

COMPUTERS IN THE PRIMARY CLASSROOM: BARRIERS TO EFFECTIVE USE

Michael O. J. Thomas & Carolyn Vela
The University of Auckland

The computer has been in the world's mathematics classrooms for some period of time now, but with varying degrees of implementation in the promotion of student learning. In this paper we describe longitudinal research over seven years which has investigated how primary school teachers actually make use of computers in their mathematics classroom, and what they perceive to be the major obstacles to improving or extending such use. The results show that while there are now many more computers available to primary teachers and there is some change in the software used, there are still a number of key barriers to increased use of computers as mathematical learning tools.

INTRODUCTION

Increasingly research literature over the last ten years has described the implementation of computers in school learning as rather patchy, and somewhat sparse (Ely, 1993; Askew and Wiliam, 1995; DFE, 1995). Recently Ruthven and Hennessey (2002) surveyed reports of school computer use and conclude that "Typically then, computer use remains low, and its growth slow." (p. 48). Considering possible reasons behind this situation Veen (1993) has argued that teacher factors outweigh school factors in the promotion of computer use, and Maddux (1994) agrees that computers will continue to be seen as relatively unimportant until most teachers incorporate them into their teaching. A number of reasons for the failure of many teachers to use the computer have been described (e.g., Thomas, Tyrrell & Bullock, 1996), including the upheaval resulting from the computer's presence; an unwillingness to change classroom management techniques; not wanting to lessen teacher control in the classroom; and an inability to focus on the mathematics and its implications rather than the computer.

Considering the primary school situation in particular, a survey on types of software use by Niederhauser and Stoddart (2001) found that primary teachers use both skill-focused and open-ended software. Considering reasons why teacher do not use the computer, Dunn & Ridgway (1991, 1994) found that, among student primary teachers, a lack of teacher confidence was the major reason why the computer was not employed in class, with 40% of one sample saying they were unsure or anxious about using computers. The study by Thomas (1996) agreed with this finding, citing 55% of primary teachers as giving the same reason.

This paper reports on a study which tracked computer use in the primary classroom at two discrete points seven years apart and sought to identify both patterns of usage and perceived barriers to use, with the aim of recording advancements in implementation and changes in attitudes to obstacles preventing it.

METHOD

In 1995 a questionnaire on computer use was sent out to every primary/intermediate school in New Zealand and replies were received from 480 of the 2471 schools (19.4%) in the primary/intermediate sector. Within each of these schools a number of teachers

responded and so 1500 individual teacher replies were obtained. Some of the results of this survey of computer use were published by Thomas (1996). In 2002 it was decided to follow up the earlier survey in order to gain some longitudinal data on how the situation might have changed in schools over this time. While there are well over 2000 primary schools in New Zealand many of those in rural areas are very small, sometimes with only one or two teachers. These small schools, while very important in New Zealand, were not considered typical examples of the social and economic activity occurring in a larger school which would have many more teachers, a larger budget and probably more computers. Hence in the follow up study we chose to survey Auckland, a major centre with one third of the student population of the country, which is likely to be more representative of these types of schools. On this occasion 300 questionnaires were sent to the ICT or/and mathematics leader in all the primary and intermediate schools in the Auckland area, and 87 (29%) were returned. This level of response, which is acknowledged as quite good for a postal survey, should give a representative sample. Many of the questions asked the leader to fill in answers for all the computer use they were aware of in their school, while others asked for the teacher's personal professional opinion. Only a single teacher was employed because in the intervening years since 1995 it has become apparent that teaching has become an even more stressful and demanding profession in many ways, and particularly in terms of demands on time. Teachers are more reluctant than ever to spend their valuable time filling in forms or research questionnaires, and hence we targeted the person we thought would feel the greatest obligation to complete the questionnaire, and would be more interested in doing so. We also offered the incentive of a full report of the findings to all who responded.

