagogy used in Society and Environment and English; the web with its vast array of resources offered further opportunities for this to expand. A question for mathematics educators becomes what pedagogy for web use in the classroom might emerge so that mathematical learning is nurtured? Moor and Zazkis (2000) noted the problems associated with navigating the web and proposed the learning of defined mathematical concepts through the use of a constructed web site that they termed as a virtual classroom. Although they reported enjoyment and motivation amongst students, lack of teacher support was reported as a major concern. Barnes and Loong (2003), on the other hand, proposed a task-web object approach whereby specific student or teacher tasks were replaced or enhanced through the use of particular learning objects found on the web. This approach aimed to remove the problems of unfruitful searches lamented by Gerber and Shuell (1998), while maintaining a considerable level of support for students.

The web is also particularly suited for certain conditions of mathematical discourse. Web-based delivery of mathematics discussion forums were found to present unique opportunities for students to display and develop mathematical inquiry processes (English & Cudmore, 2000), encourage creativity in looking for mathematical solutions (Nagai, Okabe, Nagata & Akahori, 2000) and have great potential to enhance mathematics students' ability to articulate and explain (Sherin, Mendez & Louis, 2000). There are numerous discussion forums for students and teachers on the web (eg Math Forum & NRICH) that can be used to foster such communications. Is this an emergent pedagogy that uses web communications to nurture mathematics learning?

A report on the use of ICTs in UK secondary schools (OFSTED, 2002) show that where the web has been used, high achievements reflected teacher intervention and well-planned use to meet clear subject objectives. This paper seeks to describe how and in what ways Australian mathematics teachers plan and use the web. Undeniably, the use of the web is still very new in the mathematics classroom and more research and documentation of teacher practice is necessary for pedagogy of this resource to develop.

The Project

The broad survey described in this paper is the first stage of a research project designed to investigate the use of the web in secondary school mathematics teaching. This survey is aimed at examining the extent teachers and students are using the web. By "extent" is meant the frequency of use, the purpose and the way the web is used for teaching and learning of mathematics. Subsequent stages of this project will involve interviews with teachers who use the web for teaching Mathematics and examining their pedagogical practices and their impacts on students' mathematical learning.

This paper examines some findings of the survey and the following questions are addressed:

a) Who uses the web to teach mathematics in high schools?
b) What is the web used for and how is it used?
c) What are mathematic teachers' perceptions of web usage in their teaching and its impact on students' learning?

Method

Participants

Notice of a web-based survey form was distributed widely through a conference and a journal. 63 participants responded to the survey. About 24 responded to an advertisement in mathematics workshops and associations' newsletters via the online survey while the remainder responded through a national mathematics conference. The response rate from advertisements could not be determined but response rate at the mathematics conference was about 40%. The respondents were from a mixture of country and town, government and non-government type schools and from different parts of Australia. Overall, the number of participants from each state is as follows: New South Wales (8), Victoria (13), South Australia (12), Northern Territory (1), Queensland (21), Western Australia (5) and the ACT (3).

The Instrument

The instrument consisted of 49 main items under 5 major headings, namely, Background information, Internet experience, Internet uses in teaching, Students' uses, and General. (Respondents who indicate they never use the internet for teaching mathematics are directed to the latter section). The survey was made available to respondents on paper as well as online at http://edudb4.education.unisa.edu.au/MathsSurveys/introsurvey/introImathssurveya.htm. Table 1 presents examples of the questions asked and the response type.

Table 1
Example of Survey Questions and Response Type

Category	Sample Questions	Response Types
Section A: Background Information	School type and region, gender, age, teaching experience mathematics teaching experience.	Click/tick choice; fill in the blanks
Section B: Teacher internet competency and experience	In terms of the internet, I would rate myself as…	Recruit/novice/fairly competent/highly competent/expert
Section C: Teachers' use with topics	Did you use the internet to teach the following topics in the last 12 months eg. Number-operations	Yes/No/ If Yes, how many times (Approx.)
Teachers' use for class presentation	I use interactive objects on the web to demonstrate mathematical concepts	Never use/For a few selected topics/ For most topics/ For every topic
Teachers' use for lesson preparation	I use material obtained from the internet to plan mathematics projects for my students	Never use/For a few selected topics/ For most topics/ For every topic
Teachers' use for communications and resource development	I use computer-mediated communications like e-mail, discussion groups or bulletin boards to communicate with other mathematics teachers in the world	Not at all/ monthly/ fortnightly/ weekly/ 2-3 times a week/ everyday
Section D: Student uses of the internet at home or in school in the last 12 months	Under my directions, students use interactive objects on the internet to investigate and explore concepts	Never use/For a few selected topics/ For most topics/ For every topic
Section E: Teacher perception and intention to use	I would like to use the internet more for mathematics teaching and learning	Strongly Disagree/ Disagree/ Undecided/ Agree/ Strongly Agree

Results and Discussion

Teachers' Background and Internet Usage for Mathematics Teaching

Data were collected from 31 male and 32 female teachers. The mean age of the respondents was 45 years with the mean teaching experience being 21 years (SD 11) and the mean mathematics teaching experience being 20 years (SD 11).

