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**Implementation of computing in schools by primary principals:**

**A longitudinal perspective**

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Abstract

*Computers are now accepted as part of teaching, learning and administration in primary schools. With the introduction of Computer Education policies in the early 1980s, principals of NSW primary schools faced complex decisions about implementing a new technology. Persistent challenges included purchase of appropriate hardware and software, their own training needs and those of their staff, location of resources, student and staff access, and ways of integrating computers into the daily life of their schools.*

*To ascertain how primary principals have met the challenges of computer use, two sets of data will be examined. Data from interviews, surveys and participant diaries from an intensive year-long study conducted in the mid 1980s of seven urban primary schools and data collected through periodic, semi-focussed interviews with a small sample of school principals over the following 15 years, will be explored. All schools were considered 'lighthouse schools' in implementation of computers in the Hunter Region of NSW,*

*Findings will highlight the key role of the principal in the implementation of computing in primary schools, the significance of their change facilitation style, the nature of their interventions and the appropriateness of implementation strategies.*

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## THE CHALLENGES OF USING COMPUTERS IN SCHOOLS

Over the last 15 years, computers have played an increasingly important role in reshaping teaching, learning and school administration in primary schools. Schools are now under increasing pressure to meet the needs and expectations of a generation accustomed to computers. Since the formation of Computer Education policies in the early 1980s, school leaders in NSW primary schools have been faced with complex decisions regarding ways of integrating computers and other forms of new Information Technologies (IT), such as the Internet, scanners, digital devices etc. into the life of the school. Decisions regarding purchase of hardware and software, staff training, parental involvement, location of resources, student and staff access and the role of information technology in education, have been challenges for school leaders.

The challenges for principals are huge. For example, in what ways do they use Information Technology (IT) to cope more effectively with their ever-increasing workload? Is their role changing as a result of using on-line approaches in an increasingly site based context? How do they assist their staff in their use of information technology? How do they ensure that IT is integrated into teaching, learning and administration?

Although computers have been used in schools for over 15 years, visits to classrooms and principals' offices indicate that information technology has not yet been integrated into the daily learning activities of the school. Computers and other forms of information technology often remain isolated from the mainstream of learning experience because of teacher apprehension and even phobia about uses of computers in the classroom (Russell & Bradley, 1997). A recent national report in the UK found that teachers lack confidence and competence in the use of information technology (Harris, 1999). In a recent Australian report (Meredyth., Russell., Blackwood., Thomas & Wise, 1999), data collected from over 200 schools in 1998 indicated that proportionately more students than teachers had acquired advanced computing skills. This national study of the information technology skills of Australian school students identified issues of concern to policy makers and educational leaders such as the need for a more integrated approach, linking information technology resources to planning at a 'whole school' level.

Similarly, relatively few American teachers (20%) reported feeling very well prepared to integrate educational technology into classroom instruction. "Technology Counts 99" contains a series of comprehensive reports (see <http://www.edweek.org/sreports/tc99/>) on teacher use and attitudes about digital content. Almost all of the 1,407 teachers who responded to the survey had access to a computer, either at home or at school and almost all of them used computers for some kind of professional development activity. For them, the major issue is "what kinds of computer-based resources, or 'digital content' should they use in their classroom" (Fatemi, 1999). However, teachers are not making more use of computers in their classrooms because there are still insufficient computers, a lack of time to prepare or try out software, the cost of software, and a lack of training.

Added to these complexities is the increasingly important pedagogical issue, namely, that classroom use of computers requires a different approach to teaching and learning (Davis, Desforjes, Jessel, Somekh, Taylor & Vaughan, 1997). Classrooms need to be organised differently, teacher conceptions of teaching and learning require considerable adjustment and teachers need to accept that some pupils may know more about computers and software than they do. At one level, careful assessment of teacher competencies and understandings is critical so that the range of skills and attitudes can be determined for selection of relevant training strategies. But, on the other hand, sympathetic understanding of teacher concerns about computers in the classroom is required by school leaders (Russell

& Bradley, 1997, Sparks & Hirsch, 1997). The challenges for school leaders continue even though IT may be more accessible and available.

## **THE PRINCIPAL AS A KEY CHANGE FACILITATOR**

The role of the school principal as an important factor in the successful operation of schools is supported through three related fields of literature: namely, literature which explores the role of the principal in implementing educational change (Fullan, 1996, Leithwood, Begley & Cousins, 1994); literature which highlights the principal as a key factor in successful school improvement (Fullan, 1993) and literature which identifies the principal as a key facilitator in bringing about successful school change (Hall & George, 1999, Hall & Hord, 1987). This literature concludes that a major responsibility for school improvement and change rests with the school principal. Further, there is a growing field of literature providing guidelines for principals in integrating IT into schools (Mauer & Davidson, 1998; Picciano, 1998). Examples of >best practice= of IT in schools identifies a key role for the principal (Michael, 1998). Effective use of information technology, particularly computers, is now a major challenge facing school principals.