The questionnaires sent out in the two years were not identical due to the differing requirements in 2002 (e.g., questions on the use of the internet) but instead had a number of questions in common. However, on both occasions they provided valuable data on: the number of computers in each school; the level of access to the computers; available software; the pattern of use in mathematics teaching; and teachers' perceived obstacles to computer use (see Figure 1 for a selection of questions from the second survey). This data has enabled us to come to some conclusions about the changing nature of computer use in the learning of mathematics in New Zealand primary schools.

RESULTS

In 1995 39.1% of the primary teachers said that they did not use computers at all in their teaching, but this had fallen to 11.4% by 2002. Of those who use computers, 93% used them in their own classroom in the first survey, and this figure has remained constant through out the period. One change though is the growing number of teachers using ICT labs that have been set up in schools as numbers of computers have increased, with 71% now able to access computers in these labs, although all of these used them in their classroom as well.

In 1995 the primary schools had a reported mean of 7.0 computers per school, although teachers saw this as insufficient and were asking for more computers in their classroom. 2.9% of the schools claimed to own no computers at all, 22 schools (4.6%) had 20 or more and two schools had 40 and 41 computers respectively. In addition 8.3% of the schools had a computer room. By 2002 there had been a huge jump in these numbers,

with an average of 46.4 computers per school and only two schools (0.02%) claiming not to have any computers at all.

	<p>Computers in Primary Mathematics Questionnaire</p> <p>School: _____ Decile: _____</p> <p>Name: _____</p> <p>(Name of teacher who is filling in questionnaire on behalf of your school)</p> <p>Email: _____</p> <p>(Your personal or school email address)</p>
Q1	<p>How many of each of these computers does your school have?</p> <p>(Exclude computers for administration purposes only)</p> <p>PC _____ Mac _____ Other _____</p>
Q3	<p>Where do teachers have access to computers?</p> <p>In their Classroom <input type="checkbox"/> ICT Room <input type="checkbox"/> Staffroom <input type="checkbox"/> Library <input type="checkbox"/> Office <input type="checkbox"/> Nowhere <input type="checkbox"/></p> <p>Other _____</p> <p>If teachers do not have access to computers please go to Q13</p>
Q7	<p>Do any teachers use computer software programs with students in their Mathematics Programme?</p> <p>No <input type="checkbox"/> Some <input type="checkbox"/> Most <input type="checkbox"/> All <input type="checkbox"/></p> <p>If no teachers use computer software with students in Mathematics go to Q11</p>
Q8	<p>How often do most teachers use computer software with students in their Mathematics Programme?</p> <p>Everyday <input type="checkbox"/> At least once a week <input type="checkbox"/> At least once a month <input type="checkbox"/></p> <p>At least once a term <input type="checkbox"/> At least once a year <input type="checkbox"/> Never <input type="checkbox"/></p>
Q9	<p>Please rank these types of software in the order in which teachers most often use with their students in Mathematics. i.e. 1 for most often, 2 for next etc. Leave blank any you do not use.</p> <p>Mathematics program Spreadsheet Database Data handling Logo Mathematics Game Other _____</p>
Q10	<p>Please rank these mathematics strands in the order in which teachers most often use computer software in Mathematics. i.e. 1 for most often, 2 for next etc. Leave blank any you do not use.</p> <p>Number Statistics Geometry Algebra _____ Measurement</p>
Q16A Q16B	<p>Would you like computers to be used more often in Mathematics at your school?</p> <p>If you answered yes to Q16A, what do you see as obstacles? Please tick.</p> <p>Yes <input type="checkbox"/> No <input type="checkbox"/></p> <p>Myself Lack of training School policy Government policy</p> <p>Availability of software Availability of Internet access Lack of technical support Availability of computers</p> <p>Other(s) _____</p>

Figure 1. Sample questions from the 2002 primary teacher computer use survey.

