A SURVEY OF TECHNOLOGY USE: THE RISE OF INTERACTIVE WHITEBOARDS AND THE MYMATHS WEBSITE

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This study reports the results of a pilot survey of UK mathematics teachers' technology use (n = 89) in secondary schools. Previous surveys are confused by a lack of differentiation between hardware and software use. This survey aims to provide insight into the types of software teachers choose to use in conjunction with particular types of hardware. Teachers were asked about their access to hardware and software; their perception of the impact of hardware on students' learning; the frequency of their use of ICT resources and the factors affecting their use of ICT.

Keywords: technology, teachers, interactive whiteboards

INTRODUCTION

The survey reported in this paper aims to explore the types of software teachers choose to use with different types of hardware and the frequency of their use. The survey was conducted as a pilot study to test the feasibility of a large-scale survey of UK mathematics teachers' technology use and to inform the future collection of qualitative data to contextualise and validate survey findings. The large-scale survey will form part of a wider study into how Information and Communication Technologies (ICT) are used in mathematics teaching and how teachers' perspectives and practices have changed as a result of the introduction of the UK National Curriculum 2007.

Governments around the world have made huge investments in ICT for education (Selwyn, 2000). Despite these investments, the TIMSS 2007 study (Mullis et al, 2008) reports that using computers for any activity as often as in half the mathematics lessons was rare, even in countries with relatively high availability. In the UK, Ofsted (2008) report that opportunities for pupils to use ICT to solve or explore mathematical problems had markedly decreased over the previous seven years of unprecedented investment in technological infrastructure. The gap between investment in ICT and the reality of its use in classrooms seems clear. Investigating the choices teachers make about the technology they use in their classrooms is important in order to understand the apparent failure of ICT to make an impression on school mathematics.

TEACHERS' CHOICES: HARDWARE AND SOFTWARE

The type of hardware and its deployment appears to be an important factor in structuring teachers' choices about technology use in their classroom practice (Ruthven, 2007). In particular, the hardware available affects the types of classroom organisation possible and the nature of pupil interactions with any software used in conjunction with the hardware. It seems reasonable then that the available hardware might also affect teachers' choice of software and how they choose to integrate the use of such software into their classroom practice.

Currently, little is known about what types of software teachers choose to use with particular types of hardware. In terms of hardware, the UK represents a special case since it became the first school-level market to invest heavily in interactive whiteboards (IWBs) (Moss et al, 2007). However, large-scale surveys of technology use within the UK have tended not to report in detail on technology use within subject areas, such as mathematics, nor to differentiate sufficiently between hardware and software use. Thus whilst such surveys provide a broad picture of technology use, they have not provided much insight into the nature of the specific uses by teachers in general or by mathematics teachers in particular. For example, the annual Becta schools survey *Harnessing Technology* reports that 53% of mathematics teachers use subject-specific software in half or more lessons (Kitchen et al, 2007). However, no further detail is given on what types of subject-specific software are used, nor an indication of the hardware involved. Surveys focusing on mathematics teachers' use of technology, such as the survey conducted by Hyde (2004), give a more detailed picture of the types of software used by mathematics teachers; however, this picture is again confused by the lack of differentiation between hardware and software use. Building on such surveys, this study aims to provide insight into the types of software teachers choose to use in conjunction with particular types of hardware. Further, this study aims to investigate the practices of ordinary teachers in ordinary classrooms, continuing the line of research suggested in Bretscher (2009).

THE SURVEY

The questionnaire design was informed by previous surveys of mathematics teachers' use of ICT, primarily Hyde's (2004) survey of mathematics teachers in Southampton and Forgasz's (2002) survey of mathematics teachers in Victoria, Australia. The questionnaire used both closed and open-ended response formats and contained sections on (a) *About you* - personal details; (b) *ICT in your school* - access to hardware/software and integration of ICT within the department; (c) *ICT use in your own mathematics teaching* - perceived impact and frequency of use of hardware and software; and (d) *Your beliefs about teaching and learning mathematics with ICT* - factors influencing the use of ICT. In line with the aims of this survey and in contrast to Hyde's (2004), teachers were asked separately how often they used software in a whole-class context (e.g. with an IWB or data projector) and how often they gave students direct access to the software (e.g. in a computer suite or with laptops). The list of software was derived from Hyde's list with the notable inclusion of the MyMaths.co.uk website since this site was known anecdotally to be widely used in UK schools. The *MyMaths* website is a subscription site offering teachers pre-planned lessons, on-line homework and many other resources. The lessons and homework are linked to an "Assessment Management system", allowing teachers to track individual students progress.

