

Spreadsheets in Year 5 Chance and Data: A Professional Development Experience

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Year 5 teachers from eight Brisbane schools took part in a professional development project to encourage them to use spreadsheet technology with their classes. Twelve of the teachers participated in follow-up research to investigate teachers' attitudes and perceptions relating to spreadsheets, implementation methods and uses, and factors that may enhance or hinder acceptance and usage. Results showed that teachers who were more confident of their ability to use spreadsheets were more likely to perceive them as useful in the teaching of Chance and Data, and more likely to use activities that developed higher order thinking. In using spreadsheet technology with their classes, teachers had to overcome a range of personal, technological and school-related problems.

The power of spreadsheets lies in their capacity to take children beyond what can be achieved in the normal classroom with pencil and paper. Spreadsheets permit the exploration of relationships without tedious calculations, and present opportunities for the development of self-directed learning and acquisition of higher order skills such as analysing, interpreting, critical thinking, and question posing.

Such skills are mandatory in current mathematics curricular documents for thinking, working and reasoning mathematically (e.g., NCTM, 2000; QSA, 2004). Technology is perceived as one way to develop these skills: *Students can develop deep understanding of mathematics with the appropriate use of technology ...and allow them (students) to focus on decision making, reflection, reasoning, and problem solving* (NCTM, 2000, Executive Summary). Thus, in a sense, learning with technology replaces learning about technology (Drier, 2001).

An abundance of articles and websites exist to demonstrate ways of integrating spreadsheets into various areas of mathematics, and at various educational levels. In Chance and Data, statistical experiences include data collection, data tabulation and representation, data reduction, and interpretation and inference (Reading, 2002). Multiple data representations and reductions are facilitated through spreadsheet technology, and the insertion of formulas allows numerical and graphical data (e.g., budget data, deforestation rates) to be investigated through *What if?* and *Why* questions, posed by student and teacher. Results of changes are instantaneous, so there is more time for reflection. Without proficiency in the use of spreadsheets as a cognitive tool, teachers cannot advance such use with their classes. In their survey of 400 Australian schools, Russell, Finger and Russell (2000), found that, while most teachers surveyed were proficient in basic computing skills (moving files, creating a document), only 37-43 percent of all teachers surveyed could create graphs or diagrams, or use spreadsheets and databases. Professional development is therefore imperative.

Successful professional development technology-based programs for teachers are well-planned and occur over an extended period of time; involve school principals and homogenous groups of teachers; include hands-on time; provide time for reflection and collaboration; are based on curriculum and student learning, and are embedded in authentic learning situations. (Barnett, 2003; Loucks-Horsley & Matsumoto, 1999; Stephens,

Mandeville, & Matthew, 2002).

Background

The research reported below is an extension of a professional development venture which contained the elements of successful professional development practice summarised above. Teachers of Year 5 in eight Brisbane state schools participated in three inservice workshops and three training sessions over several months on the use of spreadsheets in the Chance and Data strand of the mathematics syllabus. The project was supported by a government grant and initiated by the principals of two of the schools involved. It aimed at increasing the use of computers through the application of spreadsheets in Chance and Data; strengthening teacher's knowledge and understanding of the Chance and Data strand, developing authentic Chance and Data life situations and sharing these online, and strengthening the links between and among the teachers in these schools. The researcher was a consultant for the venture, introduced at the workshop stage to present two seminars and provide a list of suitable spreadsheet websites. The researcher also assisted in the training and discussion sessions. This venture was developed further by the researcher to facilitate more detailed and prolonged observations than the original project could deliver.