Now 68 schools (78.1%) have 20 or more computers with 27 (31.0%) having 50 or more and 4 schools have more than 100 computers. Also 71% of the schools now have a computer or ICT room. In one school there were 200 school computers and another 300 laptops belonging to students, who were all encouraged to obtain one. 10% of teachers themselves now have access to a laptop computer in the school. One reason for this growth in the numbers of computers in primary schools is the support of the New Zealand government, which has pushed a considerable amount of funding into getting computers into schools. The question arises though as to whether these increased numbers of computers have changed the pattern of use in the teaching of mathematics, remembering that in most of these schools the teachers will be general teachers who teach all curriculum subjects.

COMPUTER USE IN MATHEMATICS TEACHING

Although access to computers is now relatively good for teachers and students, only 3% of schools said that all of their teachers use software with students in their mathematics programme and 15% said that most do. A large proportion of schools (70%), said that only some teachers at their school use software in mathematics, and 12% of schools did not use any software at all. When those who did use the computer were then asked how often they used it in their teaching the results were as shown in Table 1. From this we can see that there has been an increase in the frequency of computer use in mathematics. Now 3.4% claim to use the computer every day, and the number using them at least once a month has risen from 45.2% to 76.6%.

Table 1: Primary Teachers Using Computers in their Mathematics Teaching

Amount of Use	% of 1995 teachers (n=1500)	% of 2002 teachers (n=84)
Every day	---	3.4
At least once a week	31.9	43.7
At least once a month	13.3	29.5
At least once a term	11.5	11.4
At least once a year	3.2	6.9

The mathematics curriculum in New Zealand schools is divided up into strands, with the content being Number, Statistics, Geometry, Algebra and Measurement, along with a Processes strand. An emphasis on number work in the primary school is to be expected, and even in 1995 a sizeable proportion (83%) was using computers in the number strand content area in the schools, and this has continued with little change into 2002 (now 80% — see Table 2).

Table 2: Curriculum Areas where Primary Teachers are Using Computers

Area of Use	% of 1995 teachers (n=915)		% of 2002 teachers (n=84)	
	Some Use	Most Often Used	Some Use	Most Often Used
Number	83	59	80	62
Geometry	51	10	52	1
Statistics	45	11	64	22
Measurement	30	2	40	1
Algebra	25	2	44	0

Results based on replies to Q10 in Figure 1.

There has been, according to these figures, an increase in the use of computers for the learning of Statistics, Measurement and Algebra in the primary school over this period, with Statistics leading the way. This not surprising since there is a strong emphasis on Statistics in New Zealand schools (Statistics is seen as a separate subject from Mathematics in New Zealand), and it lends itself readily to an approach where the computer can be used to perform routine calculations such as means as well as investigational work.

To gain some idea of the variety of uses that computers are being put to in primary schools we asked the teachers to rank in order of regularity of use the types of software they employed in teaching mathematics (see Q9 in Figure 1). The results from each of the two surveys can be seen in Table 3.

In the first survey the most common use of software was mathematical programs. However, there was some doubt as to what type of programs these might be. This time we also included the option of mathematics games, and while many teachers (61%) also use other programs, it is these games that are the most popular choice, with 78% of teachers making some use of them.

Table 3: Types of Software Primary are using with Computers

Area of Use	% of 1995 teachers (n=915)		% of 2002 teachers (n=84)	
	Some Use	Most Often Used	Some Use	Most Often Used
Mathematical Programs	78	56	61	25
Word Processing	43	19	2*	1*
Graph Drawing Package	27	7	---	---
Database	23	5	32	1
Spreadsheet	22	6	59	14
Data Handling Package	12	1	20	0
Mathematics Games	---	---	78	45
Logo	---	---	10	2

*Likely to be an underestimate since it was not included in the options given.

This could be an interesting area for further research, since although it is possible to make good use of games in mathematics learning it is also very easy to use them simply in a drill and practice mode. As Noss and Hoyles (2000, p. 219) observe about computer games, they "typically cast children in the role of game-player, playing according to the rules programmed by someone else - a situation which however motivating sets strong boundaries around what might be learned." Research such as that of Moseley, Mearns and Tse (2001) supports this view and suggests that there are possible detrimental effects from the playing of computer games in primary schools. Noss and Hoyles' (2000) solution is to allow students to interact with games where they are in control, programming attributes and functions in Microworld-like games software.

