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ABSTRACT

This report describes research conducted on the use of computers in Australian classrooms in order to assist the Australian Education Council task force on education and technology in the preparation of policy advice for the Council. The first of eight sections presents the specific aims of the project, which were to: (1) examine the current use of computers for the support of learning programs; (2) examine attitudes of students, parents, and teachers toward the use of computers in learning programs, and to determine whether any differences exist in attitudes between boys and girls, male and female teachers and parents, and between public and private schools; (3) to review and analyze Australian and overseas literature to identify training and teacher development needs and other targeting of programs that may be required; and (4) to examine other forms of support or assistance that could lead to an improved use of computers for learning purposes. The second section provides a literature review of computer applications in schools and attitudes of teachers, parents, and students; the third describes the survey design used in the study. Results of the survey are reported in the fourth and fifth sections, which outline computer uses, attitudes, and sex differences. The sixth section provides data from the student questionnaire on topics such as perceived competence and computer use, computer attitudes, and differences between female users and non-users. The seventh section comments on sex differences in computer use and attitudes; a summary and recommendations are provided in section eight. (72 references) (GL)

Commonwealth Department of Education

COMPUTER APPLICATIONS IN AUSTRALIAN CLASSROOMS

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Foreword

The research reported in this book was requested by the Australian Education Council's task force on education and technology and funded by the Commonwealth Department of Education under a research title 'Teachers and the Use of Computers in Classrooms'. The research was carried out by D. Fitzgerald and J. Hattie of the Centre for Behavioural Studies, University of New England, Armidale, N.S.W., and P. Hughes of the Department of Education, University of Tasmania, Hobart, Tasmania.

The research was to provide information to assist the task force prepare a report to the Australian Education Council which was due in October 1985. A draft of the research report was presented to the task force in early September. This document is the final report with respect to the Contract Research Project funded by the Commonwealth Department of Education.

The research was conducted under severe time constraints—commissioned in April 1985 with the report due at the end of August—and a preliminary report was presented on 31 August. Although the data provided in this report respond to the research brief, the data available from the program of research are extensive and analysis is continuing. Subsequent publications will reflect the richness of the data.

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1 RESEARCH BRIEF AND PROPOSAL

Research brief

The research brief indicated that the main purpose of the project was to provide information to the Commonwealth Department of Education on 'the use of computers in Australian classrooms' which could assist in the development of policy advice for the Australian Education Council task force on education and technology. The research was commissioned and funded at the end of April 1985 with a completion date of 31 August 1985.

Aims of the project

The general aim of the project was to examine and report on the use of computers in Australia in learning programs and on the attitudes of students, teachers and parents to possible uses of computers to support the learning process. The specific aims of the project are set out below.

AIM 1: THE USE OF COMPUTERS FOR THE SUPPORT OF LEARNING PROGRAMS

(a) To examine the current use of computers for learning purposes in primary and secondary schools in Australia with respect to the extent and kinds of use and the provision of hardware and software.

(b) To determine whether there are differences in the levels and kinds of use of computers for learning purposes between men and women teachers and between boys and girls.

(c) To examine (a) and (b) in relation to type of school (primary/secondary, public/private), the socioeconomic level of the community, ethnic composition of the school, region (rural/city), school size and science/non-science areas of the curriculum.

AIM 2: ATTITUDES TOWARDS THE USE OF COMPUTERS IN LEARNING PROGRAMS

(a) To examine and describe the attitudes of parents, teachers and students to different kinds of use of computers in learning programs.

(b) To determine if there are differences in attitudes to the use of computers in learning between boys and girls, male and female teachers and parents, and between public and private schools.

(c) To examine the relationship between the information processing abilities of students and the attitudes of students to the use of computers in learning programs, with particular reference to differences between boys and girls.

AIM 3: REVIEW, REPORT AND RECOMMENDATIONS

(a) To review and analyse Australian and overseas literature relevant to Aims 1 and 2.

(b) Arising from (a), to examine and report on training and teacher development needs and other targeting of programs that may be required.

(c) To examine and report on other forms of support or assistance that could lead to an improved use of computers for learning purposes.

2 REVIEW

Review of computer applications in schools

EFFECTIVENESS OF COMPUTERS

Computers have been heralded as saviours for schools, the beginning of an information revolution, a replacement for teachers, and as the students' best friend. As with most innovations, exaggerations come easily. Still, there is no doubt that the introduction of computers has had, and will continue to have, significant effects. Simon (1977) pointed to four major areas in which the effects would be felt: economic consequences that increase human productivity; consequences for the nature of work and leisure, and the quality of life; consequences for privacy and liberty; and consequences for our view of ourselves, for our picture of the universe, and for our place and goals in the universe. To these, we can add consequences for the way we learn, educate, and evaluate performances. The new information technology will dramatically influence the process of educating our youth and the forms of lifelong education.

It is possible to locate thousands of articles outlining the effectiveness of computers. But finding articles that go beyond opinion and conjecture is much more difficult. The few empirical studies that do exist are most cautious in their claims. Debate about the value of Logo is a good illustration.

Logo is a graphics-oriented structured language that allows students to create designs and generate computer code. Logo has raised high expectations and claims, but empirical studies have yet to provide substantiation for these claims. Krasner and Mitterer (1984) reviewed the effectiveness of studies relating to Logo and concluded that 'there is as yet no good evidence that any of the powerful ideas...(in Logo)...generalise to other domains' (p. 137) and they 'found no evidence that the Logo experience with turtle geometry (would) facilitate the development of general problem-solving skills' (p. 141). They go on to elaborate various conditions when Logo may expedite learning, and which subgroups of students it may benefit, and they make a plea for more objective and systematic examinations of the Logo experience and its effects. Of particular interest, they warn that unreal expectations for Logo may eventually work against the productive use of computers in education. Too often, reviews of literature conveniently leave out studies that provide negative evidence, but instead highlight views shared by the reviewer. Reviews of literature could lead to reasonable accusations of bias. A recent advance in literature reviewing called meta-analysis can be used to overcome this problem.

Meta-analysis involves locating the entire set of empirical studies on a particular topic and by using simple statistical transformations, convert the findings to a common metric (normally a z score) which permits the results of many studies to be directly compared. Details of this method are now readily available (Glass, McGaw & Smith 1981; Hattie & Walberg 1985).

There have been at least six meta-analyses relating to the effectiveness of using computers in education. A team of researchers from Michigan have completed three such analyses of computer-based education.

COMPUTERS IN PRIMARY SCHOOL

In their study relating to primary school students, Kulik, Kulik and Bangert-Drowns (1984) searched various data bases for studies that met three criteria. First, the studies had to take place in Grades 1 to 6. Second, the outcomes had to report measured outcomes in both computer-based and traditional classes. Third, the studies had to be free from such crippling methodological flaws as substantial aptitude differences in treatment and control groups, unfair 'teaching' of the criterion test to one of the comparison groups, or differential rates of subject attrition from the groups being compared. Twenty-nine studies were located that met these criteria. The outcome measure was usually achievement examinations given at the end of a program or a follow-up examination.

Four studies reported results from computer-managed instruction and the differences in achievement between those students and control students were small and non-significant. The other twenty-five studies related to computer-assisted instruction and the results indicated larger effects (from experience, it has been found that a z score greater than 0.4 indicates that an effect could be considered educationally 'meaningful'). In all twenty-five studies, the computer-assisted instruction students outperformed the control groups, and in most cases the differences were statistically significant. The overall effect size, using meta-analysis procedures, was 0.48. This result indicates that, considering the twenty-five studies, on average 68 per cent of the students using computer-assisted instruction outperformed the average student from a traditional classroom. An alternative interpretation is that the use of computer-assisted instruction accelerates a typical student by five months compared to students taught by conventional methods.

Students using the computer in tutorial mode outperformed those using drill and practice, short interventions were more effective, the younger students (Grade 1–3) gained more, and the less able students gained much more (effect = 0.55) compared to the high ability students (effect = 0.06). There were no differences in effectiveness relating to whether the computer software was locally written or commercially produced, whether the area was mathematics or reading, or the year in which the research was published.

COMPUTERS IN SECONDARY SCHOOL

In their meta-analysis using secondary school students, Kulik, Bangert and Williams (1983) located fifty-one studies. The average effect size was 0.32. In secondary school, 63 per cent of students using computer-assisted instruction outperformed the average student from a traditional classroom. Short interventions (four weeks or less) led to greater gains, and there were higher gains in the more recent studies. There were no other significant relationships (e.g. relating to how the computer was used, whether it was a substitute or supplement to teaching, grade level in secondary school, or subject matter). There was a trend for the lower ability students to gain more than middle or higher ability students.

Further, there was a tendency for student attitudes toward subject matter to be more positive in computer-assisted instruction classes (average effect = 0.12) as were ratings of the quality of instruction (effect = 0.19). Two studies reported data on the time taken for learning to a prespecified level of mastery. In one of the studies there was a 40 per cent saving of time in classes using computer-assisted instruction, and in another study there was an 88 per cent saving.

COMPUTERS IN COLLEGE AND UNIVERSITY

The third meta-analysis by this team related to college students (Kulik, Kulik & Cohen 1980). Using the same criteria as before, fifty-four studies were located which compared computer-assisted instruction with conventional classes. The average effect size was 0.25, which corresponds to the typical college student using computer-assisted instruction outperforming 60 per cent of colleagues in traditional classrooms. There were no systematic differences in effect sizes relating to how the computer was used, duration of use, course level, or year of study. Attitudes towards instruction (effect = 0.24) and attitudes toward subject matter (effect = 0.18) were more positive in computer-assisted instruction classes. Using computer-assisted instruction led to a 64 per cent reduction in learning time.

COMPUTERS IN MATHEMATICS TEACHING

Burns and Bozemann (1981) located studies on computer-assisted instruction in the area of mathematics in primary and/or secondary schools. The average effect from forty studies was 0.34 for drill and practice and 0.45 for tutorial uses. For drill and practice, the effects were larger for primary students, for males (effect = 0.42) rather than females (effect = 0.17), and for high compared to average ability students. For tutorial use, secondary students outperformed primary students, and average ability students gained more from the use of computer-assisted instruction than higher ability students.

Leong (1981) conducted a meta-analysis on the use of computers in teaching mathematics in secondary schools. She located fifteen studies in which there were 110 effect sizes relating to the comparison of traditional classes with classes supplemented with the use of computers. The median effect size was 0.029, indicating that there was no general improvement in achievement in mathematics related to the use of computers although there were differences related to content area. Using the computer to help teach geometry had much greater effects (0.47) than algebra (−0.07), trigonometry (−0.15), and number theory (−0.08). Exposures to the computer of shorter duration were more effective, and achievement decreased when more students shared terminals. These conclusions were not moderated by grade or ability level.

Hartley (1978) also completed a meta-analysis relating to the effectiveness of computers to teach mathematics. She compared the effects of using computers with other methods such as programmed instructions, individual learning packages, and tutoring. From 153 research studies (producing 380 effects) she found that tutoring was the superior instructional technique (mean effect = 0.60), although computer-assisted instruction occupied a respectable second place (effect = 0.41). That is, approximately 72 per cent of the computer group gained more than the average student in the ordinary classroom. When computers were used as a supplementary program the effect was much greater (effect = 0.47) than when it was a replacement (effect = 0.08).

The reason why Hartley found stronger effects than Leong is probably because Hartley used students from all grades, whereas Leong only used secondary students.

GENERAL COMMENTS ON THE META-ANALYSES

Overall in these seven meta-analyses the average effect size was 0.35. In a recent synthesis of 123 meta-analyses of programs and interventions aimed at enhancing achievement, Hattie (1985a) reported that an effect size greater than 0.40 can be considered educationally meaningful. Thus, compared to other educational innovations, computers can aid in enhancing achievement. Certainly, there are conditions when computers are more effective—for example, when computers are used with feedback, in tutorial mode, with shorter interventions, for younger students, with the less able (except in mathematics, where the more able seem to gain more), and when computers are used as a supplement rather than as a substitute for teaching.

Besides the improvement in achievement, the use of computers appears to lead to major savings of instructional time.

Computer applications in Australian schools

While there are a few reports on the distribution of computers and how they are used in Australian schools, these reports are primarily at the State level. Consequently, they vary in detail and as to when they were conducted, making it very difficult to collate the reports into an overall picture.

Anderson (1984) has noted four major differences between States. First, some States have supported computing in schools over a longer priod than others. Second, there is a perceived need by some States to adopt a co-ordinated centralised approach to computing in schools. The States which have been involved for the longest time in computers have adopted more centralised approaches. A third difference relates to the range of computer equipment in schools. And fourth, there are differences in the extent to which the purchase of equipment is subsidised or supported across States.

It appears the use of computers has expanded in both government and independent schools. For example, the West Australian Independent Schools' Education Committee (1983) surveyed all independent schools in West Australia, and from the 151 replies (60 per cent response rate), 37 per cent indicated that they currently used computers in school. The major uses in primary schools related to computer awareness and in various modes of computer-assisted learning. In secondary schools, the major uses related to teaching computer awareness, programming and specialist courses in computing.

Review of attitudes of teachers, parents and students

Allen (1985) completed a survey of principals, teachers and parents from six Catholic primary schools on the Gold Coast of Australia. The response rate from parents was only 38 per cent (n = 725) and of these respondents, 25 per cent used a computer as part of their jobs and 21 per cent owned a computer. Because of the low response rate it must be noted that this high percentage of ownership may be inflated. The main uses of computers by the childen at home were games, programming and learning keyboard skills, whereas parents believed that keyboard skills, word processing and programming were the most important. The majority (94 per cent) regarded the use of computers in school to be very important, and the same percentage would be happy for their children to eventually work in the computer industry.

There was a 50 per cent (n = 59) response rate from teachers and of these, 18 per cent owned a computer; 86 per cent were interested in computers; 47 per cent rated themselves at least 'good' in computer experience; 95 per cent regarded computers as important, particularly in the use of keyboard skills and word processing; 98 per cent claimed their students were intelligent or highly intelligent in using compuers; 98 per cent believed parents saw computers in school as important; and 53 per cent preferred a specialist to teach computer education rather than themselves.

All principals (n = 6) regarded computers in school as important in all grades. Like teachers, but unlike parents, programming was not rated as critical as keyboard skills and word processing.

