The Notebook Curriculum: An Innovative Approach to the Use of Personal Computers in the Classroom

Despite widespread enthusiasm for the role of computers as an aid to more effective learning, there are few examples of the actual integration of computers into the curriculum. In Australia, a small number of schools have developed programs in which a personal computer has been made available to students for day-to-day use. This has led to what we describe as 'the notebook curriculum', which represents a significant departure from more traditional approaches to computer education in schools.

This paper provides a framework for debate about the merits of the notebook curriculum. Based on a recent school level evaluation of a notebook curriculum in its introductory phase, it identifies the major implementation characteristics of the notebook curriculum and investigates claims made in support of its introduction into classrooms.

The notebook curriculum is conceptualised as a 'double innovation' from the perspective of teachers, one related to the computer as a tool, the other related to the notebook curriculum. Implications for the support needed for successful implementation are discussed.

Introduction

While the diffusion of computers across school systems in Australia has been pervasive during the past decade, there is still debate about their effective usage within the curriculum. Some patterns have, however, begun to emerge. Computers are often set up in laboratories separate from other classrooms, especially in secondary schools. In primary (elementary) schools, students and teachers have relied on the use of small banks of computers in class or in a room somewhere down the corridor. There has been a tendency for computer use to be associated with an identifiable subject or as a special activity separated from the mainstream curriculum.

Within these patterns, the computer has been perceived as a tool that assists in the management of information. Typically, computers have been used for tasks such as writing, calculating and constructing spreadsheets. However, critics claim that, in practice, there has been a tendency for computers to be used more for drill and practice activities rather than for more educationally acceptable tasks (Farmer and Simicevic, 1993).

There is now emerging support for the use of computers in an alternative mode in which students take greater control of the computer, communicating with it in its own language while concurrently confronting new ways of thinking and new subject material. This kind of interaction with the computer is believed to encourage higher order skills in areas such as problem-solving, independent thinking and creativity and is associated with the regular use of computers across a range of subjects.

The approach reflects a belief that computers have an educational potential far beyond their basic use as a tool for undertaking tasks which have traditionally been done by hand. This view assumes that a fundamental goal for schools is to create an environment where students construct their own knowledge and understandings in interaction with others and their environment (Papert, 1980). Computers are seen to have a unique capacity to assist schools achieve this goal, and therefore provision for access to computers on a regular basis is regarded as essential. However, despite some impressive school-based studies of the impact of computers on student learning such as one undertaken by Harel (1991), there are few well documented case studies of the actual integration of computer use into the school curriculum.

During 1993, an evaluation of an attempt was made to implement such a curriculum at a large Australian private school at Grade 5 level. Students in the classes are 10-11 years of age. There was a strong press from parents who were eager for their offspring to have extended exposure to computers at school. Parents perceived that a high degree of computer
literacy would be essential for their offspring to compete adequately with students from other schools where computers had become a feature of the educational offerings. It could be argued that introduction of computers across the curriculum was thus seen by the school to provide a marketing advantage over other private schools. However the decision to implement an innovative integrated computer curriculum was strongly influenced by educational leaders in the school, who believed that such integration would offer significant educational advantages for students.

As part of this initiative, the authors were engaged to conduct an evaluation which would assist in the implementation of the integrated computer curriculum in its introductory phase and guide decisions about future development. A key role of the evaluation was to clarify the essential features of the program and its likely outcomes.

**Evaluation as Clarification**

While the school had a general up-front view of what the computer program might achieve, a comprehensive implementation plan was not possible prior to the adoption of what was a complex curriculum innovation. Despite some writers calling for more extensive program philosophies to be developed in advance of program delivery (Ryan, 1991), experienced program designers have concluded that a comprehensive statement about the characteristics of an innovation can only be developed during the trials or first stages of its implementation (Smith, 1989).