This paper will focus on the experiences of selected groups of principals of government primary schools in NSW as they cope with these challenges. The appropriateness of staff development strategies, concerns about access to IT, variations in implementation and the significance of the change facilitator=s leadership style and nature of their interventions, will be highlighted in the context of a period of significant technological change impacting on education.

## **DATA COLLECTION**

Initial data were collected during an intensive year-long study of seven urban primary schools in the Hunter Region of NSW (Schiller, 1990, 1991, 1992, 1997). These data were supplemented by interviews with school leaders of those schools at intervals over a 10 year period. Schools in this study were selected on the change facilitation style of the principal as predicted by Regional Office personnel and on their prioritisation of implementation of the NSW Computer Education Policy of 1984. At the beginning of the study period, each school was regarded as a 'innovative' or 'lighthouse' school as computers were not in use in many primary schools at that time. During a twelve month data-gathering period May 1985- June 1986, several diagnostic instruments, based on Hall and Hord's (1987) Concerns-based Adoption Model (CBAM), were used to determine changes in the teachers' Stages of Concern (SoC) and Levels of Use (LoU) of Computer Education. The actual nature of Computer Education at each school (the Innovation Configuration [IC]) was also determined. Detailed records were kept of all interventions made by key facilitators in implementing Computer Education. Surveys, semi-structured interviews, personal diaries and document analysis provided data to determine similarities and variations between the seven schools of similar size, similar organisational structure and located in the same educational regions of NSW (Schiller, 1990, 1991, 1992).

Additional semi-structured interview data were collected by the author over the last five years from another set of selected schools in the same geographic are of NSW. Nine primary school principals were selected on the basis of their schools being involved 'at the cutting edge' in using information technology as identified by their peers and confirmed independently by School District Technology Advisors.

Further, to give a wider cross section of views, written and verbal comments made by 35 principals attending a professional development workshop in April, 2000 on current school IT challenges, as well as online discussion comments by postgraduate students undertaking Master's level subjects about IT and leadership, were examined.

### RESULTS FROM INITIAL DATA ANALYSIS - 1985/1986

As computers in primary schools in NSW were relatively new in 1984 there was no dominant organisational structure for their use so the focus of the year long study was to determine variations of implementation success based on the CBAM data and by comparing hardware configurations at the beginning and end of the study period. The variations in computer education configuration are shown in Table 1 and Table 2 (NOTE: the seven schools are referred to with pseudonyms and the student populations ranged from 200 - 250 children).

Table 1

Computer Education hardware configurations - MAY 1985

|                  | SCHOOL     |            |            |            |            |               |            |
|------------------|------------|------------|------------|------------|------------|---------------|------------|
|                  | WESTERN    | HILLSIDE   | PACIFIC    | SOUTHERN   | VALLEY     | CENTRAL       | LAKEVIEW   |
| Type of Computer | Apple IIe  | Vic 20     | Micro-B    | Micro-B    | Micro-B    | Micro-B       | Micro-B    |
| Number           | 4          | 2          | 2          | 9          | 6          | 9             | 2          |
| Drive            | disc       | cassette   | cassette   | Cassette   | cassette   | disc          | cassette   |
| Printer          | 1          | 1          | 1          | 3          | 1          | 1             | 1          |
| Location         | class room | class room | class room | Class Room | class room | computer room | class room |

|                   |                |                |                |                |                |                         |                |
|-------------------|----------------|----------------|----------------|----------------|----------------|-------------------------|----------------|
| Configurat<br>ion | stand<br>alone | stand<br>alone | stand<br>alone | Stand<br>Alone | stand<br>alone | Beenet<br>(networ<br>k) | stand<br>alone |
|-------------------|----------------|----------------|----------------|----------------|----------------|-------------------------|----------------|

Table 2

Computer Education hardware configurations - JUNE 1986

|                     | SCHOOL         |                      |                             |                |                             |                         |                      |
|---------------------|----------------|----------------------|-----------------------------|----------------|-----------------------------|-------------------------|----------------------|
|                     | WESTE<br>RN    | HILLSI<br>DE         | PACIF<br>IC                 | SOUTHE<br>RN   | VALL<br>EY                  | CENTR<br>AL             | LAKEVI<br>EW         |
| Type of<br>Computer | Apple IIe      | Vic 20               | Micro-<br>B                 | Micro-B        | Micro-<br>B                 | Micro-B                 | Micro-B              |
| Number              | 4              | 4                    | 5                           | 9              | 7                           | 13                      | 6                    |
| Drive               | disc           | cassett<br>e         | cassett<br>e<br>and<br>disc | Cassette       | casset<br>te<br>and<br>disc | disc                    | cassette<br>and disc |
| Printer             | 1              | 2                    | 5                           | 3              | 1                           | 1                       | 1                    |
| Location            | class<br>room  | comput<br>er<br>room | class<br>room               | Class<br>Room  | class<br>room               | comput<br>er<br>room    | class<br>room        |
| Configurat<br>ion   | stand<br>alone | stand<br>alone       | stand<br>alone              | Stand<br>alone | stand<br>alone              | Beenet<br>(networ<br>k) | stand<br>alone       |

Computer Education was a high priority at each school at the beginning of the study and each principal regarded the implementation process as successful over the twelve month

period. However, the nature of the interventions of each principal contributed to variations in teacher implementation of computer education. A major finding of the study was the positive relationship between change facilitation style of the principal and implementation success in Computer Education.