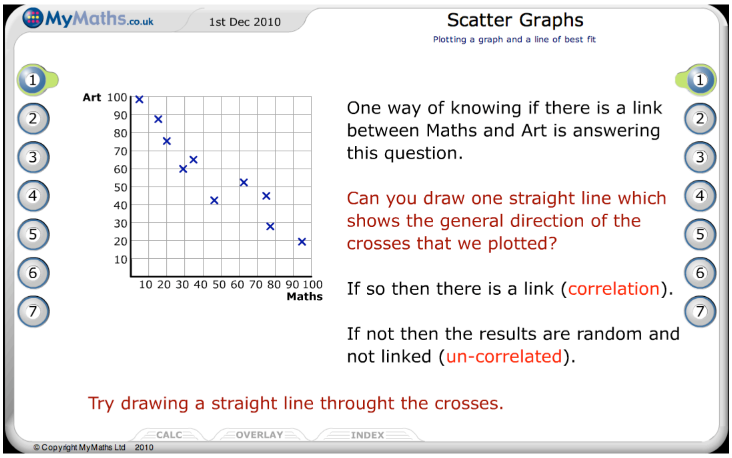

Figure 1. Screen snapshot of a *MyMaths* sample lesson on scatter graphs.

Ten questionnaires were sent to 27 schools working in partnership with King's College London to offer initial teacher education in secondary mathematics, with 18 schools agreeing to participate in the survey. A total of 89 completed questionnaires were returned, an average of five per school: the lowest number returned by a school was 2 and the highest 9. Since the survey was a pilot study, it was not necessary to select a representative sample of schools. Nevertheless, the participating schools cover a range of characteristics including a wide range of attainment in national tests; some have speciality status and some do not; some are single sex and some are selective. The participating teachers (37 F; 50 M; 2 unspecified) had an average age of 37 years and an average length of service of 10 years. The low percentage of women (42%) is surprising since women tend to outnumber men in teaching. In common with Forgasz' (2002) findings, no obvious differences in ICT use between the genders was found. The majority of respondents (41) described their main responsibility as classroom teacher. The sample also included 10 heads of department, 9 deputy heads of department and 13 Key Stage coordinators. Comparing themselves to their colleagues, 37.1% of teachers thought they used ICT much more or more frequently; only 11.2% thought they use ICT less or much less frequently. This might suggest that the respondents are relatively well-disposed towards ICT or that they wish to be seen as frequent users of ICT.

Data that could be analysed statistically were entered into PASW Statistics 18.0. This package was used to generate descriptive statistics (i.e. frequency distributions and means). Open-ended responses were analysed manually. In tables 1-3 in the results section below, the findings of this survey are compared with Hyde's to give a sense of changes in ICT use over time. Hyde sent one questionnaire to each of the 38 schools working with the University of Southampton to deliver initial teacher education (33 returns). Her results give an overview of departmental ICT use whereas this survey reports individual teacher's responses, thus comparisons should be treated with some caution. Data was unavailable from Hyde's survey for comparison in tables 4 and 5.

