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ABSTRACT

Integration is based on the assumption that computers should be an integral part of the learning process, both for servicing curriculum needs and as an object for study. The integration of computers into everyday classroom activity has proved to be more slow and difficult than expected, creating the notion that there are incentives enhancing the adoption of technology in some schools and barriers or organizational constraints blocking wider acceptance in others. A study of six schools was conducted to explore the integration of computers across the curriculum in Western Sydney (Australia) secondary schools. The study used a survey drawn from existing literature on teachers' intentions to use information technologies as teaching strategies. Teacher computer skill was tabulated and examined for its influence on each of seven categories: anxiety, self confidence, perceived relevance, pedagogical practices, staff development, access to resources, and policy formation. One-way analysis of variance (ANOVA) was used to compare groups of teachers. Results showed significant differences between groups on the anxiety, self confidence, perceived relevance, and pedagogical practices scales. Post hoc analysis using the Newman-Keuls technique was used to determine how the groups differed. Analysis of the data shows fluctuation in the way teachers feel about computers. These feelings manifest themselves within the skill base of teachers and in turn influence teacher intentions to use computers as tools for learning and discovery. The analysis found a pool of highly skilled computer-using teachers, most from the mathematics and technology faculties, who could act as catalysts for the creation of a computer culture. A computer culture could serve to promote motivation, cooperation, and collaboration among faculty as a means of altering the ways teachers feel about computers. For this group to succeed, it must be aware that the appropriate culture is based on the use of computers for learning rather than learning about computers and computing. The fact that there is diversity in teachers' computing skills highlights the multiplicity of the problems faced by advocates of integrating computers across the curriculum. For any long term solution, sufficient time must be provided for teachers to learn how to use technology in their teaching and to plan for its use. (Contains 36 references and 8 tables.) (Author/SWC)

# Factors Affecting the Integration of Computers in Western Sydney Secondary Schools

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*Integration is based on the assumption that computers should be an integral part of the learning process at all levels (Lockard, Abrams & Many, 1994), that is, the tool should service curriculum needs first and then be an object for study. However, the integration of computers into everyday classroom activity has proved to be more slow and difficult than many may have expected it to be (Collis, 1988), giving rise to the notion that there are incentives and barriers at work enhancing the adoption of technology in some schools while effectively blocking wider acceptance in others.*

*A study was formulated to explore the Western Sydney experience of the integration of computers across the Secondary School Curriculum. Six schools agreed to participate. The study used a survey drawn from the literature on teachers' intentions to use information technologies as teaching strategies. Data were analysed to reveal seven broad categories; Anxiety, Self Confidence, Perceived Relevance, Pedagogical Practices, Staff Development, Access to Resources and Policy Formulation, which explained teachers' intentions to use computers. Data about Teacher Computer Skill were also tabulated.*

*One-way analysis of variance (ANOVA) was used to compare groups of teachers based on perceived computer skill and the seven categories. The results showed significant differences (p2 0.01) between groups on the Anxiety, Self Confidence, Perceived Relevance and Pedagogical Practices scales. In order to determine how groups differed, post hoc analysis using the Newman-Kuels technique was used.*

## A Theoretical Perspective

The growth and acceptance of computers in our schools has been nothing short of spectacular, or has it? There is certainly evidence worldwide (Pelgrum & Plomp, 1991) describing the phenomenal infusion of information technology in schools. Similarly, research findings have made it clear that computer applications have undeniable value and have an important instructional role to play in classrooms (Roblyer, Castine & King, 1988). However, the acceptance, or more precisely the role of information technology in the classroom remains problematic.

The question of how schools can best use their computing resources to bring about positive and lasting effects upon student's learning has resulted in the development of two broad sets of curriculum practices (Bigum, 1990; Hodson, 1990; Wellington, 1990). These are:

i. Learning about the computer and its impact upon society — ie. computing studies.
ii. Learning with, through and from computers — ie. Computers integrated Across the Curriculum.