It is also noteworthy that the use of the spreadsheet has also increased, with 59% (up from 22%) of teachers now making some use of them. The most surprising thing about this is that 41% of the teachers never use a spreadsheet in their mathematics teaching,

even though the program is virtually always provided along with the computer. It seems that the spreadsheet is still very much under-appreciated as a freely available resource. The increase in the use of statistical data handling programs is not unexpected.

OBSTACLES TO COMPUTER USE

In the original survey 93% of the primary teachers responded that they would like to use computers more in their mathematics teaching, and in the latest survey 95% agreed with this sentiment. Since this must mean that a proportion of the teachers who are not currently using computers very much would like to, we are led to ask 'what factors do they perceive as preventing them from doing so, or are preventing them from making greater use?' The results from the two surveys on this aspect are shown in Table 4.

In 1995 there were two areas where the teachers wanted to see improvement in order to reach their goal of using computers more. They were the provision of resources, in terms of available hardware and software and the increasing of their confidence through satisfactory training.

Table 4: Obstacles Preventing Teachers Using Computers More in their Teaching

Obstacle	% of 1995 teachers (n=1500)	% of 2002 teachers (n=87)
Available Software	65	49
Available Computers	57	36
Lack of Training	56	41
Lack of Confidence	41	6
Government Policy	12	8
School Policy	9	0
Lack of technical support	---	25
Time, etc	---	13

In addition 8.3% of primary teachers in 1995 mentioned some other obstacle; in 2002 18% mentioned unavailability of the internet as an obstacle.

In 2002 more teachers see themselves as confident in computer use, which is possibly a natural consequence of the wider use of computers in society, but their concerns still surround the provision of resources and suitable training. While the percentages in each category have fallen over the seven years, 49% continue to perceive a lack of software as a barrier to increased use. It may be that through professional development along with better sharing of ideas and resources they could be directed to employ what others are using, such as spreadsheets. Certainly, with 41% citing it as a need, the provision of suitable in-service training for primary teachers is still a particular area needing to be addressed. In later discussion with a small group of the teachers it emerged that very little, if any, of all the professional development they had received had been targeted at teaching mathematics with computers. Instead the technology assistance had been too general to be of real help in mathematics.

It is somewhat surprising in view of the numbers of computers in the schools that 36% are still citing a lack of computers as a barrier to improving application of computers in their classroom. However, this may be a consequence of the increase of ICT rooms and may refer to an access problem rather than anything else. This time around 25% mentioned a lack of technical support and 13% mentioned a lack of time as factors

preventing them using the computer more. The former may mean that computers are too often out of action, while the latter is a measure of the increasing pressure that teachers are under in today's schools.

GROWTH OF INTERNET USE

In 1995 use of the internet in primary schools was so rare (if it existed at all) that there were no questions asked in our survey about it. However, in the latest survey we did question schools about their access to the internet and the type of sites they made use of. 71% of the teachers have access to the internet in their own classroom, and 69% in an ICT room. Of these 20% had access only in the classroom and 18% only in an ICT room. Figures were very similar for student access and it seems access for teachers is also open to students. When it comes to using the internet in teaching mathematics though 44% never used it, and only 26% used it at least once a month. On closer inspection it appears that the teachers rarely used the internet as a tool for mathematics learning, but most used it as a resource base and as a support for their own professional development, citing: professional support and communication; preparing mathematics lessons and units; and preparing learning resources, such as accessing problem solving ideas. When the internet was used in the classroom it was nearly always for drill and practice games.

CONCLUSIONS

While the second survey is somewhat smaller in size than the first it does represent a larger number of teachers than the 87 schools suggests. However, some caution should still be exercised on the interpretation of the results. Over the period of seven years we believe we can say that there has been:

- A huge increase in the numbers of computers in primary schools.
- An increase in the number of teachers using computers and in the frequency of computer use.
- A change from solely classroom use to a mixture of classroom and ICT room use.
- A small growth in the use of laptops, with these now available to 10% of staff.