RESULTS

Access to hardware and software

Only two schools did not have any IWBs in the mathematics department but each teacher in these schools had access to a data projector. Thus every teacher participating in the survey had access to either an IWB or a data projector. The apparent decline in access to data projectors from Hyde's (2004) survey is likely to be due to the rapid expansion of IWBs over the same period (see Table 1). Only 66% of teachers reported having access to a computer suite shared with other departments. This seems surprisingly low, especially when compared with the coverage of IWBs. In fact, in every school at least one teacher claimed to have access to a shared computer suite. The lack of consistency between teachers in the same school suggest that while some teachers are responding on the basis of the existence of hardware, others are responding according to their perception of availability of the hardware for use. Difficulties in booking computer rooms mean that, although shared computer suites exist, their availability is often severely restricted. The quote below is representative of many teachers' comments on hardware access and neatly summarises the contrast in accessibility between IWBs and computer rooms.

> "Computer room access very limited due to lack of resource in school (and monopoly on it by ICT dept lessons). IWBs readily available in all maths teaching rooms."

Access to hardware	**Bretscher**	**Hyde**
IWB	81	64
Data projector	63	76
Computer suite (shared)	66	-
Computer suite (maths only)	16	-
Laptops	26	-
Graphic calculators	26	94

Table 1: Access to hardware, *n = 89*. Hyde's (2004) figures are shown for comparison. All figures are given in percentages.

None of the teachers from schools with a computer suite dedicated to the mathematics department complained about lack of access to hardware. Although this seems a successful solution to the problem of computer room access, a mathematics only computer suite is still a rare resource (16% have access). Due to their portability, a class set of laptops might be seen as an alternative solution to the access problem.

However, access to laptops is also fairly rare (26%) and comments by teachers suggest they may bring additional technical difficulties:

> "The laptops are of poor quality and not enough for 1 between 2 if you have a full class: there are 14."

The collapse in access to graphic calculators since Hyde's (2004) survey is impressive – this may be the result of their exclusion from A-level module examinations, whereas previously their use had been encouraged. Again there is a lack of consistency over access to graphic calculators between teachers in the same school. In thirteen of the schools at least one teacher said they had access to graphic calculators. The following comment suggests that the low reported access to graphic calculators may reflect a lack of awareness of their existence, rather than difficulties in booking the resource as in the case of computer rooms:

"We do have a department set of graphic calculators (ie. not explicitly for my classes) but they are rarely (if ever!) used."

Access to software was not generally seen as a problem: access to generic software such as word processing and presentational software is almost universal (around 90%) and graphical software (81%) also appears to be readily available. Geometry software appears to have declined slightly (-13%) since Hyde's survey, although the majority of teachers (60%) say they have access. Logo has suffered a sharp decline (-49%). In Hyde's survey, 100% of teachers said websites were used in their school, however no further detail was given. The results from this survey suggest that access to the *MyMaths* website (91%) has risen to near ubiquity - it is possibly the dominant resource designed for mathematics teaching in the UK. It is unlikely that any textbook has such a wide coverage of schools, for example. Some teachers did complain about restrictions on downloading software, such as *GeoGebra*, and access to some websites being unnecessarily blocked. Although software was available, teachers expressed uncertainty over whether it had been installed on all computers, thereby adding complexity to conducting lessons in a computer suite.

> "Some ICT suites do not have all the mathematical software which can mean plans and resources need to be adapted. Must check prior to booking."

For many teachers, the software was readily accessible however they lacked training in its use.

> "Access not a problem – time to train and develop is a problem. Desperately needs a directory/classification system."

The time taken to develop and prepare lessons was seen as a considerable hurdle initially; however, once surmounted, teachers found that the resources could be re-used, thus reducing planning time eventually.

> "Time required to prepare using ICT is a bar to entry however a number of resources I have spent time developing can then be reused very efficiently in other contexts."

Access to software	Bretscher	Hyde
Spreadsheet (eg Microsoft Excel)	92	97
MyMaths.co.uk	91	-
Word processor (eg Microsoft Word)	90	79
PowerPoint	90	79
Email	82	-
Graphing software (eg Omnigraph, Autograph)	81	73
CD-ROMs	67	85
Other websites	67	-
Geometry software (eg Cabri, Geometer's Sketchpad)	60	73
Database (eg Microsoft Access)	37	-
Logo	24	73
SMILE mathematics	17	-

Table 2: Access to software *n = 89*. Hyde's (2004) figures are shown for comparison. All figures are given in percentages.