Allen concluded that the attitudes of the Gold Coast Catholic primary schools community were clear. 'They want computer education for their children and are prepared to support it' (p. 48).

In the United States, Cooper and Pace (1982), in a mailed survey of five hundred parents (chosen randomly), also found majority support for the use of computers in schools. In their study they reported support for using computers to enrich the curriculum for highly motivated students but were less enthusiastic about using computers for remedial work. It appeared there was less support by parents for computers when the parents were themselves not really aware of the potential. Cooper and Pace found that parents who used computers at work were less satisfied with current provisions for teaching students to use computers, but the entire population expressed the belief that knowledge of computers was becoming increasingly important.

With respect to teachers, the Western Australian Independent Schools (1983) surveyed all primary and secondary teachers in their school system. Replies were received by 46 per cent primary (n = 643) and 51 per cent secondary (n = 920) teachers. About 2 to 4 per cent of secondary and 5 to 7 per cent of primary teachers professed no basic understanding of basic computer competencies (such as knowledge of elementary computer terminology), and the majority claimed they had some understanding but were not competent in many aspects of computer literacy.

Goddard and Pereira-Mendoza (1984) surveyed the attitudes of 434 teachers in the United States towards computers. Where there were computers in schools, teachers were much more positive. Teachers were positive regardless of which grades they taught, whether they were male or female, their academic background, and the number of computer courses taken. But teachers in schools where there were already computers were much more positive than those in schools where there were no computers. There are studies which report resistance by teachers to using computers (Griswold 1984; Killian 1984), and others which highlight the importance of the teacher as an active leader to organise and promote computer awareness (Hiltz 1984).

Review of sex differences in attitudes and computer use

It has become almost axiomatic to assume that there are critical differences between males and females with respect to attitudes to computers and computer use. So many writers have commented on these differences that these opinions themselves may lead to negative attitudes on the part of females and subsequent avoidance of the technology. Examples of such writings include Tobias (1980), *Businessweek* (June 21 1982), Mathews and Winkle (1982), Campbell (1984), Gripshover (1984), Hawkins (1984) and Lockheed (1984).

One widely cited Australian book, *Gender at work* (Game & Pringle 1983) provides an example of researchers making claims about differences between males and females on little, if any, data. Without citing evidence, Game and Pringle noted that women are over-represented in the unskilled data entry jobs, coding, the more 'feminine' jobs of demonstrating, management, teaching and consulting, but not the operating, programming, systems analyses, management, sales and installation jobs. They argued that these differentiations occur because of the image that computers were for the maths or science persons (i.e. boys), were associated with power and control, and were primarily military related and involved heavy work. Game and Pringle argued that clear demarcations between jobs are evolving. For example, system analysts were defined 'as requiring creative thinking (male!) and business skills. Since women have never been welcome at the top of the business world, they were substantially excluded' (p. 85). The position of operators, the most rapidly deskilled job, became more manual such that it was unnecessary for operators to understand what the programs were ever intended to do. This role stayed male, claimed Game and Pringle, because of the extra monies that could be earned via shift work and overtime. Data processers, who apparently do not gain from shift work and overtime, are typically women and are usually segregated from males to minimise interaction. They also argued that women are being allowed into the lower roles as this 'makes junior males feel a lot more secure about **their** promotion prospects' (p. 90). There has been a move by women into programming, and this, they argued, can be explained by the development of languages like Fortran and Cobol and by the introduction of structured programming. This 'made possible a fragmentation of jobs and the setting up of complex hierarchies. The work is controlled by the chief programmer or team leader and much of the work is extremely routine' (p. 87). This is a difficult argument to defend as Fortran and Cobol have been in widespread use for at least twenty years.

Game and Pringle concluded their interpretations of the computer industry by claiming that the reason for male dominance related to 'toys for the boys':...the computer is the ultimate in machines, the giant phallus. Men see it as an extension of the social power they are allocated through possession of a penis' (p. 89).

While not denigrating the role of speculation and conjecture in the early stages of research, it is unfortunate that more systematic research has not been used to support or refute these opinions. It may be that there are differences, it may be that building expectations about differences can create differences, and it may be that there are differences only in certain aspects of using computers. It seems important to review the literature and establish a reasonable data base **before** making claims, and promoting causes.

A meta-analysis of research on sex differences and computer use

To assess whether differences between male and female usage of computers has been found in previous literature, a meta-analysis was conducted. To identify the articles for the meta-analysis, a search of three data bases was carried out. Using the terms 'computer or microcomputer', and 'attitude or achievement', and 'woman, girl, female or sex (and derivatives)', ninety-two studies were identified in ERIC, thirty-two studies were identified in Psychinfo, and zero in Microcomputer index. The bibliographies from these studies were also inspected for further relevant studies. Unfortunately, most of these articles were statements of opinion on how girls are different from boys in the use of computers. Only nineteen articles included an adequate level of data to permit the studies to be used in the meta-analysis.

Although these nineteen articles yielded ninety-seven comparisons between males and females (based on twenty-two thousand persons) the generalisability of any meta-analysis based on this number is seriously compromised. At least, the limited set of studies generates the strong conclusion that there is little substantive empirical data on how males and females differ with respect to computers. Before embarking on the meta-analysis, four representative studies are reviewed to provide a flavour of the literature.

Fletcher and Atkinson (1972) investigated the effects of a computer-assisted instruction package primarily aimed at teaching reading decoding skills. Prior to receiving any exposure to the package, twenty-five pairs of first grade boys and twenty-five pairs of first grade girls were matched on reading readiness skills. One of each pair received the package, and the other student received normal classroom instruction. The computer-assisted instruction students received eight to ten minutes of computer-assisted instruction each school day for about twenty-one weeks. Three outcome measures were used: the Stanford Achievement Test (word reading, paragraph meaning, vocabulary, and word study), the Californian Co-operative Primary Reading Test, and a test constructed specifically to assess the goals of the reading program.

Because of attrition, only twenty-two pairs of boys and twenty-two pairs of girls were available at the end of the course. The results for the computer-assisted instruction groups are presented in Table 1. Girls are, on average one-quarter of a standard deviation above boys on the Stanford Achievement test, one-tenth of a standard deviation behind in the test aimed at assessing direct gains of the package, and were similar to boys on the co-operative reading test. Results from the subtests of these tests were also presented. While the differences were generally small, girls outperformed boys (overall effect = −0.09). Yet, when compared to the non-project groups, boys gained more than girls (effect sizes = 0.89 vs 0.63).

TABLE 1 EFFECT SIZES FOR BOYS AND GIRLS FROM FLETCHER AND ATKINSON (1972)

	Stanford achievement		*Co-operative reading test*		*Specifically constructed*	
	Mean	*Standard deviation*	*Mean*	*Standard deviation*	*Mean*	*Standard deviation*
Boys	109.7	24.1	33.2	8.6	64.9	7.0
Girls	115.7	26.2	33.7	10.4	64.1	7.6
Effect	−0.24		−0.05		0.11	

Overall, Fletcher and Atkinson concluded that daily, eight to ten minute computer-assisted instruction sessions in initial reading yielded significant improvements, both statistically and practically. We would add that these gains were greater for boys than for girls, yet girls typically outperformed boys.

An example of a study that assesses differences in male and female attitudes to computers is provided by Wagman (1983). He developed the Cybernetics Attitude Scale with ten items on each of ten subscales. These subscales related to the impact of computers on society, the value of computers, the use of computers to aid understanding, in counselling, in education, in medicine, in politics, in the justice system, in finance and banking, and in mathematics and statistics. He administered the scale to sixty-three male and fifty-eight female undergraduates. The means, standard deviations, and effect sizes for the scales, where there were significant differences between the sexes, are presented in Table 2. Overall, females had more negative attitudes to computers than males.

TABLE 2 DIFFERENCES BETWEEN MALES AND FEMALES FROM WAGMAN (1983)

	Males		*Females*		
	Mean	*Standard deviation*	*Mean*	*Standard deviation*	*Effect*
Society	33.11	8.61	38.31	9.04	0.59
Values	42.40	6.50	45.85	6.71	0.52
Cognition	40.98	8.34	44.60	8.93	0.42
Education	45.03	9.38	49.24	8.61	0.47
Justice	31.25	7.02	34.19	7.40	0.41
Total	392.52	53.62	417.22	57.79	0.07

Note: A low score represents more favourable attitudes.

Fitzgerald, Hattie, McGrath and lakin (1982) evaluated the introduction of computers in the Nyngan school district. The aim of the Nyngan project was to increase computer awareness and to give these students an advantage with respect to possible job opportunities. More than three hundred students were tested prior to the introduction of computers and again at the end of the first year. After one year of computers, students believed, more than before exposure, that computers would not reduce working time, and that they are not necessary to handle the difficult problems of everyday life. The students also indicated that they needed to be clever to use computers and that computers had little or no effect on their lives. There were no sex differences in attitudes to computer usage.

Webb (1984) was specifically concerned with the cognitive abilities and styles related to learning by using computers in small group settings. Webb devised a study wherein thirty-five junior high school students were taught Logo and their achievement in this task was related to a variety of pretests. High scores on the Logo tests were related to previous computer experience, field independence, and high scores in mathematics, reasoning and spatial abilities. There were, however, no significant relationships between the outcome measures and sex, or holistic versus analytic processing. 'The means of girls and boys on the programming tests were nearly identical' (p. 1081). The effect sizes between sex and command knowledge was 0.10, syntax −0.10, generating programs for graphics 0.08, program generation −0.14, logical relations 0.08, and total score 0.02. Webb also reported that group composition does not seem to affect learning. For both sexes, verbal interaction in the group seemed to influence learning of basic commands and syntax but was not related to learning how to interpret and generate graphics programs, which tends to be the primary focus of Logo.

RESULTS FROM THE META-ANALYSIS ON SEX DIFFERENCES AND COMPUTER USE

The average effect across the ninety-seven comparisons was 0.104 (standard error = 0.03) indicating that there was, at best, a small difference between males and females. Even when individual studies rather than the effect size was taken as the unit of analysis (Hattie, Sharpley & Rogers 1984), the average effect remained at 0.104 (se=0.05). Thus, on outcome measures, males score about one-tenth of a standard deviation above females. Or about 4 per cent of male students exposed to computer learning score higher on various attitude and achievement tests than female students. Like most meta-analyses, it is necessary to look at possible moderators before making any strong conclusions about this overall effect. Unfortunately, because the sample of studies is so small, it is not possible to investigate many interesting interactions.

A typical study included 165 female and 172 male 14-year-olds. There were no differences in the average effect when the higher quality studies were compared to the medium quality studies ($F = 2.47$, $df = 1, 91$, $p = 0.12$), but there were differences relating to where the article was published ($F = 2.88$, $df = 4, 92$, $p = 0.03$). Studies published in the less accessible sources (e.g. theses and conference papers) reported greater differences favouring males than those published in the more accessible sources (e.g. journals or ERIC). Maybe, the differences favouring males are so self-evident that such studies are not published. There was a significant positive correlation between the effect size and year of publication ($r = 0.24$, $df = 95$, $p < 0.001$). This suggests that the more recent studies reported greater differences between males and females.

The average age of students was 14.47 ($sd = 4.49$) and there was a significant positive correlation between age and effect size ($r = 0.34$, $df = 95$, $p < 0.001$). Differences between the attitudes of males and females towards computers became noticeably stronger with age. There were no major differences between boys and girls up to the age of 9 to 10. The differences in favour of males became more pronounced after this age, peaking around 15 to 17. This age difference may be caused by a psychological developmental trend, or by a cultural developmental trend in that children in today's schools, compared to those five years ago, have a richer and greater exposure to computers.

Very often, the duration of the computer course was inadequately specified. Some studies indicated a number of weeks (e.g., thirteen weeks in Stephens, Wileman & Konvalina 1981; twenty-one weeks in Fowler 1983), whereas others specified minutes (e.g. seventeen minutes in Webb 1984; 189 minutes in Fletcher & Atkinson 1972). As far as was meaningful, the duration of the study was converted to days. The correlation between duration of the computer course and effect size was 0.06 ($df = 27$, $p = 0.37$), indicating the length of the program was unrelated to the differences between males and females.

Computers were used as supplements to teaching for thirteen effects and as a substitute for twenty-six effects. There were no differences between the two average effects sizes ($F = 2.41$, $df = 1,37$, $p = 0.13$). It was possible to identify six different kinds of computer usage (drill and practice, tutoring, computer-managed learning, simulations, programming, and Logo), and there were no overall differences in the effect sizes across these usages ($F = 1.81$, $df = 5,32$, $p = 0.14$). There was one notable exception in that courses using simulations led to females having greater achievement gains and more positive attitudes (average $= -0.26$, $se = 0.06$, $n = 5$) than males.

Mathematics and science computer courses tended to produce greater differences favouring males, whereas reading courses favoured girls. When the achievement tests were commercially standardised tests, there were no differences between males and females (effect $= -0.05$, $se = 0.07$, $n = 16$), but when the tests were created by the researcher or teacher there were larger differences favouring males (effect $= 0.13$, $se = 0.03$, $n = 74$). Thus, there may be bias or expectations built into studies when teachers devise their own instruments.

The majority of outcome measures related to end-of-course examinations (average $= 0.00$, $se = 0.04$, $n = 28$) or attitudes (average $= 0.15$, $se = 0.03$, $n = 66$). Girls did not differ from boys in terms of how much they learn, but boys developed more positive attitudes towards computers, as a consequence of using computers, compared to girls. Any differences between the sexes in time to learn favoured girls rather than boys (average $= -0.07$, $se = 0.17$, $n = 3$).

CONCLUDING COMMENTS ON THE META-ANALYSIS

Perhaps the major finding from this meta-analysis must relate to the paucity of empirical research. Of the few studies that were located, the conclusion is that the effect size is not indicative of substantial differences between males and females. Yet, if the effect size is greater with older students (as is indicated by the meta-analysis), the discrimination against females could develop into a substantial effect.

3 RESEARCH DESIGN OF THE AUSTRALIAN STUDY

Survey of a thousand schools

A detailed questionnaire was sent to a thousand schools throughout Australia. The sample was a proportional stratified random sample based on metropolitan/country, primary/secondary, government/Catholic/other, independent, and State or Territory. The response rate was 82 per cent. The letter accompanying the survey requested both the principal and/or the computer resource person(s), complete the survey. From the obvious diligence most gave to completing the survey, it was our impression that accurate data were provided. Table 3 presents the number and per cent return of the questionnaires.