A key contribution evaluators can make during the formative or prototype stage of program development is to clarify the essential components of the program (Cronbach, 1980). This has been described as evaluability assessment (Smith, 1989) or design evaluation (Owen, 1993). Clarifying the design of a program has several important outcomes pertinent to different evaluation audiences. These include making program planners and deliverers in an organisation (the primary audience) aware of the key features of the program for which they are responsible. A second outcome is to provide decision makers, planners and administrators (the secondary audience), with evidence from which they may make a decision about expanding the program within an organisation. Thirdly, a design evaluation can provide information to other interested parties outside the organisation (the tertiary audience) about the benefits of adopting the program.

In this case, the curriculum and professional development directors and six teachers responsible for introducing the personal computers were the primary audience. The secondary audience was the Technology Working Party of the School which reported to the Principal about the progress and future of the curriculum. The tertiary audience were staff of other schools which were coming under increasing pressure to follow suit.

The evaluation findings have been reported to the two primary audiences and are now being used to consolidate the program in the school which commissioned the evaluation. The purpose of this paper is to disseminate the findings to the tertiary audience and more widely so as to inform others interested in the essential characteristics of the integrated computer curriculum.

**The Notebook Curriculum**

The evaluation was designed to describe in detail the rationale and implementation features of the curriculum which flowed from the integration of computers across a range of subject studies. In this case, computers were used predominantly in core subjects including English, Humanities, Science and Mathematics. Regular access was ensured by the provision of highly portable personal computers, hereafter referred to as ‘notebooks’, available to all students for the duration of the school year. We have labelled the program developed at the school in Grade 5 as the notebook curriculum.

In implementation terms, the notebook curriculum is more than just an alternative to computer education approaches that have been traditionally offered in schools. There is a move away from a situation where the teacher has the major control over the knowledge acquired by students.

The notebook curriculum is a quadratic involving teacher, students, content, and notebook use. In a notebook curriculum, students have individual access to their own personal computer which is integral to the day-to-day learning activities planned by the teacher.

The computer is used ‘off and on’ throughout the day and, at home when appropriate. In the case studied the computer was in use for between 30 and 50 percent of the school day, on average. Students come to regard the computer almost as an extension of themselves and are asked to take responsibility for the computer throughout the school year. This involves not only ownership of the machine but also of the intellectual property they produce through their interaction with the machine. The computer becomes a personal assistant, a modifiable tool which can be used to communicate ideas and to expand the nature and place of learning.

Use of a personal computer in the ways described above leads to a curriculum which replaces more traditional arrangements between teacher and student. It impacts on the style of curriculum planning, classroom management strategies, student response and methods of assessment. The students have control or power over knowledge within frameworks set up by the teacher.

A notebook curriculum can be implemented when there is a large degree of integration of the curriculum and so is well served by the homeroom arrangements which characterise elementary (primary) school settings.

The notebook curriculum is thus very different from introducing notebooks as an aid to students within individual subjects taught by different subject specialists. In this scenario, the tendency is for notebooks to be used to embellish traditional cognitive achievement depending on the software available in those subjects, rather than to encourage the qualitatively different learning experiences believed to occur where computers are made integral to the curriculum and used across a range of subjects.
Benefits of the Notebook Curriculum: Examining the Evidence.

As indicated earlier, the evaluation was designed to provide evidence about the benefits or outcomes which would follow from the full implementation of the notebook curriculum. This information was designed to provide the primary and secondary audiences with assurances that, if the curriculum was fully implemented, there would be benefits for those involved.

While data collected at the school during the first five months of implementation was important, the evaluators also sought information from other studies to compose a statement about benefits and potential benefits. We concentrated on evidence from studies which had assessed the impact of computer curricula similar to the notebook curriculum. This included data collected from the small number of Australian schools further down the implementation track, and information from selected experts and relevant journal articles.

As a basis for synthesising this information, a set of eleven claims made by the school in its preliminary documentation was used for reviewing benefits or outcomes. The claimed benefits, which appear as Table 1, can be divided into those which relate to the acquisition of student skills, (Claims 1-4), classroom dynamics (Claims 5-10), and the overall quality of the teaching/learning environment (Claim 11).

