

Computers in the Mathematics Classroom: A Survey

M.O.J. Thomas

The University of Auckland

In this paper a quantitative analysis of the results of a nationwide survey into the use of computers in New Zealand primary and secondary classrooms is described. The hardware and software distribution and pattern of classroom use in mathematics is outlined. The reasons teachers perceive for not being able to make even greater use of both calculators and computers in their mathematics teaching raises some important issues which have strong implications in terms of school funding and teacher training.

Introduction

The computer's potential for improving students' understanding of mathematics has long been discussed. In spite of this potential, a review of recent research in mathematics education in the 5-16 year old age range, (Askew and Wiliam, 1995, p.34) said of the UK position "Although computers have been in use in mathematics education in this country [UK] for well over twenty-five years, the pattern of usage is still very varied and very sparse."

A recent United Kingdom department of education report (DFE, 1995) reported the same low level of usage of computers in mathematics, with an average of 15.6 minutes of lesson time per week spent using the computer. In the United States the position on computer use, described by Ely (1993) is very similar. This study aimed to address the question of why the computer has not been more widely influential in the teaching of mathematics by discovering the pattern of use, and the factors influencing it, in New Zealand schools.

Method

A questionnaire about the use of, and attitudes to, calculators and computers in mathematics teaching was sent out in January 1995 to every school in New Zealand. Although having much in common, the primary and secondary school questionnaires were tailored to the different circumstances in each type of school. The questionnaires were in two parts; one for information on the school and the other for the perspectives of the teachers. Part one was filled in by the person responsible for mathematics in the school and they were encouraged to ask all the other mathematics teachers to fill in part two. The quantitative data from the questionnaire's closed response questions was coded and analysed using the spreadsheet Excel. The qualitative data gathered from the open response questions has been entered into the NUD.IST software package and is currently being analysed there.

The Samples

Replies were received from 480 of the 2471 schools (19.4%) in the primary/intermediate sector and 90 of the 336 schools (26.8%) in the secondary sector. For the 480 schools represented in the first questionnaire responses, 45% were from primary schools, 44.6% from full primary, 6.3% intermediate. The mean number of students was 179, with 24.7% of schools having fewer than 50 students and 20.7% having more than 300. Of the 90 secondary sector schools, 13% were all boys schools, 25% all girls and 59% co-educational. Their mean size was 622 students, with 17.8% of schools having fewer than 300 students and 28.9% more than 900 students.

This discussion is based on 1500 replies from teachers in 480 primary/intermediate sector schools and 339 teachers in 90 secondary sector schools. Of the primary school teachers 25.2% were male and 74.8% female, with a mean age of 39.9 years, whilst the

secondary teachers were 51.5% male and 48.5% female, with a mean age of 41.5 years. This sample is large enough to be representative of what is happening in schools, and it was pleasing from this standpoint to see that those not using computers in their teaching were well represented.

Results

When the teachers were asked if they use computers at all in their teaching, 38.7% of primary and 32.8% of secondary teachers said that they did not, however this primary/secondary difference is not statistically significant. 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.

Table 1. Primary and secondary teachers using computers in their mathematics teaching

Amount of Use	% of primary or intermediate teachers (n=1500)	% of secondary teachers (n=339)
At least once a week	31.9	5.9
At least once a month	13.3	19.2
At least once a term	11.5	26.5
At least once a year	3.2	16.2

This summary gives a rather less encouraging picture of computer use than the broad question of whether or not one uses a computer. Only 45.2% of primary and 25.1% of secondary teachers use the computer at least once month. We note that significantly more of the primary teachers than secondary use the computer at least once a week (χ^2 , $p < 0.0001$). One reason for this higher use in primary schools is likely to be the different accessibility of the computers. In primary schools, 93.3% use computers in their own classroom, whereas 89.1% of secondary teachers usually use a computer room. An obvious conclusion is that if the computer is available in the mathematics room it is more likely to be used in teaching. The pattern of computer use among the teachers, the curriculum areas are they using the computers for and the types of software are they using are shown in tables 2 and 3.