TABLE 3 TOTAL NUMBER OF SCHOOLS IN AUSTRALIAN SAMPLE (PER CENT RETURN IN PARENTHESES)

	Government		*Other*		
	City	*Country*	*Catholic*	*Independent*	*Overall*
Primary	373 (71%)	225 (99%)	132 (80%)	27 (70%)	757 (80%)
Secondary	70 (94%)	41 (93%)	40 (72%)	9 (100%)	160 (91%)
Combined	26 (12%)	20 (100%)	13 (77%)	30 (100%)	89 (72%)

Survey of students, teachers and parents in thirty-two schools

In each State and Territory of Australia, one Catholic, one independent, and two government schools were chosen provided that two of these schools were primary and two were secondary schools. The schools were chosen by the computer branch of each State Education Department (or non-government or Catholic department) as having been involved in computers for a number of years and which were in the capital city. In the primary schools samples of Year 5 and Year 6 students, and in the secondary schools samples of Year 8 and Year 11 students, were used (n = 30 in each grade/school). An independent random sample of sixty parents (thirty questionnaires were addressed to the father and thirty to the mother), and at least eight male and eight females teachers were also surveyed. Altogether, 1868 students, 1361 parents, and 385 teachers from thirty-two schools responded to the questionnaire. This represented response rates of 97 per cent, 71 per cent and 75 per cent respectively.

Research questionnaires

As much as possible, the questionnaires presented to students, parents and teachers were made as similar as possible.

SCHOOL QUESTIONNAIRE FOR NATIONAL SAMPLE

The school questionnaire asked for information on types of school, location, sources of special funding, numbers of students, teachers and specialist teachers. Estimates were requested of the percentage of students who had one or both parents born in various regions of the world and of the percentage of parents in upper, middle and lower income levels.

Under a heading 'Advantages of computers in classrooms', the respondent to the school questionnaire (which was addressed to the school principal) was asked to rate fourteen statements from 'strongly undesirable' to 'strongly desirable' in terms of the contribution of computers to classroom activities. Examples of the statements that were rated include:

- for helping students who are having problems coping with normal classwork;
- for developing language and writing skills through word processing;
- for developing learning and skills through simulation and educational games;
- developing social skills; and
- teaching, questioning, and adapting to student learning problems.

A second set of statements under the heading 'Computers could introduce a number of problems' were rated from strong disagreement to strong agreement. Examples of the statements include that:

- there are not enough teachers with both teacher training and specialised training in using computers to act as key resource people in my school;
- there is little appropriate high quality computer software available to support the curriculum in Australian schools;
- insufficient funds are available for the purchase of computer equipment; and
- computers will lead to a reduction in important social activities in the classrooms.

All schools were requested to complete the background data and rate the advantages and problems. The second section of the questionnaire was completed only by schools involved in computer activities.

Schools with computer activities indicated the nature of work with computers and the number of male/female students and teachers involved. Information was requested on the purchase and funding of computers from 1982 to 1985 and on the funds spent on software.

Questions 17 to 25 sought information on the level of training of computer resource people in the school, the organisation of computer activities, the grade levels in which computer activities were implemented and the kind of equipment in use.

QUESTIONNAIRE FOR ABORIGINAL SCHOOLS IN SOUTH AUSTRALIA

In order to examine computer activities in schools with a high proportion of Aboriginal students in a little more detail than was possible in the general school survey, the school questionnaire was modified to obtain additional information from schools in one State (South Australia). The additional information included whether funds had been obtained from the Aboriginal educational grants, the number of Aboriginal resource teachers and Aboriginal education workers, the number of Aboriginal students from various types of traditional and non-traditional communities. Two open-ended questions were included which asked about uses of the computer that had been found to be particularly useful for Aboriginal students, and areas in which the respondent would like to see software development particularly appropriate to Aboriginal students.

STUDENT QUESTIONNAIRE

Background items

Most of these items are obvious and appear in many questionnaires. The birth order item was included because of arguments about the potency of this variable to account for differences in behaviour (Zajonc & Marcus 1975).

Socioeconomic status was a difficult variable to measure. This was complicated as it was desirable the item be similar in the student and parent questionnaires. It is a sensitive item, and when asked in certain ways the question can occupy an inordinate amount of space. In Australia, the Congalton scale (1971) is widely recognised as a useful index of socioeconomic status. Occupations are divided into four levels. For the present questionnaires, a variety of occupations were grouped according to level, and students were asked to identify which group included their father's or mother's job, or the group which was the closest. If this was not possible, they were requested to describe the job, and these descriptions were subsequently coded by the researchers.

Upon advice from the Department of Immigration and Ethnic Affairs concerning the distribution of ethnic groups in Australia, an item was constructed to assess where the parents were born. If both parents were born overseas, then the parent from the culture most different to Anglo-Saxon culture was coded.

Given the time constraints, it was not possible to administer an achievement test. From our previous research, students are reasonably adept at estimating their performance, although they tend to overestimate. Good estimates can be obtained provided some benchmark of comparison and an understandable range is provided (Mabe & West 1982). From our previous research, the correlation between these estimates and actual performance is high.

It was obviously necessary to assess the degree of usage, the length of usage, and competencies of computer use.

The last two items in the background section relate to preferred school options and plans for future study (although the last question was generally appropriate only for the secondary students).

Self-concept

The self-concept instrument was devised in previous studies (Song & Hattie 1984; Hattie 1985b). It has been extensively trialled (with more than six thousand students) and has good psychometric properties. The instrument is based on a modification of a model of self-concept proposed by Shavelson, Hubner and Stanton (1976). This is a hierarchical model and in the instrument there are five items for each of the seven scales. The seven dimensions are classroom, ability, achievement, peer, family, confidence in self, and physical self-concepts.

School environment

Two scales, opportunity and general affect, were used. These scales are derived from the research by Williams and Batten (1981) measuring school climate in Australian schools. The items actually used in the present study were those which were most psychometrically robust as reported in Williams and Batten and by Hattie, Byrne and Fraser (1985).

Attitudes to computers

The instrument used in the present study was based on research by Fitzgerald, Hattie, McGrath and Iakin (1982) and assessed eight domains: usefulness of computers in classrooms; apprehension towards computers; alienation; perceived usefulness for job opportunities; sexism; future use of computers; association of computers and cleverness; and teachers and computers.

Processing styles

A particularly potent set of variables relates to processing style. More than actual achievement, processing styles can account for important and substantial amounts of variability in classroom learning. From a recent resurgence of interest in processing variables, it is clear that there are at least two important dimensions of information processing ability which are at times called serial and parallel processing and in other contexts called simultaneous and successive processing.

The development of models of simultaneous and successive processing is closely related to the earlier pioneering research by Luria (1973). The effectiveness of these variables, in accounting for variance in both laboratory and school learning tasks, has been repeatedly established by postgraduate research supervised by the authors at the Centre for Behavioural Studies, University of New England (Fitzgerald 1973, Green 1977, Grabham 1980, Tulloch 1981, Ransley 1982, Walton 1983, Klich 1983, Angus 1984).

The tests used to tap these processing abilities are, unfortunately, rather lengthy and certainly beyond the logistics to administer in the present study. As an alternative, a set of items was developed such that only a stated preference was required. These items were based on an earlier study (Hattie 1985b), but were refined in a continuing program of research (Fitzgerald & Green 1985) to improve their validity.

A larger set of cognitive preference items was administered to a group of 109 students who had already been administered the full Luria battery, initially developed by Fitzgerald (1973). Items were selected on the basis of the correlations between the preference items and the Luria battery, the reliabilities, and the degree to which the items discriminated between simultaneous and successive processing (as measured by the Luria battery).

Anxiety

Four items were included to assess anxiety.

Suspension of judgment

To assess this variable, four items were included.

Scenario analysis

Given that the schools chosen for the study of student, teacher and parent attitudes had been substantially involved with computers for a number of years, it is expected that most students would have been exposed to computers. This is not to say, however, that the students would be accomplished users and certainly, many might not appreciate some of the diverse uses of computers in classrooms. The same problem of understanding could well apply to teachers and parents.

To counter this, a set of nine typical uses were described, and then nine attitude questions were asked about each use. Further, for the students, a question was asked about how much time on average per week the student used a computer for each activity. The nine activities described were word processing, drill and practice, improving thinking processes, computer-managed learning, games and simulations, programming, as an 'intelligent' tutor, data base applications, and a general use relating to using computers in classrooms.

PARENT QUESTIONNAIRE

Questionnaires were sent to sixty parents from each school. As far as was practicable, the parents were randomly chosen. Each questionnaire was sent home in an envelope addressed either to the mother or the father. A covering letter explained the purpose of the survey and asked the person to whom the envelope was addressed to complete the questionnaire.

In the background section, parents were asked to indicate gender, socioeconomic status (in the same way as students), computer usage, competencies, and length of computer experience.

A set of fourteen advantages of using computers in classrooms was listed and parents were requested to indicate the desirability of each. Further, a set of fourteen problems associated with the introduction of computers was also presented. For each set, there was provision for parents to add advantages or problems.

Like the questionnaire administered to students, the parents' questionnaire included items on the attitude to computers. For each of the scenarios, parents were asked the same nine questions as the students, but the tenth item related to the lowest grade in which they believed each type of computer activity would be useful in helping students learn.

TEACHER QUESTIONNAIRE

The background items asked about teaching experience, training with computers, computer competencies, and amount of preparation time they perceived as necessary to use computers.

The same sets of advantages and problems as in the parents' questionnaire were included, as was the attitude to computer and scenario analyses.

4 RESEARCH RESULTS FROM SURVEY OF A THOUSAND SCHOOLS

Responses to school survey

Before detailing computer usage, it is useful to place the results in perspective by describing an 'average' primary and secondary school in Australia. In such an 'average' primary school there were thirteen teachers (four males and nine females) and 253 students (129 males and 124 females). In an 'average' secondary school there were fifty-five teachers (twenty-six males and twenty-nine females) and 752 students (353 males and 399 females). In this secondary school there would be nine male and five female mathematics/ science teachers.

There was considerable variation in the distribution of students from different ethnic backgrounds. The typical school had 2.6 per cent Asians, 10.2 per cent from Southern Europe, 8.5 per cent Northern Europe, 1.6 per cent from the Middle East, 2.6 per cent Aborigines, 73.3 per cent other Australian, and 1.1 per cent from other regions not listed. Similarly, the distributions varied for socioeconomic status with an average of 13.7 per cent in the upper income levels, 49.1 per cent in middle, and 37.2 per cent in the lower levels.

Computer activities in schools

Table 4 indicates the percentage of schools reporting computer applications. Computers were more likely to be found in secondary schools (98 per cent) than in primary schools (57 per cent), and there was an average of three computers per primary school and fourteen computers per secondary school (in those schools which had at least one computer). There were more independent schools with computers (82 per cent) than Government (67 per cent) or Catholic schools (67 per cent). There was a similar distribution in the city (58 per cent) and the country (50 per cent). There were twice as many computers per city school (9.3) than country school (4.9), but this statistic does not take into account that many country schools can be quite small. There was one computer per 123 students in city schools and one computer per eighty-two students in country areas. It does not appear that country schools are disadvantaged with respect to computer hardware.

TABLE 4 PERCENTAGE OF SCHOOLS REPORTING COMPUTER APPLICATIONS (NUMBER OF SCHOOLS IN PARENTHESES)

	Government		*Other*		
	City	*Country*	*Catholic*	*Independent*	*Overall*
Primary	60% (263)	60% (229)	45% (94)	58% (19)	55% (605)
Secondary	98% (66)	95% (33)	97% (32)	89% (9)	98% (145)
Combined	33% (3)	95% (21)	90% (10)	97% (30)	92% (64)

Of the schools surveyed, 67 per cent had some computer activities in their school. Of the schools which had computers, there was an average of eight computers per school (at a cost of $1656 each in 1985, of which 66 per cent was funded by the government). There were more secondary schools with computer activities (98 per cent) than primary schools (57 per cent). There was no difference in the number of schools reporting computer activities with respect to socioeconomic area of the school (69 per cent of schools largely drawing on upper socioeconomic status reported involvement with computers; middle socioeconomic status, 67 per cent; lower socioeconomic status, 69 per cent). Given that the sample represents 10 per cent of the total number of schools in Australia, it is estimated there are about thirty-five thousand computers in Australian schools. This represents an investment in hardware of approximately $57 million.

There was an average of two to three teachers who act as computer resource persons in those schools which had computer activities. Sixty-four per cent of these were men, and the average age was 3?. The resource people in secondary schools were most likely to be teachers of maths or science (72 per cent). The majority of these resource persons had attended no courses or formal training, or received minimal preservice or inservice courses in computer applications (69 per cent). Another 19 per cent had substantial inservice training, and 12 per cent had a diploma, certificate or degree in computer applications.

Computers are primarily used for word processing, drill and practice, simulation and gaming, computer awareness courses, in maths and science, and least used for data base applications, specialist courses in computer studies, and computer-managed learning. There were more male teachers than female teachers (relative to the number of male and female teachers within each school) using computers for simulation and gaming, as a tutor, for Logo, and for word processing. Male teachers also used the computer more often. Male and female students tended to use computers for the various tasks to a similar degree. The only differences were that more female students used computers for graphics and word processing. It is of some interest that word processing is the activity that principals considered to be the activity increasing the fastest. Other reported increases were Logo, data base applications, learning in subjects other than maths or science, simulation and gaming, spreadsheets, and the use of graphics. The declining uses were computer-managed learning, programming, drill and practice, school computer clubs, computer awareness courses, and specialist courses in computer studies.

Computer applications in South Australian Aboriginal schools

Of the fifty Aboriginal schools surveyed, thirty-eight or 76 per cent returned questionnaires. The majority of these schools were in the country (87 per cent) and were government schools (97 per cent). Consequently, to facilitate interpretation, all government and country schools in the sample from South Australia were used for comparison purposes (n=23). Fifty-three per cent of the Aboriginal schools were primary schools, 16 per cent secondary and 32 per cent were combined primary and secondary, and all were co-educational. There was an average of twelve male and thirteen female teachers, as well as 1.1 male and 1.2 female Aboriginal resource teachers, and 1.3 male and 2.2 female Aboriginal education workers. Of the average there were 327 students per school and 34 per cent were Aboriginal (13 per cent from traditionally-oriented communities, 16 per cent from rural non-traditional communities, 4 per cent from urban non-traditional communities, and 1 per cent from dispersed urban families).