Below, we briefly examine the status of each of these claims at the conclusion of the evaluation.

Evidence provided by Eastman, (1989), Harris & Bond, (1992), Hiebert et.al. (1989), Kleifgen, (1989) and Moore, (1989) supports the belief that computer use enhances the acquisition of literacy, word processing and creative writing skills (Claim 1).

Improvements in the quality of writing (argument and report writing in particular) have been related not only to the ease of redrafting made possible by computer use, but also to the impact computers have on classrooms generally (Snyder, 1992). Computer classrooms have been shown to be more open and relaxed environments in which student behaviour tends to be more cooperative, collaborative, independent and task-oriented (Snyder, 1992). Practising teachers indicate that student use of printers encourages constructive discourse amongst students which results in an increased level of revision and editing (Eastman, 1989, Owen et al., 1993). Those working in the field of special education indicate that less able students are far more prepared to re-read, correct and be critical of their work when it looks presentable and is easily read (Yau et al., 1990, Owen et al., 1993). These teachers also remark on the absence of negative feelings which are often associated with re-reading poor or illegible hand-written work (Owen et. al., 1993).

While practitioners and experts in the field support the claim that computer use enhances the acquisition of data manipulation/research skills (Claim 2) a critical factor in this is the range and quality of software available to students over time (Owen et al., 1993). Empirical studies have demonstrated significant improvements in hypothesis testing, categorisation and the questioning skills of students who have had experience with computer data-bases and simulation activities (Underwood & Underwood, 1990).

The acquisition of skills in instructing and controlling the computer (Claim 3) and in programming in particular is linked to the potential of computer use to enhance problem-solving skills (Claim 4).

Whether or not students develop sophisticated skills in instructing and controlling the computer (Claim 3) heavily depends upon the skills of the teacher and the time devoted to programming instruction, not computer use per se. However, empirical studies, and teachers using notebook computers in their classrooms point to the benefits of
Learning to program in enhancing the acquisition of problem-solving skills. Improvements have been shown to occur in mathematical and spatial abilities (Clements & Gullo, 1984; Finlayson, 1984; Hughes & Macleod, 1986; Robinson & Uhlig, 1988), scores on standardised measures of non-verbal intelligence (Chambers, 1987), school ability (Clark, 1986) and the students' ability to monitor their own thinking (Bower, 1985). Teachers believe that classroom-related problem-solving skills are enhanced by non-judgemental feedback provided by computers and a greater preparedness on the part of students to persist in solving the problem (Owen et al., 1993).

Nevertheless, there is continuing controversy in the literature as to whether students develop the higher-order problem-solving skills which allow them to generalise their skills from one situation to another, whether that be to another computing environment or from one discipline to another (Larkin et al., 1980; Resnick, 1983; Scribner & Cole, 1981; Rowe, 1993). A recent study with university level students provides strong support for the proposition that instruction in programming improves problem-solving skills which can be transferred to multiple problem solving situations (Norris, et al., 1992). However, concern has been expressed about the amount of time required for students to gain the level of programming skills that will enable them to acquire these higher order problem-solving skills (Palumbo, 1990). It may well be unrealistic to expect such higher order skills to be developed in the current school environment where the classroom teacher may lack the sophisticated programming expertise and where curriculum time is limited.

As already noted in discussion of Claim 1, there is support in the literature (Carmichael, 1985; Snyder, 1992, Methodist Ladies College, 1993) and among practicing teachers (Owen, et al., 1993) that computer classrooms tend to be more interactive, cooperative and collaborative than pen and paper classrooms and related to this, that more able students are encouraged to work with students of lesser ability (Claim 5). Nevertheless, teachers indicate that this in itself can be associated with problems such as:

- difficulties in drawing the line between independent learning versus an excessive amount of copying/helping
- the tendency for teachers to rely too heavily on stronger students for providing assistance to weaker students, and related to this,
- the danger of potentially limiting the development of stronger students who may in turn resent this and the requirement to spend time with others.