Respondents were given a statement "I use the internet for teaching Mathematics" The response types were Never use, For a few selected topics, For most topics, and For every topic. To obtain an overview of internet usage to teach mathematics, the response types were recoded as Never use=0 and Use=1 (whether for a few topics, most topics or every topic). Based on this recoding, internet usage for mathematics teaching was indicated by 50 (79%) of the teachers. Chi-square tests indicated no significant differences between male and female teachers as well as age categories in this aspect. No significant differences were obtained for teaching experience. It was heartening to note that age and teaching experience was not a barrier to teachers' usage of the internet for teaching mathematics contrary to popular beliefs that the more experienced teacher is probably less likely to change set ways of teaching or to implement new ways of teaching. Chi-square tests also indicated that there were no significant differences between region (country and town) and types of school (government versus non-government) with internet usage to teach mathematics. This is probably because country, town, governmental and non-governmental schools in Australia are likely to have rather similar access to internet and computer facilities and teachers' uptake of the internet is governed not so much by these facilities but probably by other factors such as teachers' beliefs and readiness to use this technology.

Teachers' Competency and Frequency of Use With the Internet

Respondents were questioned on their competency and frequency of use with the internet. Teachers rated themselves in terms of internet competency as either novice (11.1%), fairly competent (57.1 %), highly competent (23.8%) or expert (7.9%) but none rated themselves as having just started using the internet (or recruit). Chi-Square tests indicated no significant differences between internet competency and teachers' use of the internet for teaching mathematics. The data, however, indicated that teachers who use the internet to teach Mathematics are also frequent users of the internet ($\chi_(1)=6.25$, $p=0.012$). The causative effects of this association are unclear in this study.

Teachers' Professional Development and Internet Usage for Mathematics

Of the teachers surveyed, about 56% indicated that some of the professional development courses that they have attended included sessions on the use of the internet for teaching mathematics. Chi-square tests however showed no significant differences between professional development on the internet and internet usage for teaching mathematics. It is probable that professional development in this area has not been particularly extensive due to the novelty of this resource and the slow uptake of this technology amongst mathematics teachers. Although the findings show that 79% of teachers surveyed use the internet, many of them are probably grafting it onto existing preferred methods and are thus using it even without any professional development in this area.

Teachers' Perceptions of Web Usage

Teachers' perceptions and inclination to use the internet were ascertained through questions in Table 2. Responses were coded as Strongly disagree=1, Disagree=2, Undecided=3, Agree=4 and Strongly agree=5. The results indicate that most teachers (73%) recognise the value of this resource but the majority (92%) are probably more interested in having access to material that is deemed useful and beneficial for mathematics learning as opposed to just having more (or mathematically unstimulating) material on the web. That some 88% of teachers want to see more useful material on the web suggests different things. Possible interpretations are that (a) there is a shortage of materials; (b) they do not know where useful materials are; and (c) the materials they see are not as useful as they might be. Possibilities (a) and (c) seem to be addressed by ongoing major initiatives on the internet but the issue of usefulness may remain. In fact, there is a significant correlation between teachers seeing the web as a "useful tool" and utilizing it for teaching ($r=0.309$, $p=0.01$).

Table 2
Teachers' Perception and Inclination to Use

Question	Response Type (%)				
	1	2	3	4	5
I think the internet is a useful tool for Mathematics	1.6	7.9	17.5	49.2	23.8
I would like to use the internet more for Mathematics teaching and learning	1.6	1.6	2.7	54.0	30.2
I would like to know more about where useful Mathematics materials are found on the internet	1.6	3.2	3.2	30.2	61.9
I would like to see more useful material placed on the internet for the teaching of Mathematics	1.6	0	9.7	29.0	59.7