In spite of this progress in the hardware provision and use of computers there appear to have been relatively few changes in the curriculum areas where computers are used or in the type of programs used with the computer. However, the primary teachers are:

- Still using mathematical games and programs, often in a drill and practice manner.
- Increasing in the use of the spreadsheet, although 41% still never use them.
- Using the computer more for algebra, statistics and measurement.

While most teachers (79%) believe that the use of computers can significantly enhance student learning in primary/intermediate mathematics a minority (15%) do not accept this. Although many felt that computers could enhance learning in primary mathematics, many did not really know how, or how to overcome the barriers to increased use. Apart from an increased personal confidence in the use of computers the following barriers remain, or have more recently appeared:

- Lack of available software and hardware.
- A lack of suitable training on using the computers in primary mathematics teaching.
- Insufficient technical support.
- A lack of time for learning and proper lesson preparation.

Hence, there is still a clear need to address the provision of primary teacher in-service training specifically aimed at the teaching of mathematics with computers. One method of training attempted in a study by Ainsworth, Grimshaw & Underwood (1999) was the creation by inexperienced primary teachers of Intelligent Tutoring Systems for use in their classrooms. The research showed that it is possible for teachers to construct systems matching the needs of their students even when they have had no previous experience in computer-based work. Certainly our research shows little progress in this area has been made in New Zealand over the past seven years, and if the training and resources teachers need, and are asking for, are not provided then it will lead to increased frustration and a loss of enthusiasm for technology on the part of teachers (Dunn & Ridgway, 1994).

References

- Ainsworth, S., Grimshaw, S., Underwood, J. (1999). Teachers implementing pedagogy through REDEEM, *Computers and Education*, 33(2-3), 171-187.
- Askew, M., & Wiliam, D. (1995). *Recent research in mathematics education 5-16*, London: OFSTED.
- Department for Education (1995). *Statistical Bulletin*, 3/95, Darlington, UK.
- Dunn, S., & Ridgway, J. (1991). Computer use during primary school teaching practice: A survey, *Journal of Computer Assisted Learning*, 7, 7-17.
- Dunn, S., & Ridgway, J. (1994). What CATE Did: An exploration of the effects of the CATE criteria on students' use of information technology during teaching practice, *Journal of Information Technology for Teacher Education*, 3(1), 39-50.
- Ely, D. P. (1993). Computers in schools and universities in the United States of America, *Educational Technology*, 33(9), 53-57.
- Maddux, C. (1994). Integration is the only option we have, *Journal of Information Technology for Teacher Education*, 3(2), 129-133.
- Moseley, D., Mearns, N., & Tse, H. (2001). Using computers at home and in the primary school: Where is the added value? *Educational and Child Psychology*, 18(3), 31-46.
- Niederhauser, D. & Stoddart, T. (2001). Teachers' instructional perspectives and use of Educational Software, *Teaching and Teacher Education*, 17(1), 15-31.
- Noss, R. & Hoyles, C. (2000). Changing the rules: Children, creativity and computer games, In M. O. J. Thomas (Ed.) *Proceedings of TIME 2000 an International Conference on the Technology in Mathematics Education*, Auckland, 219-225.
- Ruthven, K. & Hennessy, S. (2002). A practitioner model of the use of computer-based tools and resources to support mathematics learning and teaching, *Educational Studies in Mathematics*, 49, 47-88.
- Thomas, M. O. J. (1996). Computers in the Mathematics Classroom: A survey, *Proceedings of the 19th Mathematics Education Research Group of Australasia Conference*, Melbourne, Australia, 556-563.
- Thomas, M. O. J., Tyrrell, J., & Bullock, J. (1996). Using computers in the mathematics classroom: The role of the teacher, *Mathematics Education Research Journal*, 8(1), 38-57.
- Veen, W. (1993). The role of beliefs in the use of information technology: Implications for teacher education, or teaching the right thing at the right time, *Journal of Information Technology for Teacher Education*, 2(2), 139-153.