The emphasis on number work in the primary school is to be expected, though it is pleasing to see a sizeable proportion using computers in each curriculum content area in these schools. In secondary schools the emphasis is on graphical work and statistics, and the decline in use for measurement is not surprising.

Table 2. Curriculum areas where primary and secondary teachers are using computers

Area of Use	% of primary or intermediate teachers (n=915)		% of secondary teachers (n=229)	
	Some Use	Most Often Used	Some Use	Most Often Used
Number	82.7	59.2	41.0	12.2
Geometry	50.9	10.1	34.1	4.8
Statistics	44.9	11.1	75.1	38.0
Graphical work	44.6	13.3	74.2	35.4
Measurement	29.7	2.4	16.6	1.3
Algebra	24.8	2.0	32.3	4.8
Trigonometry	–	–	22.7	3.1
Calculus	–	–	24.0	3.9

Table 3. Types of software primary and secondary teachers are using with computers

Area of Use	% of primary or intermediate teachers (n=915)		% of secondary teachers (n=229)	
	Some Use	Most Often Used	Some Use	Most Often Used
Mathematical Programs	77.9	55.8	61.1	25.8
Word Processing	42.6	18.6	23.1	3.5
Graph Drawing Package	27.4	7.0	61.1	22.3
Database	22.5	4.5	14.0	0.9
Spreadsheet	22.2	5.9	67.2	31.9
Statistics Package	11.6	1.3	44.1	11.8

In addition 7.4% of secondary teachers said that they used desk top publishing software.

Many of the aspects of this pattern of software use are not surprising. Specific mathematical programs are widely used at primary level and continue to enjoy widespread use in secondary schools. The significant (χ^2 , $p < 0.0001$) increase in the use of the spreadsheet in the secondary classroom is a move from content-oriented software toward a generic type. What is not clear and requires investigation is the types of use to which spreadsheets are being put. A previous year long study (Barton *et al*, 1994) suggested strongly that teachers may have little idea of how to extract the mathematical value of spreadsheets. The results also show a significant increase in the use of graph drawing packages (χ^2 , $p < 0.0001$) and statistics programs (χ^2 , $p < 0.0001$) in the secondary years. It is interesting too to note that 44.9% of the primary teachers use the computer for statistics but only 11.6% use a statistics package. Similarly in secondary schools, the corresponding figures are 75.1% and 44.1%. Thus quite a proportion of the statistics is taking place on generic or other software rather than specifically written statistics software.

How do teachers organise their lessons around the computer use? We can get some idea of what is happening in the classroom by looking at table 4, which describes the methods of using the computer. One might expect teachers to use the computer either to attempt to improve students' skills or to allow them to investigate and solve problems, but not to do both. However, it would appear that a substantial proportion of teachers in both primary and secondary sectors use both methods and do not see themselves as on one side of a dichotomous ideological fence. The continuing decline in the time spent on programming in the secondary school is evident from the low percentage of teachers (8.7%) promoting this. Although this is understandable there is evidence that programming may encourage the formation of mathematical thinking (e.g. Pea & Kurland, 1984).

Table 4. Methods which primary and secondary teachers are using computers in their teaching

Method	% of primary or intermediate teachers (n=915)		% of secondary teachers (n=229)	
	Some Use	Most Often Used	Some Use	Most Often Used
Skill Development	68.3	36.3	67.7	37.6
Free Use	63.0	19.2	34.9	3.1
Investigations/PS	62.6	28.7	68.6	38.4
Demonstrations	19.3	2.7	40.6	10.9
Programming (inc. Logo)	23.1	7.8	8.7	1.3

The significant drop (χ^2 , $p < 0.0001$) in the amount of free use allowed by secondary teachers and a corresponding significant increase (χ^2 , $p < 0.0001$) in the use of demonstrations is interesting. The reasons for this need further investigation but may involve both classroom management and computer access issues.