Today, both sets of curriculum practices command a significant proportion of schools' resources (Bigum, 1990). During the 1980s though, curriculum practice emphasising learning about computers gained dominance. Hodson (1990) stated that specific subjects were developed to teach about

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computers because they provide a highly visible and traditional secondary school response to problems, problems in computer education that Morton (1994) identified as:

i. a lack of range and quality of software alternatives;
ii. high establishment costs relative to other teaching / learning tools;
iii. a lack of familiarity by teachers of how to promote learning through and from computers (p.208).

The popularity of this approach to computer education has not been without its critics (Adams, 1992; Bigum, 1990; Wellington, 1990). Bigum questioned the legitimacy of learning about computers, suggesting that the conspicuous position of Computing Studies has arisen without real debate. In Great Britain, Wellington argued there were significant economic pressures behind the push for students to learn about computers.

During the 1990s, the pendulum has begun to swing in favour of learning with, through and from computers across the curriculum. That shift has reflected a growing awareness of the disadvantages of specialised computing subjects — fragmentation, mystification and academicisation (Hodson, 1990) — and an increasing consciousness of the interactive nature of computers, as tools for learning and discovery.

This awareness owes much to the many empirical studies of computer use in teaching and learning. Findings of many of those studies have subsequently been combined using meta-analysis techniques. Meta-analysis is a research synthesis methodology used to transform the features and outcomes of a set of related empirical studies into quantitative measures, which can then be used to calculate a measure known as an effect size. As a research tool, the power of meta-analysis arises from the ability of the researcher to summarise the breadth of the literature and generalise about relationships (Borg & Gall, 1989).

A key focus of early meta-analytic studies was the relationship between interventions involving computers and student achievement, as measured by test scores (Burns & Bozeman, 1982; Kulik, Bangert & Williams, 1983). The studies found learning involving computers was as effective as traditional instruction or resulted in greater gains for students. In summarising these findings, Kulik (1985) concluded that students whose learning experiences involved computers generally spent less time learning, learned more in class and remembered it longer.

A more recent meta-analysis using empirical studies not included in earlier syntheses (Khalilli and Shashanni, 1994), concluded that while computer applications remain an effective means of improving students' academic achievement these gains were greatest when simulation and problem solving tools are used. A meta-analysis of studies reporting cognitive performance . (Liao and Bright, 1991), also found evidence suggesting that the use of simulation and problem solving software impacted beyond specific content, affecting student's planning skills, reasoning, logical thinking and ability to transfer.

Despite growing support for computers as tools for learning and discovery, why is there a general unwillingness among teachers and schools to promote the use of computers across the curriculum? According to Collis (1988), the advocates of integration have failed to account for the reality of school life. The lack of appropriate teacher role models for those teachers implementing and managing computers in their classrooms is a fundamental cause of the problem. Complicating the situation is that those role models who do exist, are generally computing studies teachers using computers in laboratory situations. Wellington (1990) believes that the physical obstacle of computer rooms and the more subtle obstacle of computing being the domain of mathematics / computer studies boffins inhibits the spread of computers across the curriculum.

The existence of subtle obstacles suggests that teacher beliefs or values play an important role in influencing the integration of computers in general teaching areas. In a recent review of the literature on teacher attitudes towards computers, Dupagne and Krendl (1992) identified twenty aspects related to teacher's perceptions of computers, the impact of computer use and the impact of personal and learning environment characteristics affecting a teacher's intention to use computers as teaching learning strategies.

Chandra, Bliss and Cox (1988) studied the implementation of computers in secondary schools in the United Kingdom and found organisational constraints within schools were a significant impediment to the diffusion of computers across the curriculum. More recently, Schofield (1995) following a two year study of Whitmore High School, stated "preexisting attitudes and social structures shape the extent to which technology is used as well as the way it is used" (p.94).