The principals could be grouped into three broad categories. In the first category were the principals who 'let it happen' in that they did not become personally involved in Computer Education. The principals of Hillside, Western and Valley Schools allowed their teachers to implement Computer Education if they wanted to, they were supportive of staff members who wanted to promote it, they helped in the implementation process when asked, but their overall reaction to Computer Education was to respond to the initiative of others. They exhibited a 'Responder' Change Facilitation (CF) style (Hall & Hord, 1987).

The second category consisted of principals who 'help it happen' in that they were actively involved in promoting Computer Education. They took teachers classes to provide in service time, they sought advice from regional computer personnel, they ensured that teachers had ready access to equipment but they left the nature of the implementation to the individual teacher. They exhibited a 'Manager' Change Facilitation style (Hall & Hord, 1987).

The third category included the principals and other school leaders who 'made it happen' Being able to see how to develop and implement Computer Education characterised the change facilitation style of one of the assistant principals and the principals of Central and Lakeview schools. They were able to single-handedly devise long-term goals and implementation strategies for Computer Education, and to work out specific day-to-day tactics to accomplish them. They facilitated staff decisions to accept Computer Education as a priority, and then ensured that all staff met their obligations. They used an 'Initiator' CF style in implementing Computer Education.

Although Computer Education was a voluntary area for implementation by individual teachers in other schools, the principals of Central and Lakeview schools expected every teacher to become a user of it, as that had been the decision of the staff. They stressed it during staff meetings, they organised staff training, they ensured adequate time and resources were available, and they monitored and checked every teacher's progress in implementing Computer Education. They did this by visiting classrooms to watch and talk with teachers and students as they worked with computers. They used these classroom visits to 'monitor and evaluate' the implementation process. Inspection of teacher's planning documents and subsequent individual discussion were also used to monitor each teacher's implementation intentions and actions. They initiated and encouraged staff participation in the implementation process through regular staff discussion. They actively sought parental involvement and support through parent workshops and meetings.

This twelve month longitudinal study concluded that the greatest implementation success occurred in schools where principals exhibited either an 'Initiator CF' or 'Manager CF' style. They "made Computer Education happen" or "helped it happen" rather than merely "let it happen". Less progress in implementation took place in schools led by principals who demonstrated a 'Responder CF' style in terms of Computer Education, despite attempts by the second change facilitator to influence implementation. The number of interventions by the principal was also related to implementation success of Computer Education, as indicated by teachers' Levels of Use and Innovation Configuration. More interventions were associated with greater success in implementation and 'Manager' or 'Initiator CF' styles of principal leadership (Schiller, 1990, 1991, 1992).

## **Other findings from the year long study**

Other findings from the one year study indicated that none of the principals used computers for their personal use as a principal; their focus was on experimenting with childrens' and teachers' use of this new technology in classroom applications. Further, no use was made of computers in the daily worklife of the study principals. Essentially, their concerns and the focus of their attention was on how to acquire more computers and appropriate software, how to convince more teachers on their staff to experiment with computers in their classrooms and how to keep the newly acquired equipment secure and working effectively. Staff training was essentially ad hoc and focussed on the small group of teachers enthusiastic about computer usage. Teacher resistance, computer 'crashes' and malfunction were commonplace as these technology pioneers struggled to encourage regular classroom use of computers in their schools.

## **The study schools - five years later**

At the end of the school year in 1990 and 1991 the principal of each of the seven study schools was interviewed to determine major changes which had taken place at the school since 1986 in terms of Computer Education. These changes included:

- growing concern with the reliability and appropriateness of the computer hardware which had been in use since 1986 and the desire to upgrade to MS-DOS equipment,
- staff training was still a major concern. Insufficient time and lack of appropriate skilled personnel on staff to accommodate staff needs for training were given as the major reasons for concern,
- relatively few staff changes had taken place over the four years. However, where a computer literate staff member had been transferred, another member of staff had replaced them as the computer contact person or the new person appointed to the staff had appropriate expertise. In other words, each school continued to have at least one staff member who knew how to operate and maintain the computers,
- in all but one school, the principal had changed. Retirement and promotional transfer were the two major reasons for leaving the school,
- a shift in emphasis had begun in that each principal now faced the introduction of a computerised information system which had been provided for all schools in the NSW Department of Education. This Office Administration in Schools Information System (OASIS) necessitated changes in organisation of the school information systems and required extensive training of clerical staff. Principals' reactions to this information system have been analysed elsewhere (Nebauer & Schiller, 1994),

## **The initial study schools - ten years later**

In June 1995, a half hour semi-structured interview was conducted with each of the current principals at the seven schools in order to gain an overview of the current situation in each school regarding computer education, to make comparisons with information provided in previous interviews, and to determine whether there were major differences within and between schools since the major study in 1985/1986. Although none of the principals had been in the school for 10 years, six of the principals were unchanged since the 1991 interviews. One principal was recently appointed but had been interviewed as the Assistant Principal in the same school in 1991.