Research project. Twelve Year 5 teachers (from six of the original eight primary schools) were interviewed in July and August, two months after the completion of the staff development program. The second interview was to take place at the end of the year, but due to the researcher's illness, survey forms were designed and sent to the teachers instead. The interviews were semi-structured in nature, in that they allowed and encouraged the development of ideas along predetermined broad topics rather than specific questions. Thus they permitted further probing and extension of ideas. To encourage ongoing discussion and contact amongst participants throughout the semester, a Blackboard space was set up on the World Wide Web, to which teachers could add their own spreadsheets, share experiences with each other, and discuss any issues that arose in the teaching or learning of spreadsheets in Chance and Data. Thus the research project contained elements of action learning research, because the teachers as a group were not isolated from each other, they were encouraged to continue to reflect on their teaching, learning from each other and planning future teaching informed from their own experiences and those of others in their group. Student learning was not addressed. A training session to help teachers access and use this site was organised by one of the school principals, but some teachers did not attend. Hence the researcher provided all teachers with step-by step instructions by email, and teachers were provided with individual passwords and usernames. At the time of the first interview, no contributions had been made to the site.

Characteristics of the sample. The majority of teachers in the project were comfortable with using computer technology, such as word processing, emails and the internet. However, some needed assistance at times from family or supporting staff members. The remaining two or three teachers were comfortable with some software, but had had limited experiences. Half of the teachers had computers at home. Prior to the commencement of the original venture, about half of the teachers had had experiences with Excel before, while the other half had either not used it, had had little success with it, or lacked the confidence to persevere with it. The positive outcomes for the teachers from the original venture were that they felt they had acquired new skills, gained confidence in using Excel, or felt empowered to use Excel in ways different from their previous experiences. The negatives

were generally associated with the pace of the training sessions — too slow for some, too fast for others.

This paper reports on the results of the interviews and survey questionnaire with respect to the aims: (a) to investigate (i) teacher's ongoing attitudes towards and perceptions of usefulness of using spreadsheets in the classroom (with respect to Chance and Data); (ii) the methods, activities and materials used in implementing spreadsheets in the classroom; and (b) to consider factors which may enhance or hinder teachers' acceptance and use of spreadsheets.

Results

Classrooms contained between two and four computers. In each school, teachers could access a computer lab, a library or other room with computers, or alternatively, lap tops could be brought from a central position to a particular classroom. These shared facilities operated on a booking system for all teachers in the school.

Interview Results — Attitudes/Perceptions of Teachers

Rating of confidence. At the time of the first interview, teachers were asked to rate their confidence on a 1 to 7 scale (7 representing the most confident level) in using spreadsheets in their classrooms. Most teachers classified their confidence over a range.

- Rating 5-7: seven teachers (58%). Most of these teachers rated themselves lower than 7 because they considered that there were some things they had not yet explored.
- Rating 3-5: three teachers (25%). Several teachers stated that they needed to reacquaint themselves with Excel each time they used it.
- Rating 2-3: one teacher (8%). *I think if I had the time and sat down and persevered I'd be quite confident ...*
- No rating: This teacher stated that she used spreadsheets in a limited way but was confident in using spreadsheets this way.

Rating of usefulness of spreadsheets in the chance and data strand. Teachers were asked to rate their perceptions of usefulness of spreadsheets in the Chance and Data strand in a similar way to that of their confidence. Again they rated over a range.

- Rating 5-7: seven teachers (58%) (Six of these teachers had confidence ratings in the 5-7 bracket above). Reasons given were that the use of spreadsheets was particularly good for graphing because they saved time, and permitted quick analyses, interpretation and explanation, exploration, extrapolation and observation of trends. Other reasons given were that spreadsheets could be useful in "real situations" and teachers could cater for a range of abilities. One teacher in this group rated spreadsheets high for Data, but low for Chance, the latter of which had not been explored to any great extent during the inservice sessions. Other teachers stated that de-skilling over time was a problem, and that there was a need to learn more about using spreadsheets.
- Rating 4-5: one teacher (8%). This teacher observed that there were advantages in creating and manipulating data, which was less time-consuming and easier than with pencil and paper.
- Rating less than 4: four teachers (33%). These teachers were unsure about the usefulness of spreadsheets because they had not yet done enough work with them.