Software access may present a new issue to consider when applying for a teaching position in the UK. On moving to a new school, one teacher found that his pre-planned lessons had been rendered useless since the IWB software he had used previously was not available. His time investment in planning these lessons had therefore been lost.

> "Tech support have not installed Smart Notebook on the maths dept computers, and I have a lot of Smart Notebook files that I made at my previous school that I can't use now."

Perceptions of the impact of ICT on learning

Teachers were asked whether they agreed with the statement 'ICT resources can help students to understand mathematics'. In response, 97.8% agreed or strongly agreed with the statement. Teachers were also asked to rate hardware on the impact it has on student learning, using the scale in Hyde's survey from 1 (very little) to 4 (substantial). The results shown in Table 3 suggest that teachers' perception of the impact of ICT on learning varies considerably depending on the hardware being used. IWBs had the highest mean impact score (3.21), followed by data projectors (2.84). These items also came top in Hyde's survey although IWBs scored lower (2.95) and data projectors slightly higher (3.04). The reversal in score is likely to be due to the increased availability of IWBs, since they were a relatively new phenomenon in 2004 and comparatively few schools were equipped with them. Graphic calculators suffered a decline in score of 0.33. Perhaps of most interest is that a shared computer suite had the lowest impact score (2.34). A dedicated mathematics computer suite scored more highly (2.57), probably in part due to the greater ease in accessing the hardware. However the low impact score of computer rooms is also reflected in some teachers' negative comments about giving students direct access to the hardware:

> "ICT maths lessons always seem tedious as the students' development is less than in normal lessons. But with *MyMaths*, as a revision/recap lesson, there are benefits now."

> "ICT is generally extremely inefficient."

Not all teachers felt this way, some were more positive although many cited difficulties such as those detailed in the quote below:

> "In our school it is not possible to find a venue where there is one computer per child. Therefore this is a very strong de-motivating factor when planning such lessons as I know the group-work element adds a layer of complexity. If it were guaranteed pair-work I might be more motivated but, for example, I recently tried a lesson like this and ended up with 10 computers between 31 students (the IT suite was supposed to have 16 computers!)."

Undoubtedly problems of access reduce the perceived impact of computer rooms, however the results from this survey suggest that teachers remain sceptical of the educational value of giving students direct access to ICT resources.

Impact	**Bretscher**	**Hyde**
IWB, *n =78*	3.21	2.95
Data Projector, *n =74*	2.84	3.04
Computer suite shared, *n =73*	2.34	-
Computer suite maths, *n =51*	2.57	-
Laptops, *n =57*	2.40	-
Graphic calculators, *n =59*	2.46	2.79

Table 3. Mean impact scores for hardware based on a scale where 1 (very little), 2 (some), 3 (significant) and 4 (substantial).

Frequency of hardware and software use

The majority of teachers use IWBs and data projectors in most lessons. The ready availability of IWBs and data projectors in normal classrooms makes it unsurprising that they are the most frequently used hardware. It is also likely that their high frequency of use contributes to the high impact scores noted in the previous section. Computer rooms shared with other departments have a much lower frequency of use, with 58% of teachers using them once a term or less and only 17% of teachers using them every week or more. As with IWBs, the frequency of use reflects both the accessibility and impact score of shared computer rooms. Computer suites dedicated to the mathematics department appear to have much higher frequency of use than shared computer rooms, with 42% of teachers using them every week or more. This is likely to be the case (despite only *n = 14*) since not only is access easier than with a shared computer room, classes are often purposefully timetabled into mathematics only computer rooms to ensure the use of a relatively rare resource.

Frequency of hardware use	Never	Specific topics	Once a term	Once a month	Every week	Most lessons
IWB, *n =70*	3	1	1	1	10	**83**
Data Projector, *n =55*	7	0	4	0	24	**65**
Computer suite shared, *n =55*	9	20	**29**	25	15	2
Computer suite maths, *n =14*	0	21	7	29	**36**	7
Laptops, *n =23*	26	13	13	9	**39**	0
Graphic calculators, *n =22*	27	**41**	18	0	5	9

Table 4. Frequency of hardware use, with the modal frequency for each item highlighted in bold. All figures are in percentages.