All principals continue to regard Computer Education as a priority area for development. Although two schools did not have a written policy on Computer Education (Western and Valley), draft policies were in preparation.

All principals expressed dissatisfaction with the number of computers in their school for student use. They all considered the current situation of approximately 1 - 2 computers per classroom inadequate. All but one school library currently contains several computers, some with CD-ROM capability, whereas 10 years ago no computers were placed in libraries.

All principals have organised the replacement of out-dated hardware which was in operation 10 years ago although much of it has been in use until only a year or so ago. One school (Hillside) still used a few of the original computers which were 13 years old! Upgrading hardware had involved principals seeking support from their parent groups to fund either an upgrading program for all computers or a replacement program. During the 1991 interviews replacement was the major option as schools moved from Microbee computers to MS-DOS computers. The decision had been more complex in that replacement of motherboards and adding extra RAM chips to increase the speed of the computer to cope with Windows operation has been an alternative to complete replacement. Of considerable concern to all principals was the rapid rate of development of computers necessitating frequent upgrades to cope with the latest software.

Security of the hardware remained an issue of concern to all the study principals. Equipment had been stolen from several of the study schools. However, two principals commented that one >positive= aspect of a break-in was that equipment could be replaced with a newer model computer!

Concerns about maintenance of equipment were still present and appeared to be growing in intensity as computer hardware increasingly became obsolete. All principals expressed concern about the increasingly rapid rate of change in computer hardware and applications.

An example of these rapid changes in technology was the growing awareness of possible networking applications. In 1985/86 one school (Central) had a networked computer room. In 1995, all principals mentioned their current investigation of some aspect of networking computers in their schools, either to increase flexibility by linking with more powerful machines in libraries where more efficient use of CD ROM and other forms of databases was possible, or for easier or faster access to the OASIS system by clerical and senior staff. One school (Valley) was about to network computers across all classrooms. The considerable costs involved in doing this, particularly where classrooms are scattered, posed major dilemmas for school leaders in terms of cost benefits. Each principal expressed concern and some degree of apprehension about making decisions of this type.

Staff turnover has been considerable at all schools over the 10 year period. Whereas there had been only small changes in staff up to three years ago, in most cases principals reported that virtually no staff from the 1986 cohort remained in 1995.

A wide range of teacher abilities and interest in facilitating Computer Education was a common feature of all schools. Each principal mentioned that there were one or two members of staff who were not willing, able or interested in using computers in their classrooms while many teachers made frequent use of computers in many different ways. Some of these teachers tended to have more than one computer in their classrooms and gave their students much more frequent access to computers resulting in a considerable variation from class to class in terms of access to computers.



All principals had access to the OASIS Information Management system which had been standardised in NSW schools. However, not all principals used OASIS directly as they relied on clerical staff to prepare reports for them or to access the information on their behalf. Most agreed that OASIS had improved the ways in which financial records and pupil data were kept and retrieved.

There was considerable variation in using computers to prepare class and school newsletters. Several schools had purchased laser printers to improve the quality of presentation. One school (Pacific) used a digital camera to take photos for the school newsletter. In some schools, students have considerable input into school newsletters whereas in others, the principal is the major contributor and publisher of the newsletter. The number of printers per school varied enormously from two (Pacific) to one per classroom plus office and library (Southern).

The use of a computer coordinator or resident 'computer expert' varied from school to school. In 1985/1986 considerable emphasis had been placed on using the school computer coordinator as the major facilitator. Although computer coordinator positions still existed in some schools, principals indicated that providing time for such persons to assist staff was increasingly difficult. In only one school (Hillside) had a computer teacher been retained to provide specific classes in a designated computer room - a position which has been retained over the decade. However, in this school, teachers were increasingly taking their own classes to the computer room or providing for computer use within their own classroom. Another concern expressed about computer coordinators is the problem of 'expert knowledge' residing in only a few staff members. One principal (Lakeview) was making a concerted effort to have a majority of staff knowledgeable in computer use after the sudden departure of the coordinator pointed that virtually no-one on staff had appropriate skills to keep the program in operation.

Interestingly, pressure from parents to become involved in Computer Education featured prominently in the earlier study (Schiller, 1990) but was not highlighted in the 1995 interviews. However, there was considerable pressure from parents for Computer Education to remain a priority in NSW primary schools. The emphasis in the popular press at the time stressed the need for schools to join the 'information superhighway' and parents urged their school to keep up with technological developments although it is not clear what specific things parents expected from the schools.

Finally, there were considerable variations between schools in the pupil:computer ratio and pupil access to Windows interface and CD-ROM capability (see Table 3). Further, a major impression from the interviews was that student access to computers in the study schools may not have increased significantly over the decade. In 1986 each of the study schools appeared to be at the forefront of computer education in providing each child regular access to computers. In 1995 there is still regular access but to a different type of computer and a wider range of activities is possible. But for many children in the study schools access was still limited by the relatively small number of computers available and by the organisational structures of the school which indicated that computer usage was still a marginal activity.