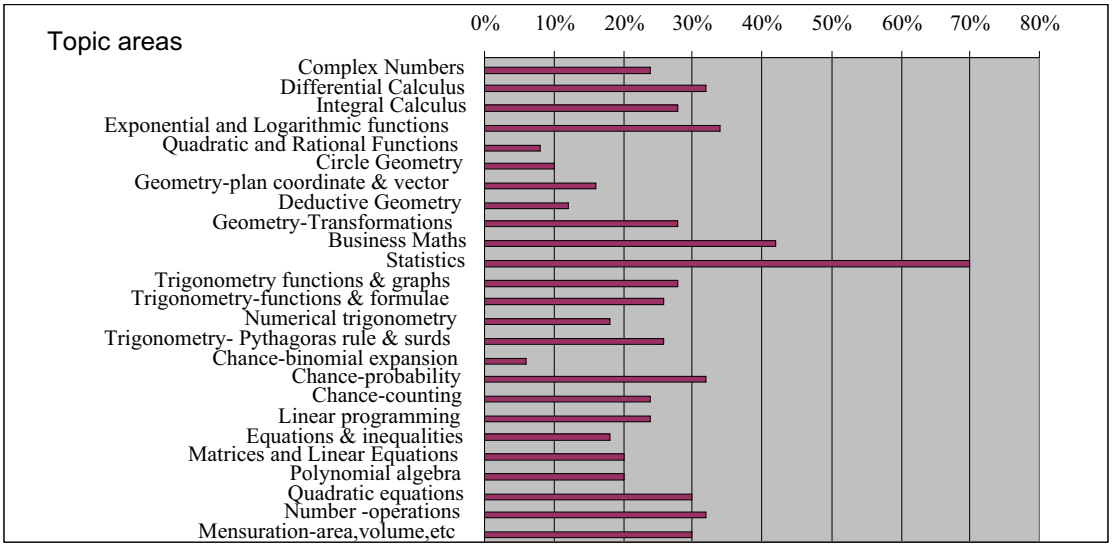

Figure 1. Web usage by topic areas. The horizontal axis shows percentage of teachers.

Web Teaching by Topic Areas

Teachers were asked if they had used the internet to teach named topic areas in the last 12 months. Figure 1 shows that all the topics listed in the survey have been taught at some time. The web appears to be most frequently used by teachers for Statistics followed by Business Mathematics. This may be due in part to the accessibility of authentic data sets from organisations such as the Australian Bureau of Statistics or useful web materials such as interactive finance simulators being present in bank sites or credit unions. This is consistent with an emerging pedagogy that sees authentic applications on the web as having value for nurturing mathematical learning. It is interesting to note that the uptake with Geometry topics is on the low side.

Elements of the Web Used by Teachers

The survey questioned respondents about how they used the internet for lesson preparation, presentation and communications and resource development. The results in Figure 2 indicate that teachers are more likely to use the web to plan projects, access databases, articles or documents, and word problems but are less inclined to utilize the interactive, dynamic objects and graphics found on the web. The data shows that less than half the number of teachers surveyed used the interactive resources or animations available on the internet in their presentations to teach their students. It is probable that teachers are not aware of the availability of good interactive resources or if they were aware, would not be inclined to use it because of a lack of other infrastructure such as data projectors or internet access in classrooms. They may also be more inclined to use other resources that are convenient and allow such forms of interactivity (eg. handheld graphics calculators). Very few (18%)of the teachers create their own web page and some (24%) e-mail their students about relevant mathematics on the web. However, more than half (57%) have participated in some form of computer mediated communications with other teachers.