Reasons For Not Using the Computer

It was very encouraging to see that 92.6% of the primary teachers and 93.5% of the secondary teachers responded that they would like to use computers more in their mathematics teaching. Hence a large proportion of the teachers at both levels who are not currently using computers would like to. What factors do they perceive as preventing them from doing so? They were asked several questions designed to discover what they saw as being at the root of the problem. Firstly they were asked about obstacles to their use of the computer. Their replies are summarised in table 5.

Table 5. Obstacles which primary and secondary teachers perceive as preventing them personally from using computers in their teaching

Obstacle	% of primary or intermediate teachers (n=1500)		% of secondary teachers (n=339)	
	First Mentioned (%)	Mentioned (%)	First Mentioned (%)	Mentioned (%)
Available Software	28.3	64.9	17.4	52.5
Available Computers	33.4	56.9	43.7	67.8
Lack of Training	22.2	55.5	17.4	45.4
Lack of Confidence	12.6	41.0	12.7	34.8
Government Policy	2.6	12.0	4.1	12.4
School Policy	0.3	8.7	0.6	8.0

In addition 13% of secondary and of 8.3% of primary teachers mentioned some other obstacle.

The pattern here is dramatically clear, with a very uniform response. As far as teachers are concerned there are two areas where they would like to see improvement in order to reach their goal of using computers more. They are the provision of resources, in terms of available hardware and software and the increasing of their confidence through satisfactory training. However, there is a slightly different emphasis at each level. In primary schools lack of software is significantly (χ^2 , $p < 0.001$) more of a problem than in secondary schools, where computer availability is significantly worse (χ^2 , $p < 0.001$). Also lack of training and confidence is considered significantly more of a problem (χ^2 , $p < 0.001$) for primary teachers. These figures indicate that primary school teachers feel in even greater need of assistance and training than secondary teachers. The provision of suitable inservice training for primary teachers is thus a particular area which needs to be addressed. Later in the questionnaire the teachers were also asked rate on a Likert scale their level of agreement with what might prevent mathematics teachers in general from using computers. Some of the responses here are summarised in table 6.

Table 6. Obstacles which primary and secondary teachers perceive as preventing teachers in general from using computers in their teaching

Obstacle	% of primary or intermediate teachers (n=1500)		% of secondary teachers (n=339)	
	Strongly Agree (%)	Agree (%)	Strongly Agree (%)	Agree (%)
Lack of good ideas	4.7	31.2	7.1	33.9
Classroom management	7.3	30.3	7.1	39.8
Lack of software	16.1	44.2	13.9	36.9
Keeping discipline	1.4	5.4	1.5	5.6
Teacher confidence	17.1	55.1	15.0	56.0
Assessment not compulsory	—	—	2.7	16.8
Computers of little benefit	0.5	0.9	0.3	4.4

Lack of Confidence and Training

A comparison of tables 5 and 6 reveals that whilst 41% of primary teachers think that lack of confidence is an obstacle to their use of the computer, 72.1% agree that it is a problem for teachers in general. Similarly 34.8% of secondary teachers admit to this as a problem for themselves but 71% agree that it is a problem for teachers in general. These figures could well show a reluctance to admit to personal feelings of lack of confidence, but they certainly highlight the way that teachers in both sectors rate this as a serious obstacle to computer use in the teaching profession. The type of training which might help to alleviate this feeling can also be discerned in the above table. Teachers do not see keeping discipline in the classroom as a problem, but 37.6% of primary and 46.9% of secondary teachers do think that the management and organisation of their classroom around the use of the computer is an area they would like assistance with. Similarly 35.9% of primary and 41.0% of secondary teachers would welcome some training which would give them good ideas to use in their classroom, and 60.3% and 50.8% respectively want to know about good software they can make use of. These figures agree well with findings of Thomas *et al* (1995), who, in a year long study of teachers using computers in their classroom found that the upheaval resulting from the computer presence had several components, including finding a place (in more than one sense) in the classroom for the machine, considering the need to extend one's classroom management techniques and recognising some of the implications of electronic technology for school mathematics.

