Transforming schooling with support from portable computing.

ACEC2008 Award Winning Paper

For over two decades educators have hailed the possibility of harnessing the capabilities of portable computing to transform Australian schools into places where students experience powerful learning environments, relevant to the 21st Century. For some schools in Australia this journey is well into its second decade with the use of networkable portable computing devices to provide anywhere-anytime learning opportunities. While some of the potential has been realised invariably the finding has been that using the technology to create powerful learning environments in real school setting is not a trivial matter and needs to consider a range of factors. So when in 2003 the Department of Education and Training (DET) in Western Australia decided to improve a regional state school and include portable computing as part of an approach to transform the school careful planning and implementation ensued. This paper discusses a range of issues around 1:1 student to computing devices in schools and reports on some of the factors that contributed to the success of the DET initiative and the direction it provides for public schooling.

INTRODUCTION

It is now a realistic possibility for all students in an Australian school to be provided with portable, independently operating computers. Becker (2001) discussed the potential negative and positive impacts, showing how the cost of the portable option is comparable with classroom desktop computer options. The question then is whether the portability of the systems provides sufficient benefits for students and teachers when compared with desktop and client-based systems.

This paper argues firstly from the literature and then from an analysis of some primary data that the use of portable computing devices by students has a substantial impact on the learning environment in school and therefore on the practice of teachers. This impact is in addition to the likely impact of generally using computers whether in a laboratory or desktops in classrooms. The key additional attribute of portable computing devices is that almost certainly the student controls the device. If the device stays with them it is likely that they will personalise and become very familiar with its operation. This shifts the control in the learning environment more towards students away from the teacher. Unlike the typical scenario where a teacher decides to take a class to a computer laboratory or instructs students to go and use the classroom computer, if students bring the devices with them the teacher has to respond. The teacher may respond negatively, positively or merely permit student use, but he/she cannot simply ignore computers as is often the case in the typical scenario. The increased student control of devices also has implications for teachers in the management of the learning environment. For example, the school needs to institute policies and the teacher needs to implement practices for student use such as putting devices to sleep when the teacher is giving instructions, when or if email, chat and other communication services are permitted to be used, when sound is permitted to be used, and physical storage and battery management. The argument is that the use of portable computing devices by students provides both students and teachers with additional opportunities. For students it provides a means of maintaining their own data and customising software tools and having them available at all times, including at home. For teachers it provides the ultimate flexibility of access to computers in that at any time they can organise activities requiring any student:computer ratio up to 1:1. For some activities they may require every student to use a computer, in others require one computer per group and in others not use any computers. They can plan this without having to book rooms, roster access to a few computers in the room, or artificially organise the learning schedule around these. Further, teachers can respond immediately to unplanned learning opportunities where computer use would be valuable.

The availability of portable computers may provide some powerful forces (e.g. accessibility and flexibility) to encourage teachers to facilitate the use of computers with students, while overcoming some obstacles (e.g. adequate access), but there will still be some opposing forces and additional obstacles to overcome. For example, the use of portable computing systems has tended to pitch IT maintenance convenience against the link between learning and the technology (Newhouse, 2002). These responsible for the maintenance of computer systems tend to want standardisation with no user control. On the other hand, educators espousing constructivist theories want environments within which the learner has maximum control, with a variety of systems to match the variety of learners and learning tasks. An appropriate balance needs to be struck which must tend towards the educators with IT support personnel doing their utmost to support.

Thus in theory it can be argued that the deployment of portable computer devices to children in schools appears to be most appropriate, particularly in secondary schools where children are old enough to...
carry and care for such a device. However, as with all 'good ideas in theory' in education it is important to ensure that this is supported by the findings from adequate research. The next section summarises some of these findings reported in the literature with the remainder of the paper reporting on some of the findings from the recent Western Australian initiative.

Research into Portable Computer Support for Learning

In essence portable computing concerns ubiquitous access to personal data files and appropriate software and hardware where and when needed. This may involve portable computer devices such as a laptop computer or Personal Digital Assistant (PDA). The use of portable computing in education has been pursued because for many (e.g. Gardner, Morrison, Jarman, Reilly, & McNally, 1994; Rowe, 1993) it offers the flexibility and educational focus that tends to be lacking in the computer laboratory. An early student laptop programme in Australia was instigated as a deliberate strategy to move to a more constructivist-based teaching culture (Loader, 1993).