For the Aboriginal schools, 50 per cent were considered to be disadvantaged schools and received grants from the disadvantaged schools program (compared to 9 per cent in the comparable but non-Aboriginal schools in South Australia), 44 per cent of the Aboriginal schools received funding from the Participation and Equity Program (compared to 0 per cent in comparable South Australian schools), 30 per cent received funding from the English as a Second Language program (compared to 10 per cent in comparable South Australian schools), and 69 per cent received funds from Aboriginal education grants.

Of these Aboriginal schools, 79 per cent had some computer activities compared to 30 per cent in the comparable South Australian schools and 67 per cent in the national sample. There were twice as many computers in the Aboriginal schools compared to the others. There were three times as many resource persons in the Aboriginal schools. These figures for the Aboriginal schools are close to the national averages.

Of the Aboriginal schools reporting computer activities, 83 per cent of the schools indicated that funding of the computer equipment was either substantially (60 per cent or more) or totally provided by parent associations. Furthermore, 50 per cent of the Aboriginal schools reporting computer activities bought the computing equipment entirely from parent association funds.

In Aboriginal schools reporting computer activities, the software being used by 60 per cent of the schools was at least 50 per cent produced in Australia. A considerable number of schools (eleven schools out of thirty) stated that 80 per cent of their software was produced in Australia, and 10 per cent of the Aboriginal schools with computer activities reported a substantial part of their software (20 per cent or more) was produced by teachers and students in the school.

The Aboriginal schools rated the advantages and problems of introducing computers, and the trends in computer use similarly to the national sample.

To the question 'Are there any uses of the computer that you have found particularly useful to Aboriginal students?' the most common responses emphasised the value of the computer for drill and practice (preferably in a gaming context) in the areas of remedial mathematics and literacy, particularly spelling. Equal stress was placed on the value of word processing applications with particular reference to the way in which the computer could provide an environment in which the student could experiment with words and sentences without fear of making mistakes.

Aboriginal schools were asked the question 'Are there any areas in which you would like to see software development particularly appropriate to Aboriginal students?' As with the first question, the responses highlighted the need for high quality software to support basic numeracy and literacy programs, particularly software with an Aboriginal cultural bias. Other comments reflecting the need to use culturally appropriate computer applications included using tribal language as a basis for developing phonics, writing and grammar skills, and developing an Aboriginal data base of historical events, dates and geographical information.

Distribution of computer makes

Tables 5 and 6 indicate the distribution of makes of computers across States, regions, and types of school. These two tables point to the remarkable diversity of machines, yet four brands constitute 78 per cent of all machines: Apple (34 per cent), Commodore (19 per cent), BBC (12 per cent), and Microbee (13 per cent).

Funding of computer applications

The funding of computers was similar across States. For both primary and secondary schools, about 70 per cent of the cost of computers was funded by government with the remainder, typically, coming from parent associations. This level of funding has not changed over the past five years, and the average cost of computers has also remained reasonably constant ($1600 per computer).

Seventeen per cent of the schools surveyed had received funding under the Disadvantaged School Program, 12 per cent of the schools had received funding under the Participation and Equity Program and 13 per cent under the English as a Second Language program. Si, y-one per cent of the schools that had received Disadvantaged School Program funds had some form of computer activities in progress. Of the schools funded under the Participation and Equity Program, 95 per cent were involved in computer activities. Of the schools funded under the English as a Second Language program, 67 per cent were involved in computer activities (compare Table 7).

Perceived advantages of introducing computers

All schools were asked to rate on a scale from 'strongly undesirable' to 'strongly desirable' fourteen statements under a heading 'Advantages of computers in classrooms'. Table 11 presents the means of the ratings.

The most highly rated contributions of computers to classroom activities were to develop language and writing skills through word processing (mean rating of 5.2 on a rating scale from strongly undesirable as 1 to strongly desirable as 6), as an information source—e.g. library support, access to information, data bases (mean=5.0), for simulation and gaming (mean=4.8), for students having problems coping with normal classwork (mean=4.7), for drill and practice (mean=4.7) for administrative tasks (mean=4.6), and to help students gain deeper understanding of school work (mean=4.3). The least desirable 'advantages' of the list of fourteen were for marking and analysing tests (mean=3.4), as a reward for students performing good work (mean=3.3), and to develop social skills (mean=3.2).

TABLE 5 PERCENTAGE DISTRIBUTION OF COMPUTERS WITHIN EACH STATE (BASED ON NUMBERS REPORTED IN SCHOOL SURVEY)

Computer	*Total number*	*N.S.W.*	*Vic.*	*Qld*	*Tas.*	*S.A.*	*N.T.*	*W.A.*	*A.C.T.*
Apple	262	37	36	52	25	18	38	4	56
Macintosh	9	2	0	1	0	3	0	1	0
Microbee	103	32	3	9	2	0	3	19	1
BBC	94	2	8	3	54	13	6	34	2
Atari	12	5	1	0	0	0	3	0	0
IBM	1	1	0	0	0	0	0	0	0
Tandy	35	3	4	11	0	3	3	5	0
Ohio	4	0	0	2	0	1	0	0	0
Commodore	148	8	32	6	3	57	29	12	1
Others	107	10	15	1[illegible]	15	6	18	23	0

TABLE 6 PERCENTAGE DISTRIBUTION OF COMPUTERS BY REGION AND TYPE OF SCHOOL

Computer	*Total number*	*Metropolitan*	*Country*	*Primary*	*Secondary*	*Government*	*Catholic*	*Independent*
Apple	262	58	42	21	79	70	2	9
Macintosh	9	71	29	0	100	71	14	14
Microbee	103	58	42	55	45	[illegible]	13	6
BBC	94	70	30	57	43	66	21	14
Atari	12	11	89	78	22	100	[illegible]	0
IBM	1	100	0	0	100	33	33	33
Tandy	35	64	36	62	38	67	18	15
Ohio	4	50	50	25	75	100	0	0
Commodore	148	57	43	80	20	74	15	11

TABLE 7 SCHOOLS WITH SPECIAL FUNDING (PERCENTAGE WITH COMPUTER ACTIVITIES)

	Funds not provided	*Funds provided*
Disadvantaged Schools Program	67%	63%
Participation and Equity Program	64%	95%
English as a Second Language Program	66%	66%

Government schools were less supportive than either the Catholic schools or the other independent schools of introducing computers for analysing tests, administrative tasks and in special education. Independent schools were less supportive than the government or Catholic schools of introducing computers for developing social skills. Catholic schools were more supportive of the use of computers for marking and analysing tests and for general administrative tasks. Secondary more than primary schools favoured the use of computers as an information source, for teaching programming, diagnostic testing, marking and analysing tests and for general administrative tasks.

Compared to schools which do not have computers, schools which have computers see more value in the use of the computer for word processing, simulation/games and developing social skills.

Generally, the advantages were rated similarly by primary and secondary principals. The only exception was that secondary principals rated administrative tasks as more advantageous than primary principals. Similarly, the ratings were similar in schools with and without computers, except that those with computers rated testing applications as not as advantageous.

Perceived problems of introducing computers

Table 12 presents the means of ratings of statements under the heading 'Computers could introduce a number of problems'.

The most significant problems associated with introducing computers were that there were not enough computers available for classroom use (mean = 5.3), there were insufficient funds for the purchase of equipment (mean = 5.1), not enough teachers with specialist training to act as resource teachers (mean = 4.7), teacher education institutions are not providing adequate preparation in the educational use of computers (mean = 4.4), lack of suitable inservice courses (mean = 4.0), and too little is known about how children learn when using computers (mean = 4.0). The problems of least concern in the list were that computers would lead to a reduction in important social activities (mean = 2.3), only the brighter students would tend to use computers (mean = 2.0), and that computers would lead to a reduction in the number of teachers required in the classroom (mean = 1.6).

Primary principals were more concerned than secondary principals with the lack of teachers with specialist training in the use of computers, insufficient funds and the lack of computers. Secondary principals were more concerned with giving up important preparation time to develop computer applications and the lack of quality software. There were no differences in the perception of problems between government, Catholic or independent schools, or between city and country schools. Generally, those schools with computers were not as concerned with these problems as those without computers.

Computer activities

In schools which have computers, about 43 per cent of the students are regular users and only 20 per cent were classified as non-users. The distribution across grades indicates the regular use of the computer peaks in the latter years of primary school. The use of computers is not maintained when children enter secondary school.

The pattern of use was quite different in primary and secondary schools. In primary schools, the most frequent activities were drill and practice (in 72 per cent of schools where there were computers), word processing (64 per cent), simulation and gaming (63 per cent), Logo (48 per cent), use in mathematics and science (48 per cent), and computer awareness (45 per cent). Least frequent were programming (15 per cent), computer clubs (15 per cent), computer-managed learning (8 per cent), and spreadsheets (7 per cent).

In secondary schools, the dominant activities were programming (83 per cent), word processing (76 per cent), computer awareness (71 per cent), data bases (61 per cent), simulation and gaming (59 per cent), in mathematics and science (59 per cent), drill and practice (56 per cent), and in Year 11 and 12 specialist courses (52 per cent). The least frequent activities were in computer clubs (44 per cent) and computer-managed learning (16 per cent).

The trends in the primary schools indicated increasing work in word processing, Logo, in areas other than mathematics and science, for simulation and gaming, and use of graphics packages. The 'trend' information indicated a decline in programming, spreadsheets activities and computer-managed learning.

The trends in the secondary schools were increases in word processing, use of computers as 'intelligent' tutors, data bases, spreadsheet applications, work in areas other than mathematics and science, and Logo. There were declines in computer clubs, computer awareness courses, programming and computer-managed learning.

Besides academic uses, schools are using computers in administration (40 per cent in schools where there is a computer) and in libraries (19 per cent).

Location of computers

Many schools have a computer laboratory where classes engage in computer activities (44 per cent), an almost equal number have computers located fairly permanently in normal classrooms (43 per cent), and somewhat less have computers mobile between classrooms (30 per cent). These percentages add up to more than 100 per cent as some schools have more than one configuration.

Few schools have access to networks located outside their schools (12 per cent) or to local area networks within their school (13 per cent).

5 COMPUTER USE AND ATTITUDES OF PARENTS, TEACHERS AND STUDENTS

Characteristics of computer users

Regular users of the computer (that is, those who used computers at home, school or work at least once a week) included 68 per cent of the students, 32 per cent of the parents, and 50 per cent of the teachers who completed the survey. Allowing for the different numbers of teachers across subjects, there was a higher percentage of regular users in primary schools. There was a higher ratio of teachers who used computers to teachers who did not use computers in secretarial studies than in art, science, music, geography, history, English and language. There was an approximately equal number of computer users and non-users in mathematics and foreign languages. Just as many males as female teachers classified themselves as regular users. There were more primary teachers than secondary teachers who were regular users of the computer.

Not surprisingly, regular users have had substantial inservice or preservice courses or have a diploma or certificate in computer education. Those who have had a few hours to less than a week of inservice coursework in computers in classrooms tend to be more regular users than teachers without that training. The majority of teachers had no computer courses in their initial teacher training.

The student users tended to be males (see Table 8), higher achievers and primary students. There were no significant differences between users and non-users relating to socioeconomic status, birth order, ethnic origin, and future plans for further study or work after leaving secondary school. Boys, more than girls, claimed they were more competent at using computers. As many girls as boys, however, rated computer activities among the most preferred activities at school, but more girls than boys rated computer activities among the least preferred subjects.

TABLE 8 THE NUMBER (AND PERCENTAGE) OF MALE AND FEMALE RESPONDENTS WHO ARE REGULAR OR NON-USERS OF COMPUTERS

	Irregular or non-users		*Regular users*		
	Male	*Female*	*Male*	*Female*	*Total*
Student	242 (13%)	343 (18%)	685 (37%)	587 (32%)	1857
Parent	363 (27%)	538 (41%)	286 (22%)	136 (10%)	1323
Teacher	88 (23%)	105 (27%)	86 (22%)	106 (28%)	385
Total	693 (19%)	986 (28%)	1057 (30%)	829 (23%)	3565

Parent users were more likely to be male (22 per cent were regular users) than female (10 per cent). More female teachers used computers (males 22 per cent, females 28 per cent). Users were more likely to be secondary (54 per cent) than primary teachers (46 per cent), and were teachers of mathematics or science (72 per cent in secondary schools). Computer use was unrelated to experience in computers at teacher training institutions, and regular users tended to be 'new' teachers.

Differences between male and female parents

Female parents of primary children were more strongly supportive of the use of computers in classrooms than male parents (Multivariate F: $p<0.02$), although both male and female parents of primary school children indicated they saw considerable value in computer use with young children. Differences between male and female parents of primary school children were particularly evident in the scenario 'In general, computers in the classroom would . . .' on the response 'be helpful to learning' although on every response to this scenario, except the response 'scare and worry students' the mean differences were in the direction of stronger female support.

Parents of secondary school students were also strongly of the belief that computers would have considerable value in helping students learn, although they were significantly less supportive than their primary school counterparts (Multivariate F: $p<0.001$) particularly with respect to the item 'would lead to students helping each other' ($p<0.03$).

Both male and female parents of primary and secondary school students believed computer activities would be useful in helping students learn in the primary school, although parents of primary children believed the activities could be commenced at a lower grade level in primary school than did the secondary school parents ($p<0.001$), and female parents in general thought computers could be used profitably in lower grades than did male parents ($p<0.001$).

Differences between male and female teachers

Differences between the male and female teachers were significant (Multivariate F: $p<0.001$), although the pattern of differences were not as pronounced as in the case of the male and female parents. Female teachers disagreed more strongly than male teachers with the response that computers would 'be more useful for boys than girls' ($p<0.004$). Male teachers were more concerned than female teachers that computers would 'scare and worry students' ($p<0.04$).