This survey did uncover some gender differences in what are perceived to be obstacles to computer use, as table 7 shows. We see from this summary that, in primary schools, while there is no significant difference between genders on the need for more

Table 7. Gender differences in perceived obstacles to computer use

Obstacle	% of primary or intermediate teachers (n=1487)		% of secondary teachers (n=299)	
	Female (%)	Male (%)	Female (%)	Male (%)
Available Software	64.5	68.3	65.5	53.9
Available Computers	54.9	65.1	84.8	69.4
Lack of Training	56.9	53.3	66.2	37.7
Lack of Confidence	43.5	34.9	51.7	27.9

software and more training, significantly more female teachers than males see their lack of confidence as a problem (χ^2 , $p < 0.01$), while significantly more male teachers than female view a shortage of computers as an obstacle (χ^2 , $p < 0.01$). In secondary schools significantly more female teachers than males cite each of the obstacles: software (χ^2 , $p < 0.05$); computers (χ^2 , $p < 0.01$); training (χ^2 , $p < 0.001$); and confidence (χ^2 , $p < 0.001$). It is difficult to attach any reasons to these differences without further investigation and this will be something which the interviews with the teachers will address.

Hardware Availability

56.9% of primary and 67.8% of secondary teachers cite a lack of available hardware as an obstacle to its use. In primary schools, the mean number of computers per school reported was 7.0, giving 1 computer for every 25.6 students, and while 2.9% of the schools claimed to own no computers at all, 22 schools (4.6%) had 20 or more and two schools, of more than 500 students, had 40 and 41 computers respectively. Although 40 of the schools have a computer room, of the 61.3% of teachers who used computers in their teaching, 93.3% use computers in their own classroom, with 82.4% of these usually having only one computer available in their room. The teachers generally see this as insufficient and are asking for more computers in their classroom.

In secondary schools the distribution of computers is rather different. The mean number of computers per school reported was 39.9, giving 1 computer for every 15.6

students, and this compares well with the 1994 New Zealand department of education figures of 1 for every 17 students. However, of these 40 computers in the school, only 1.7 are in the mathematics department, the rest are in the 1.8 computer rooms which the schools average. Thus 89.1% of secondary teachers using computers usually do so in a computer room. Clearly access to these rooms is a problem for many though. 44.5% said that the room was difficult to book and so they seldom used it. This issue of access to the computer is very important. It is apparently unhelpful to fill a school with computer suites full of computers if the mathematics staff find that competition to use the room is so strong that they are often unable to take their classes in.

When heads of departments and those responsible for mathematics were asked, in an open response question, what they saw as obstacles to the implementation of computers in their schools they gave the answers recorded in table 8.

Table 8. Obstacles which primary and secondary teachers responsible for mathematics perceive as preventing them from implementing computers in teaching

Obstacle	% of primary or intermediate teachers (n=480)	% of secondary teachers (n=90)
	Mentioned by (%)	Mentioned by (%)
Access to Computer Room	0.0	51.1
Lack of Training/Confidence	49.6	45.6
Lack of Time	30.0	32.2
Lack of Money	34.4	25.6
Lack of Software	16.7	18.9
Lack of Computers	20.4	16.7

Apart from confirming the pressing need to increase teachers' confidence by proper training, these replies demonstrate another important reason why school teachers are saying in such large numbers that a shortage of hardware and software is an obstacle for them. Many say that the funds are not available to purchase these items. Whilst this is not a new problem for schools it is an issue which clearly needs to be addressed by those who allocate funds. Allied to this deficit in funding is the pressure of time which these teachers feel under. Nearly a third of them feel that they do not have time to implement computer use to the extent which they would like. This problem too appears to be one which is primarily due to funding constraints. If wider and better computer use is to be achieved then adequate funding needs to be made available to schools to allow teachers to be released for both training and implementation. Clearly teachers view this as desirable, since so many would like to use computers more and, as we see from table 6 above, only 1.4% of primary teachers and 4.7% of secondary teachers see computers as being of little benefit in their teaching. Research has suggested that if the resources they are asking for are not provided then it leads to frustration and a loss of enthusiasm on the part of teachers (Dunn & Ridgway, 1994), so that the matter is urgent.