Table 3

Computer Education configurations - June 1995

| SCHOOL                 |           | WES | HIL         | PAC | SOU | VAL | CENT | LAK |
|------------------------|-----------|-----|-------------|-----|-----|-----|------|-----|
| Computer configuration | MS-DOS    | 10  | 14          | 10  | 17  | 16  | 4    | 12  |
|                        | MACINTOSH | 1   | 0           | 0   | 1   | 0   | 8    | 1   |
|                        | LAPTOP    | 2   | 0           | 0   | 1   | 3   | 4    | 0   |
|                        | OTHER     | 9   | 25<br>(old) | 0   | 0   | 0   | 0    | 0   |
|                        | CD-ROM    | 5%  | 5%          | 30% | 10% | 0%  | 25%  | 80% |
|                        | WINDOWS   | 80% | 10%         | 30% | 80% | 80% | 50%  | 60% |
| Location of computers  | CLASSROOM | 11  | 8           | 9   | 14  | 19  | 15   | 10  |
|                        | COMP ROOM | 7   | 29          | 0   | 0   | 0   | 0    | 0   |
|                        | LIBRARY   | 4   | 2           | 1   | 5   | 0   | 1    | 3   |
| Written policy         |           | NO  | YES         | YES | YES | NO  | YES  | YES |
| Modem                  |           | YES | YES         | YES | YES | YES | NO   | YES |

*NB: Student population of above schools ranged from 200 - 250 (i.e. 8 - 12 classes per school)*

In summary, Computer Education had remained a high priority in the seven primary schools over 10 years in terms of expenditure of funds and emphasis by the school leaders. However, concerns about staff training, insufficient equipment maintenance, the need to frequently upgrade hardware and software at considerable expense, and the pressure to make decisions about whether to network groups of computers were uppermost in the minds of the principals of the study schools in 1995. To this point in time, support for implementation of computers in schools had not been a priority of government. But this was about to change. At the time of conducting these interviews, the new Labor government in NSW had indicated that expanded use of computers in schools will be a priority for achieving educational outcomes and that every school will have access to the 'information superhighway'. Although encouraged by these announcements, each of the principals in mid 1995 was adopting a 'wait and see' attitude.

## Recent data collection

Over the last three years, data were collected as part of an on-going, exploratory study into the impact of information technology on the role of educational leaders. Nine primary school principals from the Hunter Region of NSW were selected on the basis of their schools being involved 'at the cutting edge' in using information technology as identified by the District Superintendent and confirmed independently with the District Technology Advisor. Each person was audio taped during a semi-structured interview ranging from 20 - 50 minutes. Initial interview questions were of a general nature, exploring each person's personal use of information technologies in their school in terms of frequency, mode of operation, method of learning appropriate skills, length of time using technologies, and current issues and problems. Specific questions were asked about their use of email and the World Wide Web, their typing competency, and their perception of the impact of information technology on the ways in which they carry out their responsibilities as school principal.

Findings from these interviews highlighted the significant changes impacting on school principals in recent time and pointed out that principals operate in more complex environments than at the beginning of these studies. In addition to implementing computers in their schools, principals are currently faced with challenging and demanding issues such as significant changes in curriculum and assessment, greater demands for accountability accompanied by increased devolution of responsibility, and changes in organisational structures, funding, and school governance.

It is important to note that during the last 4 years, large amounts of funding has been put into the Computers in Schools Program for government schools in NSW. With an investment of over \$170.6 million over 4 years, sufficient new computers were distributed to NSW government schools to achieve a computer to student ratio of better than 1:11, and to provide all schools with Internet access, a technology infrastructure grant, and a computer coordinator allowance. In addition, 15,000 teachers received training in the use of computers for teaching and learning through a centrally coordinated Technology in Learning and Teaching (TILT) course, 40 district technology advisers were appointed and curriculum support documents were produced and provided to teachers on Departmental web sites and on CD-roms (from Audit summary available at <http://www.audit.nsw.gov.au/education2000/execsummary.html>)

In terms of involvement with computers all principals interviewed:

- had a computer on their desk,
- make extensive use of OASIS (Office Automation and School Information System) for analysis of information relating to budgeting, inventories and student data,
- rely in self-instruction in use of technology. Although each of the principals had attended in service courses relating to technology, all of them reported on considerable personal experimentation, on >fiddling= with the technology, to learn how to make more effective use of it. In addition, each principal frequently called on colleagues such as a member of staff interested in computers or the District Computer Consultant to assist them with specific issues,
- none of the principals interviewed is a 'touch typist' but rely instead on fast two or three fingered typing,

- pointed out that their school was visited frequently by teachers from other schools who wanted to see how information technology is being used in the classrooms at their school,
- raised concerns about the lack of time to experiment and learn more about what is available and possible with information technology,
- were sensitive to the varying levels of expertise and willingness of their staff to use computers in education and each of them took positive steps to assist their staff acquire appropriate skills and attitudes.