Organisational constraints relate to the policies and practices (official and unofficial) that inhibit the implementation of ideas. In a survey of 26 American Principals, Hameyer (1989) noted that there was a degree of scepticism about whether or not computers would enhance learning. Hameyer also found that the financial resources innovative technology might consume concerned many of the Principals.

The impact of the school principal on computer implementation is decisive. Indeed, research has demonstrated that support provided by principals and other administrators consistently predicts successful integration of computers into the instructional process (Becker, 1984; Dupagne & Krendl, 1992; Mahmood & Hirt, 1992).

For some teachers, frequent and systematic use of computers for activities that involve higher order thinking is the norm. In a nationwide study of 608 teachers described as accomplished at integrating computing into their teaching by the Bank Street College of Education (Sheingold & Hadley, 1990: Hadley & Sheingold, 1993), it was found that exemplary practitioners, devoted considerable time and effort to teaching with computers, using computers as multipurpose tools to present more complex material to students and to foster greater independence within the classroom. The study concluded that provided there is enough technology for teachers to have regular access, ample support and time for teachers to learn how to use and plan for computer use and there is a school climate which encourages an experimental approach to teaching, then it is possible for other teachers to gain the expertise and comfort levels demonstrated by exemplary teachers.

## The Study

The present study sought information about the existence of incentives and barriers to the integration of computers across the curriculum in Department of School Education (DSE) secondary schools in Western Sydney. Issues identified in the literature as influencing teacher's intentions to use information technology provided a conceptual basis for the study.

A questionnaire was developed for use in selected schools. The literature on cross curricula use of computers, contains many examples of questionnaires (Gardner, Discenza & Dukes, 1993; Kluever, Lam, Hoffman, Green & Swearingen, 1994; Massoud, 1991; Robertson, Calder, Fung, Jones & O'Shea, 1995; Winnans & Brown, 1992; Woodrow, 1991). Selected questions from these questionnaires were chosen and categorised to reflect the broad issues identified in the literature.

The questionnaire was divided into two sections. The first sought information about gender, age, teaching experience, key learning area of teaching, teaching status, computing skill, computer availability and major use of computers. The second section contained questions organised into categories, Computer Anxiety, Self Confidence, Perceived Relevance, Pedagogical Practices, Staff Development, Access to Resources and Policy Formulation. Each question required a response on a five-point likert scale (1 strongly agree to 5 strongly disagree).

Prior to randomly selecting schools, the potential pool of DSE secondary schools was arranged into Comprehensive, Selective and Technology high schools. Six schools (2 each from each category) were then selected. Each school was located on a map to determine if the overall selection reflected the geographical and socioeconomic diversity of Western Sydney. Only then were schools invited to participate. Of the original six, one school (a selective school) declined to participate and it was replaced. The replacement, also chosen at random, maintained the integrity of the diversity of the schools originally chosen.

## The Results

Due to the magnitude of the data collected, only relationships between teacher computing skill and intentions to use computers has so far been considered. It was decided to concentrate upon this factor to determine if there were significant differences between teachers consistent with studies by Becker (1994), Honey and Moeller (1990) and Sheingold and Hadley (1990).

Questionnaires were distributed to the 407 teachers in the 6 selected schools and 150 were returned (response rate 36.9%). Teachers were asked to rate their computer skills as a means of identifying levels of expertise within the sample. The results are illustrated in Table 1.

| Comp Skill | Frequency | Percent | Cumulative |
|---|---|---|---|
| Low | 24 | 16.0 | 16.0 |
| Below Ave | 26 | 17.3 | 33.3 |
| Average | 71 | 47.3 | 80.7 |
| Above Ave | 19 | 12.7 | 93.3 |
| High | 10 | 6.7 | 100.0 |
| **TOTAL** | 150 | 100.00 | |