Since the early 1990s there has been much research into the use of portable computer devices in schools, mostly with very positive findings. The first major studies included some of the Apple Classroom of Tomorrow projects (Dwyer, Ringstaff, & Sandholz, 1991), a large project in Northern Ireland (Morrison, Gardner, Reilly, & McNally, 1993), and a number of initiatives in Australian schools (Shears, 1995). More recent research also includes the use of smaller portable devices such as palmtop computers, PDAs, handheld game devices, and mobile phones (Roshcelle, 2003). The inclusion of associated technologies such as wireless networking have further enhanced the potential of portable devices in schools (Newhouse, 2001). In Australia most of the research has been conducted in private schools but there have been some government schools (Shears, 1995) including a notebook programme commenced in 2003 in Western Australia (Carpenter, 2003) following the lead of American states such as Maine (Lane, 2003).

Much of the research tends to be qualitative (e.g. Garthwaite & Weller, 2004) and focus on the impact of the portable computer device on aspects of schools and learning environments (Committee on Developments in the Science of Learning, 2000). Fundamentally the concern is with the impact on student attitudes and achievement (Gardner, Morrison, Jarman, Reilly, & McNally, 1994) and on teachers actions and beliefs (e.g. Silvernail & Lane, 2004). Most have reported that teachers' responses vary from unbridled enthusiasm to open hostility but that with experience the latter can change (Newhouse, 1998). Very little of the traditional empirical media comparison research has been conducted, however, there was a comprehensive study conducted by Walker, Rockman, and Chessler (2000) that compared 'laptop schools' with matched 'non-laptop schools' and suggested that laptop students benefited in a number of ways.

Most research has reported the need to overcome obstacles and for teachers to adjust to the presence of the technology and its potential (Becta, 2002; Cradler & Bridgforth, 2002), the question is whether portability realises additional benefits. Many studies (e.g. Russell, Bebell, & Higgins, 2004) have found that portable devices provide increased ubiquity and flexibility leading to more use, and a greater range of use. Teachers tend to indicate that the devices can be used to improve the relevance and effectiveness of learning activities, allow students greater autonomy, stimulate motivation, and enhance their communication, collaboration and organisation skills (Crawford & Vahey, 2002).

Ultimately the concern is for the impact on students and their achievement. A clear finding is that most (85-95%) students like using portable devices (Crawford & Vahey, 2002) and that the impact on student confidence and perceptions is likely to be positive (Walker, Rockman, & Chessler, 2000). There have been positive but not compelling findings of impact on student achievement (Walker, Rockman, & Chessler, 2000), although this tends to relate to particular areas of the curriculum (Siegler & Foster, 2000) or types of student (Rowe, 1993). The support of various forms of communication, mainly in English language studies with younger students have been consistently positive (Jeroski, 2003). In general it has usually been found that portable devices have best supported process-oriented outcomes such as collaboration and problem-solving rather than content-oriented outcomes (Davies, 2004).

It can now be relatively confidently concluded that the use of portable devices is likely to significantly modify the learning environment and encourage teachers to shift toward the use of more constructivist pedagogical practices (Ainley, Bourke, Chatfield, Hillman, & Watkins, 2000). If a move in this direction is valued, this provides a compelling argument for the use of portable devices.

Trial 'Notebooks' School in WA

Prior to 2003, student-owned notebook programmes had been implemented in a number of schools in Western Australia with the first being in 1993, but they had all been in private schools. Then in 2003 the then Minister for Education (Carpenter, 2003) decided to implement a student notebook computer programme at John Willcock College for a trial period of three years with a small pilot towards the end of 2003 and the full programme implemented in 2004. This was the first time such a programme was to be implemented in a school run by the W.A. Department of Education and Training (DET). Further, a team of researchers at Edith Cowan University were contracted to evaluate the impact of the programme. The evaluation was designed to address the overall question of change in learning environments to bring about improved learning through support from the use of Information and Communications Technologies (ICT).

John Willcock College is a middle-school with a population at the time of approximately 660 Year Eight and Nine students. Approximately 23% of these students were of Aboriginal heritage and there were significant groups of students from other non-Anglo-Saxon ethnic groups. At the same time as the notebook programme was to be implemented a number of other changes were occurring at the school, in particular,
a new Principal and two new Deputy Principals were appointed, a number of minor building works were conducted and the operational structure of the school was changed. The students were organised into five sub-schools of combined Year Eight and Nine. Students and staff typically remained with a sub-school with most teaching exclusively within one sub-school except for those within the areas of Technology & Enterprise, the Arts, LOTE, and Health and Physical Education. Each sub-school had a leader who was also a Head of a Learning Area (HoLA) across the five sub-schools. Each sub-school had a designated area of the school comprising a central foyer, three classrooms with either operable or half glass inner walls, a technology suite and a staff office for about seven teachers. Although the curriculum was largely organised according to learning areas and disciplines the sub-schools did have a degree of autonomy in organising the curriculum, particularly in coordinating themes and creating integrated learning opportunities.