Regardless, it is believed that careful classroom management strategies and close monitoring of individual students can be used to counter these problems (Owen, et al. 1993).

Empirical studies generally support the claim that use of computers encourages reflection, allowing students to compare their performance with others on the same task (Claim 6) (Carmichael, 1985; Eastman, 1989; Owen, et al. 1993; Methodist Ladies College, 1993). Students generally have a more positive attitude towards revision and drafting when using personal computers, and teachers claim that the printed word, screen visibility and the use of large monitors enhances the level of peer assessment and exchange.

There is widespread agreement in the field that computers have a role to play as a motivational tool (Claim 7). Computer use generates enthusiasm for the work and encourages students to stay on task (Lepper, 1985; Carmichael, 1985; Hughes & Macleod, 1986). This is particularly evident in the development of writing skills where students using word processors show markedly higher levels of enthusiasm, comfort and persistence than when asked to write and revise their pen and paper work (Hiebert, et al., 1989).

Despite a lack of empirical evidence, practising teachers strongly believe that computer use encourages a classroom context that is less judgemental with less emphasis on right and wrong and more emphasis on what works (Claim 8) (Owen, et al., 1993). However, it has been noted by experts in the field that the role of the teacher and the selection of software are still critical factors in determining the overall classroom climate in which computers are used.

Claim 9 suggests that computer use encourages a shift from reliance on verbal learning strategies to an integration of verbal and visual learning strategies. Our observation of notebook computer classrooms would support this contention, and despite conflicting evidence surrounding the benefits of Logo, studies have shown improvements in spatial skills and visual-spatial awareness as a result of experience with the software (Knupfer & Clark, 1992; Rowe, 1993).

While there is little direct empirical evidence to validate the claim that computer use allows students to learn more independently (Claim 10), teachers working in classrooms where there is a high degree of access to computers have found that students demonstrate a greater confidence and freedom to interpret their projects in their own unique way (Methodist Ladies College, 1993). Even with younger students where a framework for response is provided (such as a broad theme or range of tasks), computers are believed to facilitate a wide range of response in this context (Owen, et al., 1993). Generally, teachers in computer classrooms remark on a higher level of student participation in the learning process and less reliance on teacher instruction. Our observation suggests that more able students in particular benefit from the enrichment opportunities provided by computer use.

The claim that computer use leads to a more rewarding teaching/learning environment (Claim 11) is supported by the literature (Ryan, 1991; Methodist Ladies College, 1993) and those in the field (Owen, et al., 1993). Computer classrooms are believed to be characterised by a productive balance between formal teacher input and individualised instruction, and between teacher-centred learning and peer-mediated learning. As indicated above, computer use provides an expanded range of opportunities for students to work independently and use their initiative, and in many instances, the teacher is placed directly in the role of learner, hence modelling the learning process. Teachers in the field believe that this is at least partly responsible for the development of...
more honest and consultative relationships between students and teachers, and for a general improvement in the quality of student/teacher interaction (Ryan, 1991). However, experts in the field stress that the teacher’s attitude and skill still remains the critical factor in whether placing computers in classrooms makes a qualitative difference in the learning environment as described here.

The evidence cited above is not definitive. However, it does lend support to the current belief that the learning environment of students will be significantly altered as a result of integrating computer use into the classroom, and that the changes are likely to engender qualitatively different and improved learning outcomes.

Unique Benefits of the Notebook Curriculum

In the previous section, we examined the benefits of the notebook curriculum in terms of a set of up-front claims found in the school’s documentation. Many have been delivered, or have the potential to be delivered through the implementation of the notebook curriculum.

While it is conceivable that many of these claimed benefits could result from use of computers in schools in more traditional modes, the notebook strategy has inherent advantages which increase the likelihood that the learning benefits described above will be fully realised. These advantages include high computer portability, relatively unrestricted access, a sense of individual ownership and an emphasis on use across a range of subjects.