Both primary school teachers and secondary school teachers agreed computers would lead to better understanding, would help students think in different and more interesting ways and would generally lead to a better use of the teachers' time. There was, however, a more positive reaction from primary teachers (Multivariate F: $p<0.001$) to the response that computers would 'lead to better understanding' ($p<0.05$), 'would help students think in different and more interesting ways' ($p<0.02$), 'would lead to students helping each other' ($p<0.001$), and in general 'be useful to help learning' ($p<0.04$).

Both male and female primary and secondary teachers indicated computer activities would be useful in helping students learn in the primary school, although more primary teachers believed that the computer could be usefully used in kindergarten to Year 2 than did secondary teachers ($p<0.001$). In general, female teachers considered the computer could be used with younger children than was felt to be the case by the male teachers ($p<0.001$).

Differences between students, teachers and parents

A multivariate analysis of variance—Manova—was calculated for each question across the nine scenarios. The independent variables were respondent (student, parent, or teacher), sex, computer use (use frequently, use infrequently or not at all), and primary or secondary. Where there were overall significant multivariate Fs ($p<0.001$), then univariate F-ratios and discriminant analyses were calculated. As there would be too many tables if all results were presented, only an overview and one example table are presented.

Table 9 presents the Manova results for the question to the scenario 'would be more useful for boys than girls'. For this question, where there were significant differences, all scenarios had significant univariate F-ratios. All respondents tended to disagree with the statement (overall mean = 1.93, standard deviation = 1.45). Students, particularly primary school male students, were more likely to claim that computers were more useful for boys. Parents and teachers consistently disagreed with the statement.

With respect to the other statements, although parents, teachers and students all supported computer applications, parents more than students and teachers supported using computers for learning reasons. They indicated that using computers would lead to students having better understanding, help students think in different and more interesting ways, and would be a faster way of learning. Students, more than parents and teachers, believed computers had value for social reasons and would improve the organisation of learning. That is, computers would lead to students helping each other, would lead to a better use of the teachers' time, and would allow students to learn more than being taught in a regular class group. With respect to particular uses, teachers, more than parents and students, were more supportive of the claim that word processors, drill and practice, and simulations would be a good use of computers in classrooms. Those who were reasonably regular users of the computer were more supportive of the various uses of the computer compared to the irregular or non-users. Similarly, primary teachers, primary students, and parents of primary students were more supportive of using computers than their secondary counterparts.

TABLE 9 MULTIVARIATE ANALYSIS OF VARIANCE FOR THE QUESTION '... MORE USEFUL FOR BOYS THAN GIRLS'

Source	*df*	*F*	*p*
Respondent	18,6502	27.25	<0.001
Sex	9,3251	15.54	<0.001
Computer use	9,3251	1.08	0.38
Primary/secondary	9,3251	9.20	<0.001
Respondent by sex	18,6502	3.56	<0.001
Respondent by use	18,6502	0.69	0.82
Respondent by grade	18,6502	5.41	<0.001
Sex by use	9,3251	2.17	0.02
Sex by grade	9,3251	2.56	0.01
Use by grade	9,3251	0.58	0.82
Respondent by sex by use	18,6502	0.40	0.99
Respondent by sex by grade	18,6502	1.55	0.06
Respondent by use by grade	18,6502	0.37	0.99
Sex by use by grade	9,3251	0.91	0.51
Respondent by sex by use by grade	18,6502	0.53	0.95

The most consistent difference relating to gender was for the question relating to sexism (see comments on this question above). The other trend was that males more than females argued that programming would help them learn faster and in different ways, and would help their understanding of computing. Excluding these two findings, there were no significant differences between males and females in attitudes towards the various scenarios.

Across all Manovas, the only significant interaction involving gender was related to 'who' responded (student, teacher or parent). In all cases, male students and female teachers and female parents were more likely to agree that computers were more useful, beneficial etc. Male teachers, male parents and female students were less supportive of using computers in schools.

General attitudes to computers

Seven scales were used to assess general attitudes towards computers: usefulness of computers in classrooms; apprehension towards computers; perceived usefulness of computers for job opportunities; sexism and computers; anticipated future use of computers; association between computers and cleverness; and perceived interest of teachers in computer activities. These scales were derived from previous research by Fitzgerald, Hattie, McGrath and Iakin (1982) and all had easonable estimates of reliability (see Table 10).

A Manova was calculated using the same independent variables as with the scenario analyses. Students, rather than parents and teachers, believed males were better at using computers than females, regarded computers as useful in schools, associated computers with cleverness, and were not scared or uneasy about computers. Parents, more than students and teachers, saw computers as useful for future job opportunities. With respect to gender, males more than females regarded computers as useful in classes, more useful in their future lives, were less scared and uneasy, and associated computers with cleverness. Females more than males claimed girls can be as able as males when using computers, although females did not perceive computers as important in their future lives. Computer users rather than non-users, and primary-related students, parents and teachers were generally more positive about computers.

From the significant interactions, student males, and female parents and teachers more strongly agreed that computers would be useful in future jobs and they were less scared and uneasy with computers.

Advantages and problems of introducing computers

Parents and teachers were presented with the same set of fourteen advantages and fourteen problems of using computers in classrooms which was in the school questionnaire. Overall, the main advantages were seen by the parents and teachers as using computers as an information source, for administrative tasks, for use in special education, and for teaching programming.

The uses which were rated of least advantage were as a reward in normal classwork, for computer-managed instruction, and to develop social skills (see Table 11). For five advantages there were differences between males and females. Females saw computers as being more useful for helping students who were having problems coping with normal

TABLE 10 MEANS AND ESTIMATES OF RELIABILITY (ALPHA) FOR THE COMPUTER A[illegible]UDE SCALES

		Students		*Teachers*		*Parents*		*Reliability*		
	Number of items	*Mean*	*Standard deviation*	*Mean*	*Standard deviation*	*Mean*	*Standard deviation*	*Student*	*Teacher*	*Parent*
Usefulness in classes	3	12.88	3.51	11.04	2.98	11.62	3.28	0.62	0.50	0.54
Usefulness for jobs	3	13.33	3.40	12.88	3.30	14.38	3.44	0.65	0.80	0.81
Sexism	3	7.59	3.75	5.59	3.02	6.66	3.50	0.67	0.82	0.72
Uneasiness	3	14.68	3.48	13.97	3.93	13.93	3.99	0.74	0.88	0.83
Future use	3	11.28	3.81	11.49	3.97	11.26	4.28	0.65	0.72	0.62
Cleverness	3	[illegible].05	3.46	7.07	2.76	7.61	3.25	0.55	0.57	0.63
Alienation	3	10.46	3.49	8.69	3.61	9.69	4.25	0.43	0.61	0.65

classwork, as a reward for normal classwork, for drill and practice, for word processing, and for use in special education. That is, females regarded computers as an advantage for students having problems n class.

Parents and teachers had different perceptions as to the problems of introducing computers, but there were no overall differences relating to sex or to whether the respondent was associated with primary or secondary students (see Table 12). For both males and females, the main problems were that: there were not enough teachers with appropriate training to act as computer resource persons; there were not enough computers in classrooms; there were insufficient funds for the purchase of appropriate software; teacher education institutions did not provide adequate preparation in the educational uses of computers; and there was a lack of inservice courses for teachers. The problems perceived of least importance were: the lack of high quality software; that computers will lead to a lack of social activities; that they will reduce class time for other activities; that only the brighter students will use the computers; and that computers will lead to a reduction in the number of teachers.

ADVANTAGES OF COMPUTERS

The means and ranks of the advantages are listed in Table 11.

TABLE 11 MAIN ADVANTAGES OF INTRODUCING COMPUTERS

Advantages	*School*		*Teacher*		*Parent*	
	Rank	*Mean*	*Rank*	*Mean*	*Rank*	*Mean*
For developing language and writing skills through word processing	1	5.2	4	4.8	7	4.6
As an information source (e.g. library support, access to information, data bases)	2	5.0	1	5.2	1	5.6
For developing learning and skills through simulation and educational games	3	4.8	4	4.8	5	4.8
For helping students who are having problems coping with normal classwork	4	4.7	7	4.7	9	4.1
For practising concepts and skills (e.g. drill and practice)	4	4.7	4	4.8	6	4.7
For administrative tasks (e.g. timetabling, records)	6	4.6	2	5.1	2	5.3
For use in special education	6	4.6	3	4.9	4	4.9
As a basis for helping students to gain deeper understanding of school work	8	4.3	8	4.2	8	4.3
For teaching programming	10	3.7	8	4.2	3	5.0

The most highly rated advantages of introducing computers were as an information source (e.g. library support), for administrative tasks, for use in special education, for drill and practice, for word processing, simulations and games, and for helping students who are having problems coping with normal classwork. The least advantageous of the list were as a reward for good work, and to develop social skills.

Compared to non-users, regular computer users believed the computer would help students gain deeper understanding of school work, and teach, question and adapt to student learning problems. Non-computer users regarded computers as more desirable for marking and analysing tests than computer users. Females saw computers as more useful in practising concepts and skills.

PROBLEMS OF INTRODUCING COMPUTERS

The means for the problems are listed in Table 12.

TABLE 12 MAJOR PROBLEMS OF INTRODUCING COMPUTERS

Problem	*School*		*Teacher*		*Parent*	
	Rank	*Mean*	*Rank*	*Mean*	*Rank*	*Mean*
There are not enough computers available in classrooms	1	5.3	1	4.8	1	4.6
Insufficient funds are available for the purchase of appropriate equipment	2	5.1	5	4.2	3	4.4
There are not enough teachers with both teacher training and specialised training in using computers to act as key resource people in our school	3	4.7	3	4.4	1	4.6
Teacher education institutions are not providing adequate preparation in the educational use of computers	4	4.4	2	4.5	4	4.3
Very little is known about how children learn when using computers	5	4.0	6	3.9	6	3.9
There is a lack of suitable inservice courses for teachers on using computers in the classroom	5	4.0	4	4.3	5	4.0

The problems which were seen as most significant were that there were not enough computers available, teachers institutions were not adequately preparing teachers in computer education, there were not enough teachers with specialist training, a lack of suitable inservice courses, and insufficient funds available for purchasing appropriate equipment. Least concern was expressed about the effect of computers to reduce the class time available for other important activities, that only the brighter students will tend to use computers and that computers will lead to reducing the number of teachers in schools.

Non-computer users more than computer users believed they would have to give up important preparation time in order to become familiar with computers, that computers would reduce class time available for other important activities, and lead to a reduction in important social activities in the classroom. Males more than female teachers claimed that only the brighter students will tend to use computers.

Appropriate level for the introduction of computers in classrooms

Parents and teachers were also asked when they believed computers could usefully be introduced into classes. The majority of respondents would introduce computers in Years 3 to 6, except for gaming and simulation, programming, and computer-managed instruction, where they would introduce them in Years 7 to 10. For all scenarios, computers would be introduced earlier by teachers than parents, by primary than secondary respondents, by regular than non-regular users, and by females than by males. There were no significant interactions.

6 DATA FROM THE STUDENT QUESTIONNAIRE

Altogether, 1835 students from thirty-six schools responded to the questionnaire. This represents a 96 per cent response rate.

The sex ratio of the sample was, by design, exactly 50:50. With respect to socioeconomic background, 15 per cent were in upper level, 41 per cent in upper middle level, 32 per cent in lower middle level, and 12 per cent in lower level. The majority of parents were born in Australia (81 per cent, of which 1 per cent was Aboriginal). This lower percentage of Aborigines compared to the total census figures is because the schools were all in capital cities. The other ethnic backgrounds included white Anglo-Saxons (17 per cent), Southern Europeans (10 per cent), Asians (5 per cent) and Middle Easterns (1 per cent).

PERCEIVED COMPETENCE AND COMPUTER USE

The following table (Table 13) portrays the students' stated usage of computers.

TABLE 13 PERCENTAGES OF COMPUTER USE IN STUDENT SURVEY

	In class activities	*In school but out of class*	*At home*
Never	25	50	58
Very rarely	21	26	15
Once a week	31	11	6
Few times a week	19	8	10
Almost daily	4	6	11

When this usage is broken down by sex, it becomes clear that boys use computers much more often than girls, both in class (chi-square = 15.01, df = 4, $p = 0.004$), out of class (chi-square = 70.52, df = 4, $p < 0.001$), and at home (chi-square = 80.64, df = 4, $p < 0.001$).

An overall index of computer usage was obtained by assuming a person was at least a regular user if he or she used a computer at least once a week in class, at school but outside class time, or at home. Overall, 68 per cent of students had used computers at least once a week.

There are no differences with respect to socioeconomic levels and the usage of computers at school, but those from higher socioeconomic backgrounds tended to use computers more often at home. There were no relationships between computer usage and birth order.

The higher achievers (as measured by English and mathematics estimates) used computers more often than low achievers (chi-square = 84.32, df = 2, $p < 0.001$). The younger students were more likely to use computers (chi-square = 227.80, df = 3, $p < 0.001$).

Only 5 per cent claimed they had never used computers. Twenty per cent claimed to have first used computers within the past six months, 26 per cent within the past year, 9 per cent within the past two years, and 19 per cent three or more years ago. For those who have started to use computers within the past two years, there are no significant differences between males and females, but more males than females have used the computer for three or more years.

There were no differences in computer usage across government and non-government schools in the sample. Primary students used computers more than secondary students.

Most students had used computers to run a computer game (90 per cent), as a word processor (65 per cent) and to write simple programs in languages such as Logo (67 per cent), whereas a minority had used computers to write advanced programs (32 per cent) or used machine language (19 per cent). Boys more than girls claimed they were more competent at using computers on all these tasks.

There was only one significant relationship between these tasks and grade. Year 8 students claimed they were not as competent in word processing as other students. High achievers (in mathematics and English) see themselves as more competent on all tasks, and there is no pattern of relationships between competencies on these five tasks and socioeconomic level or birth order.

Student reactions to classroom use of computers

There were nine attitude items relating to each scenario. Each of the items across the nine scenarios were analysed by multivariate analyses of variance using sex, computer use and grade as independent variables.

The following table (Table 14) indicates the significant main effects across the nine analyses. In the table, 's' indicates that there were sex differences, 'c' that there were differences between regular computer users and non-users, and 'g' indicates that there were grade effects.

In all cases where there were significant effects, males were more favourably disposed towards computers than females. It must be noted, however, that there were as many non-significant main effects when comparing males and females as there were differences. All the significant contrasts between regular and non-regular users favoured the regular computer users. Further, younger children were more supportive of using computers in classrooms than older students.