### COMPUTER IMPLEMENTATION OVER TIME

What has been learned from analysis of this data collected over 15 years from selected primary schools?

#### Major waves of technological development in education

It has been suggested that there have been two major wave of technological development in the ways in which computers have been used in education. Data from these studies over time support this view. Collis (1996) argues that in the first wave of technological development the focus was on the individual computer and its possible application to teaching, learning and administration in schools. With the advent of the personal computer in the late 1970s, many teachers and principals saw possible ways in which education could be changed. Although much enthusiasm was generated, some feared that the computer might replace the teacher but there was considerable optimism that computers would improve teaching and learning. Educational decision makers urged that every school should get computers, that funding must be found, that new initiatives were needed and that policy and strategy for implementing computers in schools must be developed. With the advent of the World Wide Web in the mid 1990s, Collis argues that the second wave began in which the emphasis in schools changed from a focus on individual computers to a focus on networked computers and connection to the >information highway= where every child and every teacher would be able to access the Internet. Data from these studies illustrate these two waves of technological development as shown in Table 4.

Table 4

Waves of technological development in primary schools

|                        | WAVE 1<br>Early 1980s to mid 1990s | WAVE 2<br>Mid 1990s to present |
|------------------------|------------------------------------|--------------------------------|
| Computer configuration | few classrooms with computers      | most classrooms with computer  |
|                        | standalone computers only          | standalone and networked       |

|                          |   |   |
|--------------------------|---|---|
| links between computers  | Restricted                                | commonplace (WWW, email etc)  |
| networks within a school | very few                                  | commonplace   |
| security of computers    | few concerns                              | lots of concern   |
| parental interest        | Considerable                              | taken for granted   |
| upgrade and maintenance  | large concern                             | large concern   |
| staff development        | ad hoc, up to individual                  | more systematic, TILT,  |
|                          | many variations in levels                 | still many variations of levels   |
|                          | many resisters                            | still many resisters  |
| Government support       | None                                      | considerable  |
| Principal                | experimenting with classroom applications | classroom and office applications, reports, records, analysis of data etc |
|                          | no computer on desk                       | computer on desk  |

### Staff development as a critical factor in implementation success

Over the first decade of computers in schools, teacher in service was rather ad hoc. At one level there were school-based programs in which the more computer literate members of staff assisted those less familiar with using computers. At another level, much teacher training in the use of specific computer applications was undertaken in teacher's own time at a Regional Computer Education Inservice Centre which offered workshops on wordprocessing, database and spreadsheet applications as well as desktop publishing and graphics. Some staff training was also provided by computer hardware dealerships which have supplied hardware and software but this too is provided after hours.

Implementation of IT policy depends on the effectiveness of staff development strategies. The emerging electronic technologies pose an enormous challenge to teachers because their use requires considerable shifts in their pre-existing knowledge, skills and behaviours. One of the unique aspects of computers as an educational innovation is that their use demands many new skills and competencies and embraces changes to educational ideologies. This is a major challenge for school leaders.

Use of computers in schools for teaching and learning is best served by a constructivist approach to teaching and learning - in which student-active, teacher facilitated environments, developmentally appropriate acquisition of concepts and skills, and multi-age grouping in non-graded learning families are emphasised. This can lead to "... the establishment of a community of leadership which manages changes in instructional technology through the influence of its own instructional experts " (Maurer & Davidson, 1998:3). For example, the teacher who has expertise in word processing and process writing assumes the role of expert or roving leader in that area. This 'learning from colleagues' and 'learning by doing' was identified by principals in this study as an important strategy and is a favoured model for computer training (Russell & Bradley, 1997). The discovery of a key IT application which persuades teachers that IT is relevant to their purposes and that it does enhance teaching and learning, is crucial in staff development (Sparks & Hirsch, 1997). However, the reality in many classrooms sometimes make this particularly difficult although recent use of computers to assist in preparing student reports has helped convince teachers that IT can be of use!

Another major concern of principals was how to cope with teacher resistance and apprehension about using computers in the daily life of the classroom. Fullan (1998) advocates careful listening to the resisters as this often get to the heart of educational change - its impact on emotions. Principals in this study highlighted the importance of involving all teachers in IT through frequent discussion.