Perceptions about children using spreadsheets. Teachers' observations of their students' reactions to using spreadsheets were all positive. Lessons were judged to be "successful". Teachers stated that children found the spreadsheet activities to date were enjoyable, easy and motivating. In addition, children picked up the new ideas quickly, sometimes more quickly than their teachers. One teacher stated, *What I found interesting is they do not have any fear of going outside the boundaries of what they have just been taught, they're quite happy to investigate.* This meant that children could help each other, and in some cases, their teacher. Several teachers were uncomfortable with this aspect. Three teachers were asked if students found spreadsheets challenging, and their responses, again positive, related to the novelty of the program, such as exploring graphing or making colourful displays.

Interview Results — Methods and Activities

At the time of the first interview, one teacher had still not used spreadsheets with her class. With the remaining teachers, usage seemed to reflect their own skill levels and confidence in using them. For example, Robert, at the novice stage, had completed only a simple Battleship activity with his class. This activity accustomed students to using cell references, moving the cursor around the worksheet, and highlighting and colouring cells. By contrast, Michael, had progressed his class to using multiplication formulas in a budgeting context, and operational and language grids (conditional formatting). The first spreadsheet experience was accomplished by inserting instructions and questions in boxes on a spreadsheet template, which the children filled in. This way they could work independently of the teacher. Two questions explored the *What if?* capacity of the spreadsheet. The second spreadsheet activities were drill exercises.

Most teachers reported that they had to spend time practising their spreadsheets before teaching to build their confidence. Generally they began with simple introductory exercises, such as those used in their inservice training sessions (e.g., Battleships). Nine teachers created situations which required tabulation of data, and this meant that the totalling (AUTOSUM function) and graphing functions could be used. In two classes, the students used only a single graph type, and explored the colouring and enhancement tools.

Seven teachers (those with higher confidence ratings) introduced simple higher level learning activities, such as the exploration of graphs and selection of the most appropriate one for the data. Some used the tabulation of data as the end product of a data gathering exercise within a context such as holding a Mini Olympics. Some asked for the formation of questions arising from the observation of tabulated data, such as that of an assigned First Fleet ship. Only Michael's class utilised the *What if?* capacity of tabled information. However, this was not linked to the graphical representation. In addition, because students worked independently, they did not realise that it was imperative to use formulas for totalling, so subsequent changes they made to answer the questions did not help their understanding.

Interview Results — Factors

Teachers were asked to consider factors that might influence their use of spreadsheets in the classroom, especially those that might dissuade them from using spreadsheets. Major factors are summarised in Table 1, and discussed below.

Table 1
Factors Influencing Teachers' Use of Spreadsheets

Factor	% of T.	Expansion	Quote
Conf. level	83	Knowing how to use software; having good ideas; awareness of usefulness of software	<i>I just haven't explored it enough ... as I get more familiar ... I'll get better with that (confidence).</i>
Time	67	Learning programme, planning & organisation, dealing with children's tech. problems; school interruptions; catching up with absentees; helping 32 students; dealing with other problems	<i>There's a lot of pressures in other areas. Do you put aside your lab time of one hour a fortnight just to do that for maths?</i>
Tech. Reliability	59	Dealing with network & computer problems; technical assistance; outdated equipment; assistance with Excel	<i>I had two computers for Battleships ... and one went down, and I couldn't retrieve it.</i>
Logistics	17	Planning and organisation in classroom and shared rooms; number of computers; booking processes	<i>We could have more access to computers. We have 21 classes. We all use computers. It's a scramble now (to book rooms).</i>

Confidence level was the most compelling factor to arise. Ten teachers (83%) were concerned about knowing how to use the software (and this related to finding sufficient preparation time), having good ideas to use; and insufficient knowledge and experience to realise the software's potential.

Eight teachers (67%) were concerned about the time factor. They mentioned the difficulties of finding time to reach a satisfactory level of competence for teaching; planning time (what, how, where to teach, non-computing activities, structure of classroom, decisions about additional computers) amid other competing pressures; juggling computing time with many interruptions (often unforeseeable e.g., fire drills); and catch-up time for absentees (often solved by pairing with a good student). There was also the need for time to help students with computing problems as they arose. For example, by mistake students often stored their files in the wrong area, and could not find them on subsequent visits. In addition, if a student pushed the wrong button, or something unusual was happening (e.g., no toolbar), the teacher needed sufficient knowledge of Excel to provide assistance, and the time to do it.