We have also identified benefits provided by the notebook curriculum not included in the up-front claims. In evaluation terms, these may be thought of as ‘unanticipated’ or ‘unintended’ outcomes and are summarised in Table 2 below. They are important because they are unique to the notebook curriculum and would be difficult, if not impossible, to achieve via the more traditional computer use strategies.

<table>
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<tr>
<th>Benefit</th>
<th>Description</th>
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<tr>
<td>Benefit 1</td>
<td>Encourages flexibility in the physical organisation of the classroom</td>
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<td>Benefit 2</td>
<td>Allows computers to be used across the curriculum regardless of location of class</td>
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<tr>
<td>Benefit 3</td>
<td>Removes computer use from the exclusive domain of the computer specialist and requires that it become an integral part of the general classroom activity</td>
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<tr>
<td>Benefit 4</td>
<td>Encourages students to learn independently at their own pace, using their own learning materials</td>
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<td>Benefit 5</td>
<td>Personal tool, one with applications at school and out of school (e.g. at home)</td>
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<td>Benefit 6</td>
<td>Increases the direct participation in computer technology by female students</td>
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<tr>
<td>Benefit 7</td>
<td>Enhances the acquisition of keyboarding skills through consistent practice</td>
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Table 2: Additional Benefits Related to Notebook Computer Use

Female Student Participation. The literature indicates that at secondary school level, significant attitudinal differences towards computer use emerge between the sexes, with many more males than females using computers regularly at this level (Hattie & Fitzgerald, 1987; Clarke, 1990; Rowe, 1993). The notebook curriculum offers two important conditions which favour female participation: unrestricted access which means they are not competing for computer time with males, and the use of computers as an educational tool for the purpose of achieving identifiable and relevant tasks (Nolan et. al., 1992). A recent study extending over two years placed students in Years 8 and 9 in a situation where each had equal access and where the computer was used as a student-controlled information processing device rather than as an object of study. At the end of the research, it was found that the attitudinal differences between the sexes were no longer apparent. It was concluded that where the focus was on the computer as a means to an end, rather than computer education per se all students were likely to make good use of computers as an educational resource (Nolan et. al., 1992).

Keyboard Skills. Consistent practice is fundamental to the development of proficiency in keyboarding skills, and in particular, touch-typing. In the notebook curriculum, the fact that students have almost daily access to their computers means that they can cumulatively develop skills in this area. Mastery of the keyboard greatly benefits the computer user, particularly in the word-processing applications. Furthermore, given that word-processing will become an integral part...
of the student's life (both at school, and potentially beyond), a high level of skill would seem desirable both to improve productivity and encourage personal use. Questions as to whether and how keyboarding skills should be taught remain controversial and little has been proven via systematic research. Nevertheless, what is clear from the literature is that there are potential risks associated with not teaching correct keyboarding skills. These include physical problems of fatigue/discomfort, frustration developing in students who need to scan paper, keys and screen (Wetzel, 1985), the need to concentrate on the mechanics of typing diverting students' attention away from the main focus of the task (e.g. composing or problem-solving) (Wetzel 1985; Koenke, 1987 cited in Pacey, 1991) and finally, the difficulties in correcting poor keyboarding techniques later (Kisner, 1984; Hagel, 1987; Wetzel, 1985; Jackson & Berg, 1986).

The evaluation suggests that unrestricted access is not of itself sufficient to produce quality outcomes in keyboarding. Teachers working with a notebook curriculum indicate that the provision of short, intensive periods of keyboarding lessons (for example, 20 minutes a day for 6 weeks at Year 7 level) are often not sufficient to establish touch-typing keyboard skills fully and that many students regress. Constant reinforcement of good practice both at school and at home is believed to be critical to encourage students to be efficient at keyboarding (Owen et. al., 1993).

In the absence of clear guidelines from the literature, schools introducing a notebook curriculum have no option but to develop their unique position with respect to the importance of touch-typing versus 'hunt and peck' methods, the best forms of instruction in the development of keyboarding skills, and the kinds of curriculum provision required to develop them.