One of the new Deputy Principals had been selected, at least partly, on the basis of her knowledge and experience in integrating the use of ICT in teaching and learning. This position was allocated for curriculum leadership and as such was responsible for the operation of the notebook programme in the school along with all other curriculum initiatives. The teacher groups in each sub-school and learning area was assisted by this 'Curriculum' Deputy in developing a curriculum plan to which they could then refer when devising programmes and requesting resources. The Curriculum Deputy also convened a school ICT committee that had a major focus on the integration of computer use across the curriculum and usually met on a fortnightly basis. She also liaised with personnel from DET central office, various commercial and community groups, school staff and leadership concerning almost every aspect of the notebook programme.

Early in 2004 the full programme was implemented with one notebook computer provided for each student at the school, these same computers were still in use in 2006. Each student was loaned an iBook 800MHz G4 with 12" LCD display, 30 GB HDD, USB/Firewire ports, 384Mb RAM, DVD-ROM/CD-RW slot loading optical drive, and Airport Extreme wireless card. The notebooks were stored in individually keyed, purpose-built lockers in the sub-school foyer areas and soft bags were also provided to facilitate carrying the computers. The iBooks were supported by a full-time, on-site, Apple-trained technician. During 2006 he was also provided with one day a week of clerical support. There was a separate part-time technician to support the network and other computers at the school. The Curriculum Deputy coordinated the development of a 'Usage and Policy Guide' booklet for parents and students and a 'Teachers Guideline Document' to support the implementation of the notebooks. In addition in 2005 Apple Computer supplied copies for all staff and students of a booklet introducing the operation of the iBooks.

The school was fully networked with both data cables and wireless networking extending to all areas of the school. In 2004 there had been some cross-platform issues with MacOS and WindowsOS working on the same network but these appeared to be resolved during the year. The network generally appeared to operate efficiently with fast Internet access (it should be noted that the evaluation was not intended to test the technical operation of the hardware). An intranet had been developed at the school, initially this was just based on accessing a shared hard drive but in 2006 a simple online management system was installed. This included a facility for students to submit files electronically to teachers' email addresses. Up to 2006 it was school policy that no email was available for student use. Over the three years students had access to an increasing range of software on the notebooks including: Macromedia Suite, MS Office, Appleworks, iLife, Inspiration, Kahootz 2.0.2, Music Planet, ProScope and MixScope.

The Evaluation

From March 2004 to December 2006 four sets of similar data were collected in order to evaluate the impact of the programme. The first set labelled the Baseline and the subsequent sets labelled Comparison data sets. For each set data were collected from teachers, students, parents, and school administrators using interviews, surveys, focus groups, analyses of documents and observation of facilities. For example, for the final Comparison 3 data set there were 43 teachers in the survey, 194 questionnaires completed by students, 54 questionnaires from guardian/parents, 4 teacher interviews recorded, 4 student focus group interviews recorded, and documents collected, observations made and school administrators and IT support staff interviewed.

There were a number of readily identifiable and quantifiable results indicating a positive impact of the programme. Firstly, in the first year there was almost a tripling from 16% to 43% in the proportion of teachers indicating facilitating some computer use on a daily basis with this higher proportion being maintained during the subsequent years. Secondly, student estimates of computer use at school indicated almost doubling from less than one hour per day to nearly two hours per day during the first year although this measure dropped a little to about one and a half hours for the third year. An amazing statistic during that time was that none of the notebook computers were reported lost or stolen. Most teachers and students (approx. 80%) routinely accessed online information sources and considered this to be a natural part of the learning environment. Finally, the self assessed ICT competencies of the vast majority of teachers had improved substantially with an average increase from the Baseline of 28% on the measure used, with particular improvement in the handling of digital media, particularly video in the third year. There were significant gains in the proportion of teachers indicating competence in the use of Powerpoint, Excel, email, Internet research, digital photography, image editing, and digital video.

The increased use of ICT and increased technical skills of teachers were important outcomes of the programme to identify but only if this was likely to translate into improved learning outcomes for students. This is considerably more difficult to identify and measure and to do so the Learning Environment Attributes (LEA) dimension of the New ICT Supporting Schooling (NISS) framework was employed. The LEA dimension was developed to assess the impact of ICT integration on the learning of students in schools and thus support educators in their decisions about the use of ICT. It is operationalised with a measure called the Learning Outcomes and Pedagogy Attributes (LOPA) which includes a simple descriptive rubric based on 11 attributes and the concept of progression from No Use, to Developing Use, to Routine Use, and finally to Comprehensive Use. Data from surveys, interviews and observations provide the evidence to make judgements using the rubric.