A third factor was the frustrations relating to the reliability of the technology used. All teachers discussed these, but seven (58%) stated that this could dissuade them from using spreadsheets. Students' working files were generally stored in a common class area on the school network. This meant that when the network was experiencing problems, access was denied. In one school network problems persisted for a whole term in the year of the research. This situation was exacerbated when computers were not set up for CD or floppy disk storage (one school). In some cases, printing was either not available in the classroom, or the printer did not work. One teacher stated that there was no consistency in the way the computers in his school were networked. This caused problems when students tried to gain access to their work from a shared computer room. A constant issue was

computer break-down and the subsequent delay for assistance. In one school, a technician was available only two days per week. In another, the teachers had to phone for outside help to discover that their Excel version was outdated and could not be used to practise their inservice spreadsheet work. One teacher could not find an Excel manual to help her. A common complaint was the lack of assistance available when they had trouble with Excel. This problem was lessened in two schools where teachers worked cooperatively together. However, sometimes it was the blind leading the blind. Also, while teachers had access to the online Blackboard site, none had accessed it at this time.

Again, most teachers discussed logistics problems. Only two teachers (17%) said it could dissuade them from using spreadsheets. Having only two to four computers in a room meant cycling students to computer work within other classroom activities, and keeping track of individual on-computer time. This involved additional planning time, but seemed to work better when children could share additional computers (e.g., alongside adjoining classrooms). One teacher wanted her students to be doing the same thing at the same time, so preferred taking the children to the computer lab. Another teacher in a small room found that children in the back row close to the computers were easily distracted by the computer users, and supervision was difficult; students strayed off task. Within normal classroom activities, helping individual students on computers was difficult (disruptive to lesson flow). Solving common difficulties meant bringing an overhead projector to the classroom to demonstrate, which entailed organisation and delay.

When shared computer rooms were used, greater forward planning was required. For example, a block of time needed to be booked each week, and this was inflexible due to high demand. This meant fitting in and often competing with, other bookings for the room, and advanced preparation. If students were sent to another shared computer room, pre-arranged supervision was essential. Frequently, teachers dealt with insufficient numbers of computers in these rooms, and less if not in working order. In small rooms, management issues arose. Bringing laptops to the classroom necessitated transport and setting up time, and arranging technical support. In schools that used laptops, there were never enough for one laptop per student.

Survey Results

As expected, the survey results did not produce the richness of discussion that the interviews provided. Only six teachers responded, and these responses were gathered after several requests. The timing of the distribution of the questionnaire at the end of the year was a disincentive to respond.

By the end of the semester, teachers appeared to have finished off the spreadsheet activities begun at the time of the first visit. While Robert had not progressed beyond the Battleships game, the other five had created tables and graphs with their classes. Michael continued to design and use spreadsheets for most of the semester. Bar graphs (different formats) were developed from the gathering of data on topics of interest, such as country of origin of class members, distance jumped, number of visiting Japanese students in each class. Spreadsheets using conditional formatting were designed for practising and reinforcing multiplication, operations with money, patterning and inequalities. Many of these spreadsheets had embedded instructions and motivational comments. High level questions were not evident.

At the end of semester, lack of time was the issue most frequently mentioned as a

hindrance to using spreadsheets.

Time. I had a hard time getting through everything in the curriculum. Spreadsheets were an “icing on the cake” issue and content in units took precedence. ... I felt like I had to rush to get through the content and in some cases I could fit in ICT work like spreadsheets but more often I couldn't.

Two teachers mentioned their ongoing lack of confidence, and this related to lack of preparation time and assistance, the latter of which they saw as crucial. They had not accessed the Blackboard site.