Reports cited earlier in this paper highlight the vast differences among teachers in terms of their competencies to use and to integrate IT into the life of their classrooms. Analysis of data collected in these studies demonstrate that these variations among teachers also exist in schools regarded as 'lighthouse' or at the 'cutting edge' in terms of their implementation of IT. However, the variations between teachers are not as extreme due to the following successful IT staff development strategies used by principals and their leadership teams. Teachers knew more about computers and their role in education due to:

- placement of computers into school staffrooms
- encouragement for teachers to take school computers home over weekends and holiday periods. Some schools have purchased a laptop computer to facilitate this
- regular IT discussion and frequent, brief workshops during staff meetings
- one-on-one practice sessions during lunch breaks or after school
- peer tutoring
- team teaching with, and shadowing of more experienced colleagues
- encouragement to attend at computer courses within the system and from other providers such as TAFE, or private training companies
- assistance from friends and colleagues who are more computer literate
- use of 'train the trainer' approaches
- clear identification/appointment of a >technology leader (s)= in the school

The consensus was that large workshops were of limited use in preparing teachers for computer use unless they were supplemented with individual and small group interaction on a continuing basis. This is supported by the literature (for example, McKenzie, 1999) and illustrated by the comments from an online discussion as part of a postgraduate subjects:

*There's a lot to be said for peer support in adult learning, as I am much more inclined to phone a friend who is a few steps ahead of me in understanding computers than make a fool of myself in front of the people who know all. It is very reassuring to know others in this course have difficulties as well. This all also gives me a better understanding of the need for individualised training programs for school staff (female, early childhood teacher).*

*I think having staff doing workshops as a group is a great thing. It helps sets some expectation that staff should be upgrading skills. However, personally, I have found that there is no substitute to having your own computer and 'doing the time' learning and making mistakes and learning some more. I find it difficult to understand how some staff still hope that they will get through the next 10 years of teaching without using a computer (female, secondary principal).*

Interestingly, each of the primary principals interviewed stated that they expected their staff to use IT in their teaching and learning. These results highlight a number of issues which need to be understood by school leaders hoping to influence their school staff towards greater use of computers in their school to enhance teaching and learning and to assist with administration and management. Data from a recent national study of computers in schools (Meredith et al., 1999) indicate that although most teachers possess basic skills required to use computers, those most likely to lack basic skills in using IT are over 50, female and primary school teachers. As the teaching staff of the schools examined in these studies conformed to this profile, staff development was a major challenge.

### **Recognition of different stages/phases of computer use**

Despite the principals in the study being selected on the basis of their high involvement with information technology, wide variations of teacher use of IT were indicated. Similarly, although there were similar levels of enthusiasm for IT among the principals there were different levels of expertise and understanding and IT applications were used in different ways. There was no common approach to the use of computers by primary school principals or by their staff.

Progression through various stages of use and concern about computers in education is a common experience and has important professional development implications. Interviewees spoke of having gone through different stages of development in using computers and the need for different types of activities at different levels. At the initial stage, where 'technophobia' or computer anxiety was a significant factor, help on a one-on-one basis, easy access to a computer in the staffroom or the option to take a computer home, observing skilled colleagues, and attending training courses at the school, were identified as successful staff development activities by those interviewed. This is supported in an Australian study of teacher's computer anxiety and appropriate staff development (Russell & Bradley, 1997). Later needs included group staff development strategies including school-based training courses, team teaching, input from a technology consultant and ready access to problem solving assistance. Modelling appropriate IT use by the principal was emphasised by those interviewed as an important factor in successful implementation.

There is agreement in the literature that there are distinct stages through which a person progresses in terms of computer usage and developing classroom applications for computers. What is not agreed to is the number of these stages or phases! At one level, 'resister' and 'volunteer' can be used to categorise staff (Riffel & Levin, 1997). Four stages of 'survival', 'mastery', 'impact', and 'innovation' are often used. The Levels of Technology Implementation (LoTi), uses a seven level model ranging from 'non-use' through 'awareness', 'exploration', 'infusion', 'integration', 'expansion' to 'refinement' (Moersch, 1996). Regardless of the number of phases or stages, the major issue is that principals provide opportunities for staff to progress through these phases and to accept that different sorts of activities and assistance may be required at these various phases. Adult learning theories and practices need to be taken into account when planning professional development activities. For example, there is need to consider the relevance to the present situation, past experiences and the fact that adults reconstruct as they learn, that adults need to critically evaluate any new materials before they are used, and there is need for a clear rationale and purpose.

### **Access to resources**

Although the principals in this study emphasised IT in their schools through prioritising it in their school budgets, making decisions about appropriate hardware/software, infrastructure and support and maintenance were identified as major challenges. Although huge variations in context make it difficult to provide a straightforward set of guidelines for this issue, the view of these principals can be expressed as;

*... that teachers, like students, need their 'own' computer. Every one of us needs to be able to configure our files as we wish; to personalise our work on the computer and to have on-going access. Ideally, all teachers need their 'own' portable computer that they can readily have with them 365 days a year, 24 hours a day. They need to be able to take that computer to class, to meetings and most importantly, home. They need to be able to move their 'office' with them. (Lee, 1999 at <http://www.eddirect.com/tip> ).*

Each of the principals indicated that their schools had gone some way towards meeting this goal with all classrooms having several computers and additional computers being available in computer laboratories and the library. In some schools, laptop computers were available for staff to borrow. Each school had one or more members of staff regarded as a 'computer expert' who could be called upon to provide assistance to teachers. The principals commented on the importance of these key people in effective implementation of IT in their schools. However, each principal identified concerns about how to acquire more computers and more appropriate software and in finding ways to obtain more technical support and maintenance. These concerns were similar to those expressed by principals in the major national study (Meredyth, et al., 1999) in that dissatisfaction was expressed by both teachers and principals in the lower than required level of maintenance and technical support for IT in schools. This remains another major challenge for principals.