This data analysis raises many other questions which are being explored. For example, are there any significant differences in the pattern of computer use between different types of schools, schools with different types of computers in use, teachers of different ages, teachers who have been involved in professional development in computer use, and other variables, etc.?

Discussion

What then are the implications of this study? Outstandingly it seems that more funding for computers and for training seems necessary. However, it has been observed that computers alone will not bring change in the classroom. Rather, the beliefs and attitudes of the teachers themselves seem to be major elements, since teachers have a crucial role to play (Lai, 1993; Collis, 1993). Teacher factors appear to outweigh school factors (Veen, 1993), and, as Maddux (1994) describes, information technology will remain relatively unimportant until all teachers incorporate it successfully into their

teaching. Carey and Sale (1993, p.191) agree with the need for both training and support for teachers as a primary concern:

. . .the study. . .does give educators reason to doubt that the computer is a sufficient catalyst for changing teachers into coaches and facilitators without deliberate, well-planned efforts to provide training and support for such teaching modes and for moving towards teacher education that addresses the role of the teacher as well as the role of the computer.

Veen (1993) too makes the observation that change which requires teachers to alter their beliefs and practices will only come very slowly. Thomas *et al* (1995) showed that it took a year for teachers to change their mindset, even when they were using the computer in their classroom.

What type of training is needed? I have outlined above some things that the teachers said that they thought they needed from training:

- improved confidence in using computers
- better classroom management with computers
- clearer understanding of good software available
- good ideas for the classroom use of computers

Dunn and Ridgway (1991) have also identified a lack of teacher confidence as a major reason for teachers not using computers. They found that when student teachers actually used the computer in their teaching practice 59% of them gained in confidence and they conclude that "the college course should seek to build up personal confidence to the level where students are happy to use computers during their teaching practice, and that confidence is likely to be increased by classroom uses of IT." (ibid, pp. 13,14). Monaghan (1993) concluded that teacher training should encourage students to avoid viewing computer use as an optional extra. Clearly teacher training must address the vital issue that it is primarily the classroom use of computers which can improve teacher confidence. According to Mellar and Jackson (1992, p.242), the type of training teachers need agrees with that described in this study, namely ". . . courses aimed at the educational issues - the ways computers can be used in teaching, managing the use of the computer in the classroom, and the role of the computer in aiding learning."

Dunn and Ridgway (1994, p. 48) also describe how teachers need training in the educational use of software: "More remains to be done, however, in improving students' understanding of the educational purposes of the software they are using, and to broaden the range of programs with which the majority. . .feel confident." They suggest that increasing the confidence and expertise of the tutors in the training colleges is an important element of this process. Maddux (1994, p.132) goes so far as to say that, in some countries, this is the primary goal:

The only solution involves convincing the entire teacher education staff and administration that computers can and should play an important role in all teacher education courses. This goal should be the primary goal of those of us in teacher education who believe that technology has the potential of revolutionizing teaching and learning. . . It seems obvious that until all or most teacher educators in teacher education institutions take technology seriously, our student teachers are unlikely to do so.

It is worth noting that of the 36 newer secondary teachers in this survey, between 21 and 30 years of age, only one would not like to use the computer more in their teaching but 33.3% cited lack of confidence and 44.4% lack of training as obstacles to such use.

Although change may come slowly, with evidence that it takes teachers up to a year to change their view of computers, the direction of change can be influenced if all involved act decisively (Fullan, 1991; Thomas *et al*, 1995). Teachers and teacher educators need to be aware of the changes that are needed and implement them together, so that the full benefits of computers will accrue in our mathematics classrooms.

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