TABLE 14 SIGNIFICANT MAIN EFFECTS FOR THE SCENARIO ANALYSES

Scenario	*Response item*								
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Word processing	scg	cg	cg	s g	scg	c	cg	scg	scg
Drill and practice	cg	scg	cg	s g	scg	c	cg	cg	cg
Mind tool	c		s ~	s g	scg	c	cg	cg	cg
Computer-managed learn	s g	s g	g	s g	scg	c	cg	scg	cg
Games and simulation	s		s	s g	scg	c	cg	g	scg
Programming	sc	scg	scg	s g	scg	c	cg	scg	scg
Tutorial				s g	scg	c	cg	g	cg
Data base			s g	s g	scg	c	cg	cg	cg
General computer ·lication	scg	scg	scg	s g	scg	c	cg	s g	scg

Note: Significant effects are indicated by: s = sex
c = computer user/non user
g = grade level

There was one significant interaction aross all the scenarios. This related to item 4, that computers would be more useful for boys than girls. Across all scenarios, there were larger differences between males and females (males claiming that computers were more useful for boys than girls) and in the primary grades, tapering to no differences at the secondary level. So while there are more differences between males and females in the use of computers at the secondary school, these same students do not believe that computers are any less useful for either sex.

With respect to the tenth item, the number of minutes involved in each task, the data were recoded into three categories: not used, less than 30 minutes (occasional users), and more than 30 minutes (regular users). Over all scenarios, younger students and computer users were more favourably disposed towards computers. Males more than females reported higher ratings to all scenarios except for computer-managed learning (where there were no significant differences). On the last scenario relating to the general use of computers in classrooms, there were significant differences, but the pattern was slightly different. There were no differences between males and females in the non-user and occasional users, but males tended to use the computer more regularly than girls.

MOST AND LEAST LIKED ACTIVITIES IN SCHOOL

The ratings of activities most and least liked in school are listed in Table 15.

TABLE 15 ACTIVITIES MOST AND LEAST LIKED IN SCHOOLS IN STUDENT SURVEY

Activity	*% most liked*	*% second choice*	*% third choice*	*% in three most liked*	*% least liked*
Meeting friends	41	16	11	68	1
Sport	21	23	20	64	8
Computer activities	15	16	14	45	6
Art or music	11	14	15	40	18
Mathematics	8	11	13	32	29
Science	5	7	9	21	28
Social studies	3	6	7	16	25
Technical or commercial	4	4	6	14	17
Language	2	4	5	11	37
Contact with teachers	2	4	5	11	13

Students tended to prefer meetings with friends, sport, and computer activities, and had least liking for the more traditional subjects and contact with teachers.

A series of cross-tabulations were calculated comparing those who rated computers in their first three choices, and those who rated compute[illegible]ities as least liked. While there were significant differences between the sexes, as man[illegible]s as boys liked computer activities but more girls disliked computer activities.

Up until Year 8, there were no differences in liking computers, but in secondary schooling, more students disliked computers. There were no differences related to socioeconomic level, achievement or birth order.

Only Years 8 and 11 students were used in an analysis to assess future study patterns. About half (51 per cent) intended to go on to university, 37 per cent intended to do further study but not at a university, and 12 per cent intended to go straight into a job.

There were no sex differences in these patterns, and no differences relating to experience with computers. The data do not suggest that students who intend to do further study tend to use the computer more often. The older students were less likely to say they intended to go on to university, but more likely to do further study but not at a university.

COGNITIVE PROCESSING

Unfortunately, the set of items measuring successive processing was unreliable (alpha=0.26) and could not be used in subsequent analyses. The simultaneous items had a reasonable estimate of reliability (alpha=0.61). An analysis of variance was calculated using sex, computer experience, and primary/secondary as independent variables (Table 16).

TABLE 16 ANALYSIS OF VARIANCE ON THE SIMULTANEOUS PROCESSING SCALE BROKEN BY SEX, COMPUTER USAGE AND PRIMARY/SECONDARY

Source	*df*	*MS*	*F*	*p*
Sex	1	1150.524	61.00	<0.001
Computer use	1	0.002	0.00	0.99
Primary/secondary	1	887.89	47.05	<0.001
Sex by use	1	4.57	0.24	0.62
Sex by grade	1	6.11	0.32	0.57
Use by grade	1	52.27	2.78	0.10
Sex by use by grade	1	0.10	0.01	0.99
Residual	1722	18.87		

The simultaneous scores were higher for males than females, and for younger than older students, which is consistent with previous research. There were no interactions in simultaneous processing between sex and computer usage.

SELF-CONCEPT

The means, standard deviations, and estimates of reliability for the seven self-concept scales were all satisfactorily high.

A multivariate analysis of variance was calculated using these seven variables and broken down by sex, computer usage, and grade.

As has been found in many other studies, the self-concept scores declined with age. It has been argued elsewhere, that as students progress through formal schooling, their expectations change, as does the differentiation of self-concept into separate facets (Hattie 1985; Marsh & O'Neill 1984).

While there was a significant multivariate F, the differences between the males and females across the seven scales were not substantial. Lack of sex differences is consistent with meta-analyses reported in Hattie (1985), which indicated little, if any, differences in self-concept between males and females.

Those students who used computers regularly have higher self-concept scores on all scales except on peer self-concept (where there are no significant differences). It was obviously, not possible from this study to claim that computer usage led to more enhanced self-concept rather than the converse. However, from previous research (Fitzgerald, Hattie, McGrath & lakin 1982) it seems likely that involvement in computer activities would lead to a more positive self-concept.

Of major interest is that there were no significant interactions between grade and sex. Thus, computer usage is related to more positive self-concepts, irrespective of grade and sex.

From a Manova using sex, computer experience, and primary/secondary, there were significant multivariate F-ratios for sex (girls scored lower on ability and physical self-concepts), computer usage (regular users had higher self-concepts on all self-concept dimensions), and grade (primary students scores higher than secondary students). There were no significant interactions.

ENVIRONMENT

Males more than females believed school is a place where they can cope. There were no sex differences related to general liking of school. As students became older, their liking of school and feelings of coping declined. This pattern has been found in many studies and probably reflects increased pressure to succeed and changing expectations (Hattie, Byrne & Fraser 1985).

Computer users had higher scores on liking of school and feelings of coping compared to non users. Clearly, using computers is associated with more confidence in school work and a greater liking for school. Given that there are no significant interaction effects, and that the 'school' was constant for users and non-users, this is a particularly important finding.

ANXIETY

The four items in this scale had a mean of 12.74, a standard deviation of 4.07, and an estimate of reliability of 0.48.

Older students and girls had higher anxiety scores. There were no significant differences in anxiety related to whether a student was a regular user of the computer or not, which indicates that anxiety cannot be considered as a meaningful discriminator or predictor of computer usage. Students' use of the computer is unrelated to general levels of anxiety.

SUSPENSION OF JUDGMENT

The five items in this scale had a mean of 14.70. standard deviation of 2.52, and an estimate of reliability of 0.38. This reliability is not very satisfactory. Girls and older students were able to suspend judgment more than boys or younger students. There were no significant differences, however, between computer users and non-users, and nor were there any significant interactions. The ability to withhold judgment, an ability often necessary when using computers, is not a discriminator between those who are regular and non-regular users.

Computer attitudes

Given that there are only three items per scale, the estimates of reliability are quite reasonable. The maximum score within each scale was eighteen. Thus, students typically are not scared, see computers as helpful in getting jobs, useful in classrooms, and believe they will probably be using computers in the future. There are much lower responses to associating computers with 'cleverness' and low sexism averages.

A multivariate analysis of variance was run using the seven computer scales. There were three significant univariate F-statistics for the user by grade interaction. While the perceived usefulness of computers declines with age, the older computer users are not as negative about the usefulness of computers as the older non-computer users. Computer users are not uneasy or scared about using computers, but for the non-users, secondary students are much more afraid then primary students. Non-computer users across all grades regard computers as having little or no effect on their lives. Older computer users see more and more effects of computers on their lives.

There were significant main effects for sex, computer usage and grade. All univariate F-statistics were significant. Younger students and computer users were more favourably disposed towards computers, and they saw more differences between males and females in the ability to use computers. Females claimed women would make better computer programmers than males. Males typically did not believe females would make better or worse programmers.

Differences between female users and non-users

To assess the variables that best differentiate between female users and non-users of computers, a discriminant analysis was calculated. Only using female students, the following scales were used: the seven self-concept scales, the seven computer attitude scales, mathematics and English achievement scores, perceived school environment (opportunity and effect from Williams and Batten *The quality of school life* scale, 1981), anxiety, suspension of judgment, simultaneous processing, grade, and socioeconomic background (from parents' occupation).

Girls who were regular computer users were more likely to be from primary grades, were less alienated and less uneasy about computers, perceived computers as useful, had high achievement self-concepts, high scores on mathematics, and perceived schools as relevant to their present needs and an enjoyable experience. The variables that did not discriminate between users and non-users included anxiety, confidence in self, English scores, simultaneous processing scores, suspension of judgment, socioeconomic background, and a perception that they have to be clever to use computers.

7 COMMENTS ON SEX DIFFERENCES IN COMPUTER USE AND ATTITUDES

This study has demonstrated differences between males and females in their attitudes towards computers. Primarily, male students and female teachers and female parents were more disposed towards using computers. The male students and the secondary respondents were more likely to claim the computer was of more value in supporting the work of males rather than females. Although there were significant differences in some instances, the overall picture is less clear. The effect sizes were extremely similar to the meta-analysis presented above. For students, the effect size across all comparisons was 0.15 (compared to the meta-analysis average for attitudes of 0.15), for parents the average was −0.03, and for teachers the average was 0.01.

At this stage of our research we have demonstrated the paucity of empirical research relating to sex differences and computer usage. The little research that was located was supportive of small differences, with males more positive towards computers, but with males and females having similar achievement scores after using computers. In the Australian study, because of the large sample size there were a number of significant differences between males and females, but the overall effect size for the attitude questions is not different from that reported in the meta-analysis. In primary schools there were just as many females who considered themselves regular users as there were males. In secondary schools there were many fewer females using computers than males.

Suggested reasons for sex differences in computer usage

Many reasons are cited to account for sex differences that are presumed to exist. The research reviewed and the Australian study suggest that there are no sex differences with respect to achievement or usage in primary schools. There may be justification for seeking reasons why males and females differ in attitude at the secondary level. Yet, given the data which demonstrated that just as many females as males like computers, the search should be oriented towards accounting for why more girls than boys dislike computers. Of more salience, there is a need to understand why older females become less frequent users compared to their male peers.

Sanders (1984) suggested the reasons proposed for differences between males and females in their attitudes towards and use of computers can be grouped into five categories.

ATTITUDES AND ASSOCIATIONS

□ 'Computers are associated with mathematics, which many girls feel is a male activity.' Maccoby and Jacklin (1974), in their extensive review of sex differences, concluded that boys are superior to girls in mathematical performance. Their study was published a decade ago, but more recent studies still support this conclusion (Benbow & Stanley 1980, 1983). Certainly, in the Australian study, mathematics teachers were more involved with computers, but there were no differences between males and females to the answers to the question 'you must be good at maths to understand computers'. All students rated this item in the middle of the 'strongly disagree to strongly agree' scale. Both male and female regular users tended to have high mathematic achievement estimates. But they also had high English estimates, suggesting high general achievement is more related to using computers, and not mathematics in particular. So, while computers may be used more frequently by mathematics teachers, there is little reason to believe that girls do not use computers because of an association with mathematics or because of their ability in mathematics.

□ 'Computers are seen as machines, and therefore masculine.' Scheibe and Erwin (1979) recorded the comments by forty undergraduates playing a computer game. Spontaneous verbalisations were recorded for thirty-nine of the forty students and each averaged thirty-four comments. Scheibe and Erwin noted that students tended to talk more in an isolated setting and to use more personal pronouns to refer to the computer when it displayed greater 'intelligence' in its responses. There were no sex differences in the amount or length of talking. Of the 358 pronoun references to the computer, 'it' was mentioned 68 per cent and 'he' 16 per cent, but on no occasion was the computer referred to as 'she'.

□ 'Computers are considered unfeminine because mostly boys use them.' 'Hackers' are usually males and Turkle (1984) argued that this was because of the male preoccupation with winning and of subjecting oneself to increasing violent tests. Further, males tend to dominate the 'upper echelons' of the computer world—both in business and in schools. Daniel and Barnes (1985) reported that 19 per cent of computer science graduates from Australian universities and colleges of advanced education (between 1983–85) were women. Yet, the proportion of females in highly skilled computer jobs was even less. From a survey of 376 companies, Daniel, Encol, Markus and Barnes (1985) found that females occupied 12 per cent of the high-flying sales category, 21 per cent of programmer/analysts, 1 per cent of technicians, 14 per cent in software and engineering and 1 per cent in hardware or system analysis. But in the less skilled areas such as data entry, females were over represented (93 per cent).

□ 'Computer experience can come from successful exposure to video games and video games are typically male dominated.' Loftus and Loftus (1984) noted that of 175 individuals observed in a Pittsburgh video arcade, only thirty were girls (see also Weinstein & Kestenbaum 1985). Loftus and Loftus also observed that, in constrast to boys, girls liked music videos, girls liked being told verbally how they were doing, and were indifferent to visual or graphic feedback on performance. Thus, it may be that the form of reinforcement presented in video games leads to more boys using them.

DEVELOPMENTAL AND BEHAVIOURAL FACTORS

□ 'Girls at middle school age are very social, and prefer people to things. Computers are solitary activities and non-human, and girls supposedly do not need to learn about computers.' Kagan (1966) has argued that girls depend more on the evaluation and response of others, whereas, males are more likely to be more self-reliant in feedback. It may be that girls could enjoy computers more when working in groups It is not the case that girls have less desire to learn about computers (as was demonstrated in the Australian study), it may be more the form of learning. When the students in the Australian study were asked if they would like to learn more about computers, both males and females strongly agreed.

□ 'Boys aggressively capture computer time; girls are reluctant to insist on time for themselves.' It appears there are differences in levels of aggression between males and females (Maccoby & Jacklin 1974), but it must also be noted these differences may be related to specific situations (Frodi 1978). Differences are less likely to be found when aggression is in response to provocation (perhaps such as when there are limited computer terminals and many who desire to use them). Hyde (1984) noted that differences in aggressiveness decline with age, thus this reason may not be as powerful in accounting for differences between older male and female students.