Blackboard usage. During the semester, the researcher placed five spreadsheets on the Blackboard site, with instructions, suggestions and questions which would promote thinking and exploration. By the end of the semester, only Michael had contributed to the site (15 spreadsheets). Another teacher had looked at the site, but not contributed. This was despite several reminders during the semester by the researcher. Teachers mentioned time and motivation as problems. Michael stated: *Not all that interested (in on-line discussion or using other people's spreadsheets). Am happier constructing my own games and uploading rather than vice versa.*

Discussion

The professional development project was designed to assist teachers to use spreadsheets in the year 5 Chance and Data strand. Given the range of day-to day problems that teachers face in using new technology (confidence, time, technological reliability, logistics), it is surprising and comforting that 11 of the 12 teachers participating in the interviews had utilised spreadsheets in their classrooms. Given that teachers were aware of the “use it or lose it” problem with new technology, it is likely that the remaining teacher would not utilise spreadsheets in the future without considerable motivation and support. Yet, at least that teacher was acquainted with the potential of this technology.

It was evident that teachers' confidence with using Excel spreadsheets was perceived to be governed by amount of time available to practice and prepare. Most teachers appeared to have the motivation to do so. Understandably, simple drill exercises were the way teachers began to use spreadsheets, but more confident teachers incorporated some higher level learning activities, particularly through the exploration of graphs. More confident teachers could also see the usefulness of spreadsheets in Chance and Data. Hence building teacher confidence in using new technology is a crucial aspect in their disposition to use it and use it well.

In schools where teachers worked together and discussed their problems, confidence ratings were higher. This suggests that working collaboratively builds confidence through a mutual desire to succeed. Professional development literature supports the view that *teacher learning is enhanced by interactions that encourage them (teachers) to articulate their views, challenge those of others, and come to better understanding as a community.* (Loucks-Horsley & Matsumoto, 1999, p. 261). Stephens, Mandeville, and Matthew (2002) argue that effective technology staff development must include ongoing immersion in learning. While the professional development venture with these teachers incorporated six workshops and tutorials over several months, this did not appear to be enough. Additional opportunities for contact with each other were necessary in the second semester after teachers had had time to plan and implement spreadsheets. The Blackboard site was set up specifically to address this issue, but it was not successful.

Positive outcomes were that teachers implemented spreadsheets within a context (e.g.,

First Fleet data, Mini Olympics, Japanese visitors), and students were excited by the new technology. These aspects provide a good springboard for future learning. However, the exploratory aspect through *What if?* questions was not utilised. Several reasons may be offered for this. Teachers were still feeling their way, and it was effort enough to reach the stage they had in a short space of time. As knowledge of formulas, their format, and how they operate in spreadsheets, was needed, teachers may require more time to become comfortable with using them. In addition, greater scaffolding with examples was needed to encourage exploration through such questions. The researcher's contributions on the Blackboard site contained such explorations, but these were not accessed. An additional inservice session, to be taken after mastery of the basics, would no doubt promote this.

The Blackboard access was an innovative and potentially powerful tool for the sharing of ideas, problems and spreadsheet applications. Despite reminders to all teachers during the semester, only one teacher utilised this facility to upload, and another looked at the site. Several factors could explain this situation. First, this was a new technology, which placed another layer of effort and understanding on top of the spreadsheet technology, when teachers were still grappling with time, confidence, and logistics problems. Second, it was assumed that teachers were competent email users. It is possible that some did not regularly check their emails, or did not have easy access to their email sites at work. Third, far more scaffolding was required to encourage teachers to use it. Fourth, in view of all of the demands placed on teachers day to day, learning and using this technology was not seen as a priority. Fifth, teachers had moved onto other topics in the mathematics curriculum, and interest had waned.

Given the hurdles that teachers face in the implementation of new technology, and given the emphasis in mathematics curricula to utilise technology, it is imperative that greater support be given to them by the school and authorities. Otherwise, it is hard for teachers to hold on to the big picture while dealing with the parts (Konold, 2003).

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