Conclusion

The evidence suggests that a fully implemented notebook curriculum has considerable potential for enriching the quality of the learning environment. For the more able students, the notebook curriculum provides enrichment opportunities; for the less able students, it offers assistance particularly with writing, and the opportunity for success at something that lacks a prior association with failure. For the majority of students, notebook use generates enthusiasm for classroom work and homework and enables them to respond to projects in more creative and diverse ways than previously possible.

The few teachers who have been teaching a notebook curriculum over a number of years believe students' abilities at the primary level may have been seriously underestimated. This is based on tantalising evidence in the form of complex, innovative programming efforts, creative forms of written and graphical expression and knowledge and use of computational variables well in advance of corresponding mathematical structures (Ryan, 1991). The impact of a notebook curriculum in these formative years may, in retrospect, be found to have played a significant role in developing the critical thinking skills of these young people.

Whether these outcomes will be forthcoming is yet to be seen and researched in longitudinal studies. What is apparent is the lack of evidence of negative outcomes for students as a result of using personal computers in classrooms in the ways described here.

In addition to conceptualising the notebook curriculum, attention was given to identifying factors which affected its implementation. While a full discussion cannot be presented here, some brief comments need to be made. It was apparent that the introduction of the notebook curriculum brought with it an enormous burden for teachers.

A major reason was the nature of the notebook curriculum, which is effectively two innovations as seen from the perspective of most teachers.

The first, involves teachers in learning about the technology itself, acquiring knowledge about the notebook and peripheral hardware (such as printers and monitors), the range of software appropriate to their students' needs and abilities and practical procedures related to the management of computers in the classroom setting (such as handling, storing and recharging).

Having gained some personal mastery of these fundamentals, there is the second major challenge of actually implementing the notebook curriculum with its impact on content, teacher roles, and assessment of student progress and achievement.

It is therefore important to look closely at the conditions that are required for the effective introduction of a notebook curriculum, and in particular those which relate to the professional development of teachers. Ultimately, it is not the provision of notebooks that will make the difference, it is the way in which teachers respond to their potential that will determine the kinds of qualitative changes that occur in the teaching/learning environment.

There is thus a need for classroom teachers to:

- receive hands-on experience with both the notebooks and the relevant software prior to the use of notebooks in the classroom
- develop an initial understanding of how to integrate computer use into their existing curriculum and of the basic commands/procedures required by students to enable them to achieve a functional level of competence in the introductory stages
- have access to support from experts and other teachers in implementing the notebook curriculum, and in particular during the period when the curriculum is first being implemented.

The literature on effective implementation suggests that, after attending to the professional development needs of teachers, the next most important factor is support from the educational system and school administrators (see for example, Fullan and Pomfret, 1977, Owen, Johnson et. al., 1989).

In this case the challenge for school administrators is to provide teachers at the coal-face with the amount...
and type of professional and technical support and training required. This inevitably involves careful scrutiny of the institutional arrangements which govern the initiation, planning and direction of the notebook curriculum.

This evaluation suggests that there are a number of specific conditions critical to the success of the notebook curriculum.

• discussions with the limited number of teachers
• foster an ethos of on-going educational practices. Obvious examples include the right to have influence over the decisions which affect the introduction and on-going development of the initiative.
• understand that the notebook curriculum is qualitatively different from the pre-notebook curriculum, and that this has implications for existing practices. Obvious examples include any existing provision for computer education within the curriculum, and the content and style of reporting to parents.
• foster an ethos of on-going educational support for the notebook curriculum in their interactions with the community at large.

BIBLIOGRAPHY


1 Conclusions drawn in this evaluation are based on a range of data sources, including:
• a survey of existing literature
• interviews with experts in computer education
• discussions with the limited number of teachers in Australia who had worked with notebooks for several years, and
• direct observation of the use of notebooks during the first six months of operation in the school, Details about the data management strategies used are contained in Owen et al (1993).