□ 'It is acceptable for girls at this age to give up in the face of difficulty.' Socially approved helplessness is at its strongest during puberty. There has been some evidence to suggest that girls are more likely to conform and 'give-up' in group pressure situations, particularly when surveillence from males is involved (Eagly & Carli 1981).

□ 'Girls avoid competition with boys at the computer for fear of winning and appearing unfeminine and unattractive to boys.' Douvan (1979) noted that boys do not like aggressive girls and do not want to be bested in competition by girls.

□ 'Girls prefer human rather than machine rewards for right answers.' It was noted above that girls may prefer different rewards to boys, but these differences relate to the type of reward and not whether they are from machines or not. If girls work together when using computers, then more 'human rewards' can occur.

□ 'Unlike boys, girls see little need for computers in their future lives.' Kreinberg (1982) asked students to imagine they were thirty and to describe how they would see themselves using a computer. Overall, both males and females pictured the computer taking over a substantial part of their lives, but 'females tended to focus more on the housework and what the computer (robot) would do, while males described ways in which they would use the computer for finances, games and work'
(p. 17). Similar questions were included in the Australian study. Males, more than females, claimed that when they were thirty, they were likely to be using computers quite a lot in their jobs, in the home, and for games and entertainment. Males perceived computers as having a larger role in their future.

□ 'Computers involve the use of spatial skills and in these skills, boys typically outperform girls.' Maccoby and Jacklin (1974) found that boys outperformed girls on visual-spatial tasks. Our Australian study indicated no differences in computer attitudes or usage related to spatial/simultaneous processing abilities, although the study was consistent with Maccoby and Jacklin in concluding that males have a higher level of spatial/simultaneous skill.

□ 'There are differences in achievement motivation with respect to computer use.' Women are more work achievement oriented, while men outperform women on both mastery and competitiveness-orientations (Moss & Kagan 1961; Spence & Helmreich 1978, 1983). Certainly, this could relate to using computers, as males seem to like the competitive aspects of computing and attaining a sense of mastery (e.g. as with 'hackers'). Girls seem to prefer to use the computer to do 'work' such a assignments, production of other products, and word processing.

□ 'Girls have lower self-concepts and thus are less likely to be confident using computers.' There is little evidence supporting the often cited claim that boys have higher self-concepts than girls (see Hattie 1985b, for a meta-analysis on this topic). Similarly, the Australian study found slight differences on only two subscales. There were, more importantly, no significant interactions between sex and computer usage relating to self-concept.

□ 'Girls prefer tasks where they can sense that they are in control.' In a systematic study based on many hours of interviews, Turkle (1984) traced three stages in children's relationships with computers: the metaphysical stage concerned with whether computers think, feel or are alive; the mastery stage; and the identity stage, where computing becomes a major activity and enters into the students' world of self-definition and self-concept. She argued it was at the mastery stage that differences between girls and boys become evident. Boys tend to be 'hard masters' whereas girls tend to be 'soft masters' in that girls see the computer as sensuous and tactile and 'relate to the computer's formal system not as a set of unforgiving "rules", but as a language for communicating with, negotiating with, a behaving psychological entity' (p. 107). The reasons for this difference, claimed Turkle, were because our culture teaches girls the characteristics of soft mastery, such as negotiation, compromise, give and take. Whereas for boys, decisiveness and the imposition of will are stressed. Moreover, men seem able and willing to create separate 'objective' computer worlds, which they can visit as neutral observers. For girls, the interaction with computers is more as a conversation. These differences lead to girls becoming involved more with the artistic, interactive aspects, and boys the scientific, mechanical aspects of computing.

PARENTS

□ 'Parents see technical careers as more appropriate for their sons than for their daughters. They pay for hardware, software, lessons, computer camps and clubs etc. for their sons, and encourage sons to use the computers more than they encourage daughters.' Miura and Hess (1983) completed a survey of twenty-three computer camps and reported that there was a three to one ratio in favour of boys across all grade levels. As the cost of these camps increased, the number of girls decreased. They suggest that this may reflect the general inclination of parents to encourage computer literacy more aggressively for their sons. Our Australian study indicated that mothers, more than fathers, were more disposed towards encouraging their sons and daughters.

□ 'More fathers than mothers use computers at home, creating a negative role model for daughters and further encouraging boys to use the technology.' Miura and Hess (1983) surveyed eighty-seven students in a school in which all students had had equal exposure to computers. They noted that the 13 per cent who reported they had home computers were all boys. The Australian study also indicated that fathers were more likely to use computers at home.

SOFTWARE AND COMPUTER USE

□ 'Available software is too competitive, warlike, aggressive and "macho" for girls.' Miura and Hess (1983) found that girls generally selected software that involved writing and music, while boys were more attracted to competitive 'action' games requiring eye–hand co-ordination. The Australian study indicated that students, both males and females, liked all uses of the computer and it was difficult to isolate many particular uses which males liked more or less than females.

□ 'Software is biased: language and sex roles are stereotyped and "characters" are often identifiably male and rarely identifiably female.' Miura and Hess (1983) asked 157 senior primary students to rate seventy-five software titles. More were perceived as being of interest to males. This finding was replicated with a sample of thirty adults.

□ 'Books about computers, that are commonly found in Australian schools, portray boys and girls differently.' From a survey of ten of the most commonly found books in Australian schools, we found seventy-two pictures depicting people interacting with computers. Altogether sixty-nine males and fifty females were pictured. Males were using the computer in thirty-nine pictures, females in seventeen pictures, and both males and females in sixteen pictures. In most instances, males were alone when using computers (89 per cent) whereas females were typically in groups (33 per cent). Of the sixteen pictures with males and females, seven were with males in the dominant role (e.g. using the keyboard, fixing the computer) and the females passively watching. There was only one case when the female was more active, and eight were neutral. Typically, males were portrayed as controlling robots, fixing computers, using (not watching) and working alone. Females were pictured as passive, looking at computer printouts, receiving messages and working in groups.

□ 'Advertising for hardware and software features males.' Marrapodi (cited in Sanders 1984) analysed the computer advertisements in issues of *Popular Computing* and *Personal Computing*. Of the forty-one advertisements that showed people with computers, twenty-eight featured males only, one showed females only, and twelve showed both sexes equally. This ratio is clearly not surprising when it is noted that a director of educational marketing for Apple was quoted in *Businessweek* (21 June 1982) as saying that Apple targets its advertisements towards males and has no intention of changing this. He claimed the buyers were 98 per cent male and that women do not represent any great untapped audience.

SCHOOL LOGISTICS

□ 'Arranging computers in regular rows discourages communication among students, and girls prefer communication.' We saw no evidence that computers in Australian schools are typically arranged in rows. To the contrary, computer rooms were hives of activity and abuzz with discussion—among boys and girls. More than half the schools had computers in laboratory settings (57 per cent). Forty-three per cent had computers located fairly permanently within classrooms, and 30 per cent had computers organised so that they could be moved on a regular basis from class to class.

□ 'One student per machine does not meet girls' social interaction needs.' Hanson (1983) noted that twice as many girls preferred to work on video games with someone than alone, but twice as many boys preferred to work alone than with someone (see also Hawkins 1984). Both male and female students in the Australian study were supportive of using computers because of their increased opportunities for social interactions. There were indications in the meta-analysis, however, that girls preferred working in groups—particularly groups consisting of all females.

□ 'Computers are taught by male teachers.' In the Australian study, there are just as many female teachers as male teachers using computers, yet the resource persons within schools were more likely to be males. This distribution was the same in primary and secondary schools. With respect to competencies, there were similar proportions of male and female teachers who could use the computers to perform most tasks, but the male teachers were more proficient at more advanced programming and machine languages.

□ 'Male teachers tend to become more enthusiastic and knowledgable about computers than female teachers, creating a negative role model effect.' Three questions were included in the Australian study relating to this reason. Male students believed that male teachers seem to be more interested in computers than female teachers, that teachers generally need to learn a lot more about the use of computers in classes, but both male and female students believed that teachers are interested in using computers in classrooms. Further, was the female teachers more than the male teachers who were more enthusiastic about both girls and boys using computers.

Concluding comments on sex differences

The differences between the computer attitudes of males and females may be attributed to: association between machines and masculinity; males appear to be more competitive and aggressive in capturing computer time; females prefer 'control', alternative forms of reinforcement and different social organisations when dealing with computers; software, advertising and books appear to be sexist; and female students (and male teachers and male parents) do not perceive computers as important in students' future lives. There are a number of reasons for differential use by males and females that are not supported by the Australian study: differences between boys and girls on spatial skills and self-concept; lack of enthusiasm by female teachers; lack of role models; an association between mathematics and computers; and a difference in the desire to use computers.

The differences between males and females in attitudes towards computers have some systematic trends. Two dominant trends are that differences are greater with older students, and the differences are becoming greater in the more recent studies. Yet, the differences are primarily related to attitudes, to a lesser extent to usage, and not to achievement. Girls appear to be more polarised in their attitudes towards computers. As many girls as boys enjoy using computers but many more girls than boys ardently dislike them. Yet when girls use computers, they learn as much and often learn faster than boys.

Although the average effect size from the meta-analysis and from the Australian study were quite small, it is of some concern that the present situation may progressively lead towards greater discrimination. This could lead to females having even less opportunity to further their interests in computers.

Female teachers and female parents are much more supportive of computers for males and females, although both male and female parents generally support the use of computers in classrooms. Parents are more supportive of using computers for learning reasons, students prefer the social reasons and teachers prefer specific uses that supplement teaching.

8 SUMMARY AND RECOMMENDATIONS

There are four general themes that emerge from the research. First, there is a very positive reaction from principals, teachers, parents and students to the use of computers to support learning in classrooms. Computer applications are widespread and growing in both primary and secondary schools in Australia and it is the general feeling of parents and teachers that the applications could profitably begin in the early years of primary school.

A second theme is the comparison of male and female achievement and attitudes with respect to computers and the use of computers by girls. The few studies available suggest no differences in achievement levels for males and females when using computers, and certainly there are no major differences in attitudes towards computers. The Australian study, however, demonstrated significant differences between boys and girls in the use of computers although, as in overseas research, the differences between boys and girls in attitudes to the use of computers in classrooms were slight. There were no substantial differences between boys and girls in the use of computers in primary schools, but many more boys than girls used computers in secondary schools. A variety of reasons were reviewed and a number of strategies seem appropriate to encourage girls to use computers. Some of these strategies include:

- the development of computer activities that involve collaboration, the emphasis generally on group activities and allowing females to work together on computers;
- placing equal stress on activities enjoyed by girls such as word processing and simulations where the student has control of the system;
- introducing computer activities at an early age and at least by the age of 8 to 10 when children are preoccupied with mastery and before the stage of reflection in adolescence; and
- emphasising how computers are useful for all students in their future lives.

Considerable care should be taken to eliminate bias towards males in software, computer books and magazines.

A third theme is the need for upgrading teacher education provisions with respect to computer applications in education. Teachers and principals believe there is inadequate provision for inservice courses on the use of computers in classrooms and also inadequate provision made in teacher education institutions for specialised training in the area of computer applications. Moreover, parents, teachers and principals believe one of the major problems in developing appropriate computer applications in classrooms is the lack of teachers with both teacher training and specialised training in using computers to act as key resource people in schools. At present, most specalised teachers did not receive their computer training in preservice courses

A fourth theme is the state of uncertainty with respect to the impact of the technology on the way children learn. There is some suggestion that girls will respond to computer applications in ways different to boys. From the comments of the principals of a sample of Aboriginal schools, there is a suggestion that Aboriginal children might derive more benefit from applications specially tailored to their needs with an implication from some principals that there may be a need to take into account cognitive differences in the way Aboriginal children process information. Principals, parents and teachers believe one of the problems of developing computer applications in education is that very little is known about how children learn when using computers.

Although we have made some recommendations to promote the use of computers by girls, our recommendations will mainly address themes three and four. The implications of the positive reactions of educators and parents to the use of computers and the associated issue of inadequate funds for the provision of hardware and software that stems from the first theme seem to suggest changes that are quantitative in nature (i.e. more or less allocation of resources) whereas the third and fourth themes seem to require qualitative changes that need to be examined by government if the problems of introducing computers into education are to be addressed.

Preservice and inservice teacher education

There is a strongly felt and well-based view of principals, teachers and parents that there is a major need for increased emphasis in preservice and inservice courses for teachers in computer applications in education. Principals, teachers and parents also stressed the need for training teachers with specialist qualifications in both education and information science, to act as resource teachers in school systems.

Careful evaluation is required of the nature of courses to be used in training teachers for the educational use of computers in the classroom. The variety of computer applications evident in Australian schools suggests that for the general classroom teacher courses are required that focus specifically on the connections between education and technology with particular reference to:

- the social implications of computers;
- the 'intellectual tool' use of computers in different areas of the curriculum (e.g. word processing, spreadsheets, data bases, electronic mail); and
- the uses of computers in learning and teaching (e.g. drill and practice, simulation and gaming, interactive learning).

A second level of professional training is required that includes specialist qualifications in education with experience in the areas of computer applications indicated above and also qualifications in information science. Teachers with these specialist qualifications would act as consultants and resource teachers at the regional level. It is also possible that teachers could become consultants and resource teachers after intensive inservice courses, and after acquiring much facility with computers in the classroom.

The staffing of preservice and inservice courses for teachers will be a major problem, to which special effort needs to be devoted. There is comparatively little opportunity in many teacher education institutions to recruit new staff. Retraining of personnel and restructuring of courses will therefore be the only means available for most institutions. Special provision needs to be made for new staff appointments in the area of educational technology and, in certain institutions where equipment is inadequate, equipment grants. It is recommended that special provision be made at the Commonwealth level for the upgrading of staff and equipment in the area of computer applications in education within institutions involved in teacher education.

An additional, but related problem, concerns the regular staff in teacher education institutions who need to be made aware of the range of possibilities involved in the new information technologies and need also to develop confidence and competence in their use in the teacher's area of specialisation.