### **The change facilitation role of principals**

Implementing computers in schools is like navigating in uncharted waters as principals have not had IT training as part of their own preparation and they have had little access to scholarly literature that looks at leadership dimensions of IT in schools. This tended to be a major issue for principals as the change they were exploring was not like any other change they had experienced. Further, the literature to this point has focussed on integration of computers to classroom instruction (Michael, 1998). Riffel and Levin (1997) argue that in the early phases of development of IT applications in schools, senior administrators and policy



makers tend to be in a reactive position, with implementation driven by volunteers within the system or pressure groups outside the system. In these studies however, the principals tended to be more pro active in facilitating change through IT. In terms of modelling 'best practice' as suggested by Michael (1998:281) the principals in these studies were computer literate, they were powerful advocates of IT usage, they made effective use of IT committees or teams of enthusiasts and they effectively established organisational structures and administrative procedures to support integration of computers into their schools.

As change facilitators, they actively encouraged use of IT in their schools and supported its use in a variety of ways. Although their actual 'Change Facilitation Style' varied, as explained earlier, the primary principals in these studies actively intervened to implement computers in their schools.

Interventions involved:

- Establishing and maintaining a continuing focus on a school information technology policy development and planning for computers in schools.
- Providing opportunities for teachers to experiment and 'play' with computers in a non-threatening environment such as the staffroom or at home.
- Acknowledging that there were large variations in teacher computer competency and understanding of computer applications to teaching and learning and recognising that competency and understanding of computer applications develops in stages and individuals reach these stages at different times and through different ways.
- Demonstrating support for use of computers in teaching, learning and administration, including modelling their use.
- Provision of adequate technical support, often through the allocation of a member of staff and sometimes through employment of a part time person to maintain the hardware and software and to provide technical assistance and support.

### **Importance of technology planning**

In addition to each of the recent study schools placing high budget priority on IT, each school had an up-to-date school policy in which the principal had played a major participatory role. These factors contributed to each of the schools being regarded as at the 'cutting edge' in terms of integrating IT into teaching, learning and administration. The national survey supports these factors in that;

*There were consistent links between the existence of school policy on IT and the priority given, at the school level, to resourcing, networking, technical support and professional development and to integrating IT across the curriculum (Meredyth, et al., 1999:xxx)*

A key role for school leaders, particularly in an increasingly site managed system, is to facilitate technology planning in their organisational context. Without thoughtful technology planning, school leaders face the risk of making expensive mistakes and jeopardizing the education possibilities of students. The North American literature on technology integration has identified a number of success factors for schools attempting to help teachers adopt technology in their classrooms. These factors include: administrative support, staff development and technical support, availability of technology, a technology use plan, technology coordinator, facilities and maintenance, assessment, and broad participation

(Hoffman, 1996). Analysis of the data indicates that these same factors are important in the Australian context and that staff development is a key factor, if not the key factor.

Although the primary principals surveyed in this study tended to be confident users of IT themselves and demonstrated positive attitudes to IT and its place in the curriculum, this is not a pattern across Australia. The >Real Time= report cited earlier indicates that although 90% of principals surveyed agreed that 'information technology will inevitably change how we understand the nature of schools and schooling' only 36% consider themselves able to keep abreast of the new programs and applications (Meredyth et al, 1999:179). The challenge is huge!

These studies have been limited by their small sample size, a focus on only one geographic region in NSW and by a focus on principals who were regarded as being at the forefront of implementation of computers in schools. More detailed information is required about a much wider range of principals and their use of IT as well as their change facilitation role as they cope with the challenges of integrating IT into teaching, learning and administration in their schools. This is the focus of a more extensive study involving all principals in government, Catholic and Independent schools currently being undertaken by the author in one geographic area of NSW.

## CONCLUSION

Access to technology is not enough - we must learn how to use it and to incorporate effectively into the learning process. There is need for reconceptualisation of the professional development paradigm in which competency-based approaches are used, in which teachers' knowledge, skills and attitudes are considered assets, where there is opportunity for reflection and analysis, and where learning together is highlighted. There is also the need to emphasise critical thinking and problem-solving curricula, connected to a variety of integrated content areas in which constructivist instruction models are used and supported by instructional technology applications. It is critical that primary school principals be change facilitators in terms of computer use in schools in order to achieve this outcome.

But, who should be responsible for the professional development of teachers in the use of computers for teaching, learning and administration - the educational system, the school, school leaders or the individual teacher? It is clear that all of these sectors have a responsibility. The question is; what is the proportion of responsibility for each sector and how is an appropriate balance achieved in terms of sharing the cost, determining time allocation and providing support and infrastructure? Will the delivery of education change to suit the new opportunities and challenges of information technology, or will information technology merely be a tool to bolster existing forms of educational delivery? How can educational leadership drive implementation of information technology in concert with the learning needs of the school? These are major challenges for school principals.

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