Using the results from the LOPA measure it was found that by the end of the third year of the project there had been an 174% increase in the proportion of teachers (to 27%) judged to be on average facilitating student computer use in ways likely to be conducive to
improved learning outcomes. This had steadily increased over the three years as teachers gained in experience. In particular about half the teachers were facilitating computer use with students to support the investigation of the real world and to increase student productivity, and about one third were doing so to increase student engagement with learning and to support authentic assessment. In the third year there was substantially greater focus on knowledge building, student learning independence and collaboration. This appeared to be the experience of most students in many learning areas and therefore it would be expected that measurable gains in the achievement of learning outcomes would become evident in years to come.

Overall it was found that many teachers were beginning to facilitate computer use by students to address learning outcomes involving research, investigation and the presentation of information. Some teachers were beginning to add analysis of information and problem solving. Increasingly students were experiencing this in a systematic manner. In the first year the deliberate connection made between the project and the development of curriculum improvement plans appeared to have contributed significantly to the development of a better understanding in most teachers for the connection between computer use and the achievement of particular learning outcomes. There was evidence that this had been consolidated during the second and third years within both learning area team planning and individual teacher planning. This was a move towards institutionalising the change beyond the special project status into the fabric of the school. There were many teachers who were systematically locating student use of ICT within learning programmes connected with progress maps and in the third year a number of teachers were representing this connection for students in the organization of resources on the school’s intranet. Finally, it was significant that despite the huge increase in computer use at school most students had maintained their perception that computer use supported their learning. This is a positive finding since once the novelty had worn off if the computers were not being used well, student perceptions were likely to become negative.

It was clear from the evidence that the project had contributed to the vast majority of teachers improving their integration of ICT with some doing so substantially both in terms of the amount of time and the range of activities and strategies implemented. For a few teachers this integration had become routine, well planned, learning outcome and student-centred, and had exploited well the very conducive school ICT capacity and school environment. The computer use of students was less dependent on teacher ICT knowledge and skills, particularly in Year Nine, somewhat due to the improved ICT knowledge and skills of many of these students. There had been over a 100% increase from the Baseline in the proportion of teachers (to over 85%) indicating a sense of confidence and comfort in integrating computer use in the curriculum.

Over the three years of the evaluation the use of the notebooks appeared to be a natural part of the learning environment in most areas of the school. Further, the project had had a significant positive impact on the skills, knowledge and pedagogic practices of at least half the teachers at the school that could be argued to represent an educational cultural shift. However, there were still a few difficulties, in particular by the third year the level of breakdown and repairs required appeared to be increasing, leading to there usually being a few students in each class without a computer. This was of concern to at least a few teachers who wanted to facilitate critical and consistent use of the computers. Many students were complaining of short battery life and breakdowns although this did not seem to diminish their view that the computer was a valuable learning tool. Finally, about half the teachers specifically indicated that student characteristics such as behaviour and capability was a constraint to further facilitation of ICT use. Among the students there were small groups of students (10-20%) who either didn’t like using computers, didn’t want to carry a computer, didn’t think they were used enough by some teachers, or didn’t think they had learned enough about how to use them. The reasons for this situation are likely to be complex and varied and need further investigation.

Conclusions

After three years the evidence clearly indicated that the Notebooks for Students programme at John Willcock College had successfully supported widespread and consistent use of ICT by students in their learning programmes. The notebooks played an important role in the learning for most students and for over half the teachers this clearly supported the use of what would be considered to be more student-centred approaches to teaching. It could readily be argued that this was as a result of the entire project (e.g. professional learning programme, school leadership, technical support), not just the provision of notebook computers, and supported by other changes in the school. Overall the ICT competence of teachers and their capability to integrate the use of the notebooks within their curriculum appeared to have improved significantly throughout the three years. The outcomes of this project when added to evidence from similar projects throughout Australia and in many locations internationally provide a basis to consider widespread implementation on notebooks in secondary education. If the aim is to use ICT to support more student-centred constructivist learning environments and empower teenagers as learners then clearly an approach that works is the provision of portable computing devices supported by reliable networks, appropriate software, adequate technicians, informed school leadership, skilled and effective curriculum leadership, well prepared teachers, and included local communities.
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BIOGRAPHY

Paul Newhouse (Ph.D) is an associate professor in educational computing at Edith Cowan University in Perth, Western Australia. He is currently the director of the Centre for Schooling and Learning Technologies (CSaLT) in the School of Education. He has always considered himself to be both a teacher and learner from early years in an innovative state secondary school in Western Australia to conducting research in schools and working with pre-service and practicing teachers at two universities. Throughout his aim has been to improve the opportunities for all children to develop as decision-making, empowered, responsible, relational citizens through engaging and relevant schooling. His focus is on implementation strategies for using ICT to support learning in schools, particularly as applied to portable computing, assessment and curriculum development in technology education.

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