Efforts should be devoted to the development of computer-based approaches to be used in distance courses and off-campus courses for teacher education staff. A few well chosen centres in Australia could act as focal points for such an effort. The use of AUSSAT in this regard needs to be kept in mind as do other means of communication and teaching over large distances (e.g. Viatel, teleconferencing, interactive television and video, and data base systems).

Software development, evaluation and research

A recurrent theme during the Organisation for Economic Co-operation and Development International Conference on Education and the New Information Technologies (Paris 1984) was the lack of knowledge and lack of systematic investigation of the impact of the technologies on the way children learn. The expenditure of vast amounts of public money on the development of 'computer education' programs and on the provision of computer facilities to support learning in schools is being carried out in the context of what almost amounts to a 'knowledge free' environment. In Australia, parents, teachers and principals recognise that this lack of knowledge is a major problem in the development of appropriate computer applications for children.

The growing concern about the quality and appropriateness of educational software has resulted in a number of agencies becoming involved in the detailed review of education software including, in Australia, State Departments of Education. These reviews are primarily based on content analysis rather than on any systematic analysis of the way students learn when using the software.

Many State Departments of Education include software reviews in regular newsletters or journals. A monthly journal, *SUGAR* is produced in Queensland which contains a number of software reviews. Software review journals for specific subjects (e.g. *Reviews of Mathematics Software—ROMS*) are produced in South Australia. Western Australia is also about to introduce a software evaluation journal (Sully 1985). Similar developments are occurring overseas. In the United Kingdom a project called 'Computers in Education as a Resource' (SCEGAR Project), analyses and reports on the content of courseware. In North America, the Allenbach Company produces *Software Reports* which is partially based on the comments of teachers, parents and students. The Internation Council for Computers in Education has issued an evaluator's guide for evaluating microcomputer programs.

In the main, the assessment of educational software has been by 'expert review' rather than by data based studies of student learning. In this context an interesting exception occurs in Florida where the State of Florida Senate Bill section 283-25 insists on a data based assessment of educational courseware before it is placed on the market. One of the major potentials of computer supported learning systems is that the technology supporting the learning environment can be programmed to provide much of the essential data which is required for the evaluation of learning.

Little is known about the impact of the new information technologies on thinking and problem solving. The effects might be quite subtle initially yet develop over extended time into significant qualitative changes that will have strong implications for curriculum development. An adequate evaluation of the effects of the technology will require prolonged monitoring of the cognitive and affective development of the individual learner.

EDUCATIONAL TECHNOLOGY CENTRES

It is essential that systematic data based evaluation and development of educational software be undertaken as soon as possible. If data from the evaluation studies are to provide a knowledge base for the modification of existing software and the development of new forms of computer applications to cater for the needs of individual children and disadvantaged groups, then the activities should be carried out in close association with experienced research groups.

It is clear that the study of the impact of computers on children's thinking will require a new form of analysis that will encompass attributes of psychological and educational research, evaluation and software development, and will involve both limited span and longitudinal studies In order to establish high level stable research/evaluation groups which will have a critical mass of staff and adequate facilities to provide a focus in Australia for software development, software evaluation and research, it is recommended that one or two education technology centres be established by Government.

The activities of these centres should include:

- analytic data based evalution of educational software:
- the development of new forms of educational software;
- research on the long term impact of educational technology; and
- the provision of a consultative service to various agencies.

The Harvard Educational Technology Centre established in 1984 by the United States Office of Education has some of these functions. It is likely the proposed education technology centres would be most productive if the centres had a close association with a faculty or school involved in teacher education with a strong postgraduate program and some of the activities of the centres were carried out in a school environment (e.g. a laboratory school setting).

References

J. Anderson, *Computing in schools: An Australian perspective*, Australian Council for Educational Research, Hawthorn, Victoria, 1984.

J. W. Angus, Children's learning through audio-visual media in relation to a model of simultaneous and successive processing, Ph. D. thesis, University of New England, 1984.

C. P. Benbow & J. C. Stanley, 'Sex differences in mathematical ability: Fact or artifact?', *Science* 210, 1980, pp. 1262–4.

C. P. Benbow & J. C. Stanley, 'Sex differences in mathematical reasoning: More facts', *Science* 222, 1983, pp. 1029–31.

P. K. Burns & W. C. Bozeman, 'Computer-assisted instruction and mathematics achievement: Is there a relationship?', *Educational Technology* 21, 1981, pp. 295–309.

'If women don't go into computers', *Businessweek*, 21 June 1982, p. 92.

P. B. Campbell, 'The computer revolution: Guess who's left out', *Interracial Book for Children Bulletin* 15, 1984, p. 3–6.

A. Congalton, *Occupational status in Australia*, University of New South Wales Press, Sydney.

P. Cooper & M. Pace, Attitudes of adults towards the use of computers in schools, ERIC Document, 1982, pp. 224, 589.

A. Daniel & J. Barnes, Education for the computer industry, paper presented to the S.A.A.N.Z. conference in Brisbane, August 1984.

A. Daniel, S. Encol, M. Markus & J. Barnes, (1985). Work in the computer industry. *Search*.

E. Douvan, 'Sex role learning', in J. C. Coleman (ed.), *The school years: Current issues in the socialisation of young people*, Methuen, London, 1979, pp 79–94.

A. H. Eagly & L. L. Carli, 'Sex of researchers and sex-typed communications as determinants of sex differences in influenceability: A meta-analysis of social influence studies'. *Psychological Bulletin* 90, 1981, pp. 1–20.

D. Fitzgerald, *Behavioural research in education*, Armidale, Australia, 1973.

D. Fitzgerald & K. Green, Information processing differences in Logo activities, paper in preparation, 1985.

D. Fitzgerald, J. A. Hattie, G. McGrath & A. Iakin, *The introduction of computers into schools: An evaluation of the Nyngan project*, University of New England, Armidale, 1982.

J. D. Fletcher & R. C. Atkinson, 'Evaluation of the Standford CAI program in initial reading', *Journal of Educational Psychology* 63, 1972, pp. 597–602.

J. F. Fowler, 'Use of computer-assisted instruction in introductory management science', *Journal of Experimental Education* 52, 1983, pp. 22–6.

A. Frodi, 'Experiential and physiological responses associated with anger and aggression in women and men', *Journal of Research in Personality* 12, 1978, pp. 335–49.

A. Game & R. Pringle, *Gender at work*, Allen & Unwin, Sydney, 1983.

W. P. Goddard & L. Pereira-Mendoza, 'Three perspectives for computer applications in education', *AEDS Journal* 17, 1984, pp. 14–23.

K. Grabham, Simultaneous and successive synthesis in young children: The relationship with some early school performances, field study, Canberra College of Advanced Education, 1980.

G. V. Glass, B. McGaw & M. L. Smith, *Meta-analysis in social research*, Sage, Beverly Hills, CA. 1981.

K. N. Green, An examination of a model of individual differences in sequential and simultaneous processing for the study of aptitude-treatment interaction, Ph. D. thesis, University of New England, Armidale, 1977.

N. A. Gripshover, Preventing gender-role stereotypes in classroom computer use: The importance of creating the right conditions, paper presented at the annual conference of the Speech Communication Association, Chicago, November 1984, p. 11.

P. A. Griswold, 'Computer awareness and attitudes of prospective rural teachers', *Rural Educator* 5, 1984, pp. 11–15.

J. Hanson, Video games: Competing with machines, paper presented at the International Conference on Culture and Communcation, Philadelphia, PA, March 1983.

S. S. Hartley, 'Meta-analysis of effects of individually paced instruction in mathematics', *Dissertation Abstracts International*, 38 (7–A), 1978 p. 4003. (University Microfilms No. 77–29, 926).

J. A. Hattie, 'Identifying the salient facets of a model of student learning: A synthesis of meta-analyses', *International Journal of Research in Education*, 1985.

J. A. Hattie, Self-concept, 1985.

J. A. Hattie, D. Byrne & B. J. Fraser, A study of students perceptions of preferred and actual learning environment, paper presented at the annual conference of the Australian Association for Research in Education, Hobart, November 1985.

J. A. Hattie, C. J. Sharpley & H. J. Rogers 'Comparative effectiveness of professional and paraprofessional helpers', *Psychological Bulletin* 95, 1984, pp. 534–41.

J. A. Hattie & H. J. Walberg, Research synthesis: Quantitative procedures and substantive results, paper presented at the Australian Association for Research in Education, Hobart, November, 1985.

J. Hawkins, *Computers and girls: Rethinking the issues* (Report No. 24), Banks Street College of Education, Centre for Children and Technology, New York, NY, 1984 (ERIC Document Reproduction Service ED 249 922)

S. T. Hiltz, *Online communities: A case study of the office of the future*, Ablex, Norwood, 1984.

J. S. Hyde, 'How large are gender differences in aggression? A developmental meta-analysis', *Developmental Psychology* 20, 1984, pp. 722–36.

J. Kagan, 'Acquistion and significance of sex typing and sex role identity', in M. L. Hoffman & L. W. Hoffman (eds), *Review of Child Development Research*, Sage, New York, NY, 1966.

J. E. Killian, Teachers who seek computer education: Their attitudes, needs and motivation, paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, April 1984.

Z. Klich, A cross-cultural examinatio^ of cognitive functions based on Luria's neuropsychological theory of cerebral organisation, Ph. D. thesis, University of New England, Armidale, 1983.

N. Kreinberg, 'Three thousand teachers later: What we've learned together about women in mathematics', *Women's Studies Quarterly* 10, 1982, pp. 17–20.

C. C. Kulik, J. A. Kulik & R. L. Bangert-Drownes, Effects ' computer-based education on elementary school pupils, paper presented at the annual meeting of the American Educational Research Association, New Orleans, Ar.il 1984.

J. A. Kulik, R. L. Bangert-Drownes & G. W. Williarr ., 'Effects of computer- ased teaching on secondary scnool students', *Journal of Educatior^ ?sychology* 75, 1983, pp. 19–26.

J. A. Kulik, C C. Kulik & P. A. Cohen, 'Effectiveness of computer-based college teaching: A meta-analysis of findings', *Review of Educational Research* 50, 1980, pp. 525–44.

C. L. Leong, Meta-analysis of research on the adjunctive use of computers in secondary mathematics, Master's thesis, Ontario Institute of Studies in Education, Toronto, Canada, 1981.

M. E. Lockheed, 'Sex equity: Increasing girls' use of computers', *Computing Teacher* 11, 1984, pp. 16–18.

G. R. Loftus & E. F. Loftus, *Mind at play: The psychology of video games*, Basic, New York, 1984.

A. Luria, *The working brain*, Penguin, Middlesex, 1973.

P. A. Mabe & S. C. West, 'Validity of self-evaluation of ability: A review and meta-analysis', *Journal of Applied Psychology* 67, 1982, pp. 280–96.

E. E. Maccoby & C. N. Jacklin, *The psychology of sex differences*, Stanford University Press, California, 1974.

H. W. Marsh & R. O'Neill, 'Self-description questionnaire III: The construct validity of multidimensional self-concept ratings by late adolescence', *Journal of Education Measurement* 21, 1984, pp. 153–74.

W. M. Mathews & L. W. Winkle, 'Computer equity for young women in rural schools', *Research in rural education* 1, 1982, pp. 37–41.

I. Miura & R. D. Hess, Sex difference in computer access, interest and usage, paper presented at the annual conference of the American Psychological Association. Anaheim, CA, August 1983.

H. A. Moss & J. Kagan, 'Stability of achievement and recognition seeking behaviour from early childhood through adulthood', *Journal of Abnormal and Social Psychology* 63, 1961, pp. 504–13.

W. Ramsley, The development of a model of information processing in young children based on Luria's theory of brain functioning, Ph.D. thesis, University of New England, 1982.

J. S. Sanders, 'The computer: Male, female or androgynous?', *Computing Teacher* 11, 1984, pp. 31–2.

K. E. Scheibe & M. Erwin, 'The computer as altar', *The Journal of Social Psychology* 108, 1979, pp. 103–09.

R. J. Shavelson, J. J. Hubner & G. C. Stanton, 'Self-concept: Validation of construct interpretation', *Review of Educational Research* 46, 1976, pp. 407–41.

H. A. Simon, *Models of discovery*, Reidel, Dordrecht, Holland, 1977.

I. S. Song & J. A. Hattie, 'Home environment, self-concept, and academic achievement: A causal modeling approach', *Journal of Educational Psychology* 76, 1984, pp. 1269–81.

J. T. Spence & R. L. Helmreich, *Masculinity and Femininity: Their psychological dimensions, correlates and antecedents*, University of Texas Press, Austin, 1978.

J. T. Spence & R. L. Helmreich, 'Achievement-related motives and behaviors', in J. T. Spence (ed.), *Achievement and achievement motives: Psychological and sociological approaches*, Freeman, San Francisco, 1983, pp. 7–74.

L. J. Stephens, S. Wileman & J. Konvalina, 'Group differences in computer science aptitude', *AEDA Journal* 14, 1981, pp. 84–95.

S. Tobais, 'Beyond math anxiety, a world is waiting', *Graduate Women* 74, 1980, pp. 46–8.

M. I. Tulloch, Individual differences in cognitive processing and their significance for the development of number concepts and the utilisation of mathematical apparatus, M.Ed. dissertation, University of New England, Armidale, 1981.

S. Turkle, *The second self: Computers and the human spirit*, Granada, London, 1984.

M. Wagman, 'A factor analytic study of the psychological implications of the computer for the individual and society', *Behaviour Research Methods and Instrumentation* 15, 1983, pp. 413–19.

J. E. Walton, Sequential and simultaneous information processing abilities and their interaction with instructional treatments in senior high school mathematics. Ph.D, dissertation, University of New England, Armidale, 1983.

N. M. Webb, 'Microcomputer learning in small groups: Cognitive requirements and group processes', *Journal of Educational Psychology* 76, 1984, pp. 1076–88.

L. Weinstein & G. Kestenbaum, 'Personality, psychopathology, and developmental issues in male adolescent video game use', *The Journal of the American Academy of Child Psychology* 24, 1985, pp. 329–37.

West Australian Educational Computing Consortium and AIS Librarians Group, *Schools computing in the Independent schools of Western Australia: 1983–1987*, December 1984.

T. Williams & M. Batten, *The quality of school life*, ACER, Melbourne, 1981.

R. B. Zajonc & G. B. Marcus, 'Birth order and intellectual development', *Psychological review* 82, 1975, pp. 74–88.