The number of teachers with access to laptops and graphic calculators is quite low (*n = 23* and *n = 22* respectively) so it is difficult to draw any firm conclusions from the figures presented in Table 4. However it is worth noting that despite graphic calculators having a higher impact score than either laptops or shared computer rooms, they appear to have the lowest frequency of use with 68% using them for specific topics only or not at all.

Table 5 compares the mean frequency of software use in lessons with an IWB or data projector to lessons where students are given direct access to the software, i.e. those that take place in a computer room or with laptops. A score of above 2 indicates the software is used more than once a term. Email, databases, SMILE and Logo scored very low in both contexts so no satisfactory comparison can be made for these software packages. PowerPoint was the most frequently used piece of software (3.21) in conjunction with an IWB, closely followed by *MyMaths* (3.01). 'Other websites' and graphing software also scored above 2 for frequency of use with an IWB.

The frequency of use in lessons where students were given direct access to the software was low in comparison to lessons with an IWB: only *MyMaths* had a frequency score above 2. This is unsurprising given the frequency of hardware use in mathematics lessons reported above: computer rooms are used much less frequently than IWBs. However the decrease in use is not uniform across all types of software. In lessons where there is direct student access, most software packages have a frequency score between 0.9 and 1.1 lower than in lessons with an IWB. *MyMaths* had the smallest drop in frequency use between contexts (-0.5) and geometry software fell by 0.74. The frequency score of PowerPoint dropped the most (-2.51). Since the main purpose of PowerPoint is for presentation, it appears well suited to teacher exposition in lessons with an IWB but not so relevant in lessons where students have direct access to the software.

Frequency of software use	**IWB/Data projector**	**Direct student access**
PowerPoint	**3.21**	0.70
MyMaths.co.uk	**3.01**	**2.51**
Other websites	**2.83**	1.82
Graphing software (eg Omnigraph, Autograph)	**2.01**	1.09
Spreadsheet (eg Microsoft Excel)	1.91	0.97
CD-ROMs	1.84	0.74
Word processor (eg Microsoft Word)	1.76	0.84
Geometry software (eg Cabri, Geometer's Sketchpad)	1.44	0.70
Email	0.97	0.45
Database (eg Microsoft Access)	0.90	0.44
SMILE mathematics	0.54	0.37
Logo	0.22	0.25

Table 5. Mean score for frequency of software use with an IWB or data projector compared to use in a computer room where students have direct access to the software. Based on a scale where 0 (never) to 5 (most lessons), *n = 89*.

Thus not only are computer rooms and laptops used less frequently than IWBs: teachers appear to use a smaller range of software in lessons where students are given direct access to the software. *MyMaths* appears to dominate in both contexts, with the exception of PowerPoint being used more frequently with IWBs.

CONCLUSIONS

IWBs are the most accessible hardware and teachers rate them highest for impact on students' learning. Arguably, the introduction of IWBs has coincided with, if not encouraged, the apparent rise of *MyMaths* to near ubiquity in UK classrooms. Whilst positive about ICT resources in general, some teachers appear sceptical about the benefits of giving students direct access to software. Shared computer rooms scored lowest for impact and are used infrequently and although computer rooms dedicated to the mathematics department improve matters, they are still a rare resource. When students are given direct access to ICT, *MyMaths* is the most frequently used resource. The reasons for *MyMaths* apparent dominance requires further research.

Research suggests that the use of IWBs coupled with PowerPoint and pre-prepared lessons of the sort available from the MyMaths website can lead to a reduction in the quality of classroom interactions (Zevernbergen & Lerman, 2008). The Second Information Technology in Education Survey concluded that, given the right conditions, ICT might contribute as a lever for change (Law, 2009). Although the findings presented in this paper should be treated with some caution, they suggest that, in the UK, the conditions may be right for ICT to act as a lever for change in a direction that should be of some concern to both researchers and policymakers.

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