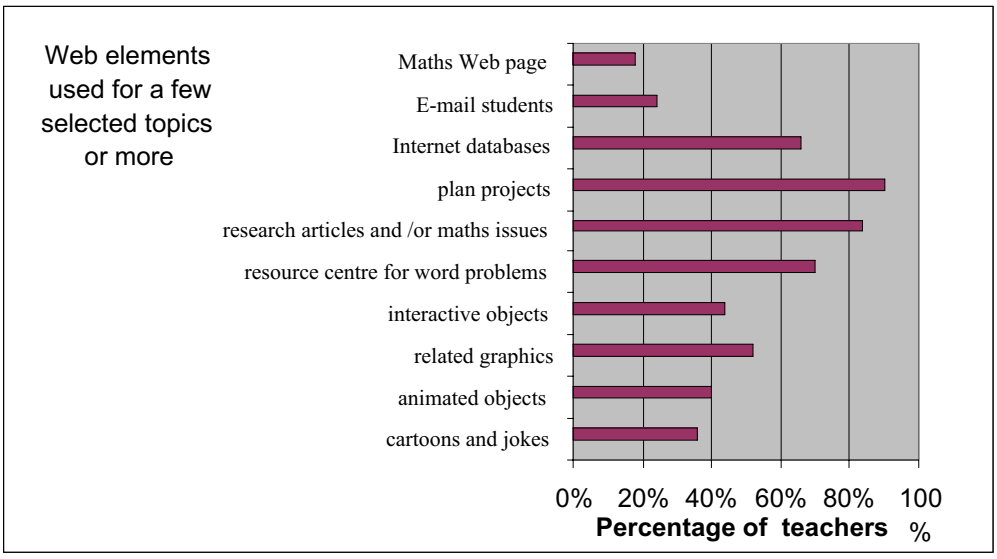

Figure 2. Elements of the web used by maths teachers for presentation and preparation.

Students' Web Use Under Teacher Direction

More than half (70%) of the teachers direct their students to obtain data from the web for Statistics at home or in school (see Figure 3). This is consistent with the

dominant use of the web in the Statistic topic (Figure 1). Although teachers were less likely to use interactive objects on the web to present and explain concepts, more than 50% of teachers who use the web directed their students to use interactive objects to investigate concepts for some topics or use the web as a resource centre and for extension activities. Interestingly, although the web contains material related to drill and practice and recreational mathematics (see Loong, 2001), more than half (60%) of the teachers never use it for remediation activities or drill and practice (74%) and less than half the teachers use the web for any form of recreational mathematics. These teachers apparently do not see much value in such materials. The results also indicate that very few teachers involve their students in any form of asynchronous or electronic discussions with other students or mathematics personnel in the world.

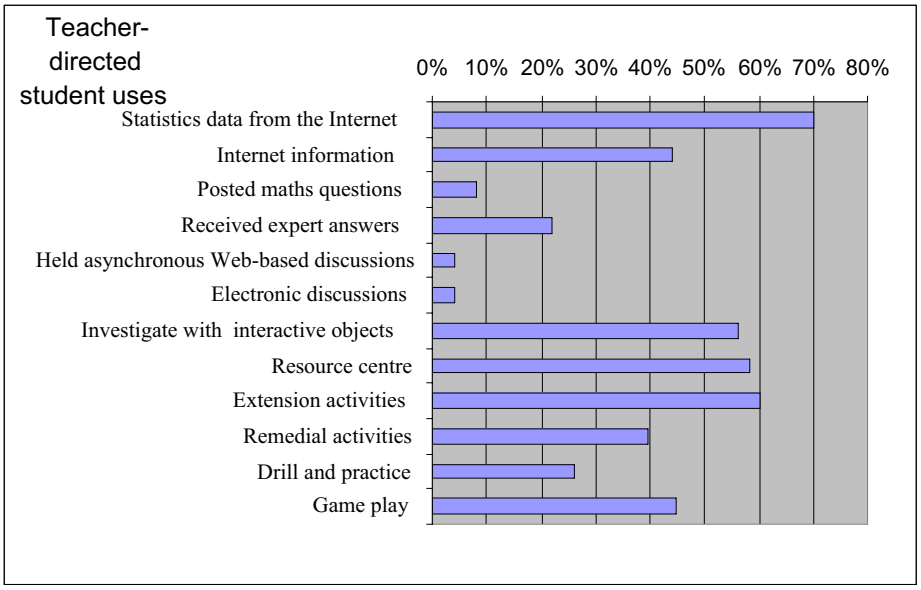

Figure 3. Teacher-directed student uses with the web.

Teachers' Perception of Student Motivation

When asked for their thoughts on student motivation, some 60% of teachers thought that students did not find mathematical activities on the internet relevant. On the other hand 63% thought students enjoyed doing mathematics on the internet. Students' enjoyment may be more apparent to teachers than their perception of the relevance of the web activities for their mathematics learning. A better understanding of both aspects of motivation requires direct study of student attitudes.

Conclusion

Although there are limits to its generalizability, the findings suggest that a good number of mathematics teachers use the internet to teach mathematics and are positive in their perception of web uses in mathematics education. While some topic areas appear to be more preferred than others there seem to be scope for web use in other less preferred topic areas such as Calculus and Geometry. Of interest particularly is how teachers, who teach such more abstract topics with the web, do so effectively. Certain web elements such as interactive objects may well be more appropriate for these areas if their use can be framed within a new emergent pedagogy. Further detailed studies with students are necessary to see the impacts of the web on mathematical learning.

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