**Table 1:** Question 6 Rating Teachers' Computer Skill

For each of the categories, data were collapsed into a single measure. To determine the consistency of the category variables, a reliability analysis was completed and Alpha scores (() calculated using SPSS for Windows. Alpha scores of 0.75 or greater were considered to indicate a high correlation between items used to measure the same variable. Data items considered to be unreliable were omitted from the category variable (see Table 2).

| Variable | No. of Items | Score | Deleted Items |
|---|---|---|---|
| Computer Anxiety | 10 | .8167 | Nil |
| Self Confidence | 10 | .8384 | Q.8 |
| Perceived Relevance | 10 | .8062 | Q.7 |
| Pedagogical Practice | 15 | .8527 | Q.1, 2, 4, 6, 7, 10 |
| Staff Development | 10 | .7554 | Q.5, 8 |
| Access to Resources | 11 | .6861 | Q.1, 2, 3, 10 |
| Policy Formulation | 15 | .7175 | Nil |

**Table 2:** Alpha Scores of Variables affecting Teachers' Intentions to Use Computers

To test for an effect of computer skill on teachers' intentions to use computers a series of one way analysis of variance (ANOVA) was used. Significant differences (p2 0.01) were indicated for Computer Anxiety, Self Confidence, Perceived Relevance, Pedagogical Practices and Staff Development (see Table 3).

Post hoc comparisons (Popham & Sirotnik, 1992) using the Newman Keuls technique at the 0.05 level of significance were undertaken to explain the between group variations in Computer Anxiety, Self Confidence, Perceived Relevance, Pedagogical Practices and Staff Development. The results are illustrated in Tables 4 to 8.

The low mean scores shown in Table 4 equate with lower levels of anxiety. The mean scores of the high skill and above average skill groups were not sufficiently different to indicate a between groups difference. This, combined with between group differences for all groups suggests that for anxiety, there may be four rather than five groups within the sample. The existence of multiple between group differences points to anxiety being a very complex variable. Dimensions covered in the survey include, fear of the unknown, an inability to conceptualise uses and above all a desire not to be seen to be inadequate either by peers or students.

Self confidence is a measure of one's interaction with computers. The lower means of the High and Above Average skills groups recorded in Table 5 identifies those group's greater interaction with technology. Again, the mean scores of the high skill and above average skill groups were not sufficiently different to indicate a between groups difference, while multiple between group differences were recorded for all other groups. Woodrow (1991) has argued that anxiety and confidence are two sides of the same coin, a result not at odds with the above. However, Gressard and Loyd (1987) suggest that there is sufficient difference between the variables to conclude that they are indeed separate.

| Variable | D F | F Ratio | p≤ |
|---|---|---|---|
| Computer Anxiety | 4,144 | 36.2318 | 0.0001 |
| Self Confidence | 4,144 | 27.7290 | 0.0001 |
| Perceived Relevance | 4,144 | 7.2703 | 0.0001 |
| Pedagogical Practice | 4,143 | 10.7703 | 0.0001 |
| Staff Development | 4,142 | 8.4712 | 0.0001 |
| Access to Resources | 4,141 | 2.1971 | 0.0723 |
| Policy Formulation | 4,141 | 0.5556 | 0.6952 |

**Table 3:** ANOVA Results: Computer Skill and Intention to Use Computers

| Mean | Skill | High | A. Ave | Ave | B. Ave | Low |
|---|---|---|---|---|---|---|
| 15.9000 | High | | | | | |
| 16.7895 | A. Ave | | | | | |
| 22.1127 | Ave | * | * | | | |
| 29.2308 | B. Ave | * | * | * | | |
| 34.7826 | Low | * | * | * | * | |

*(*) Indicates a between group difference*

**Table 4:** Results of Newman-Keuls Test Computer Skill and Anxiety

| Mean | Skill | High | A. Ave | Ave | B. Ave | Low |
|---|---|---|---|---|---|---|
| 10.6000 | High | | | | | |
| 14.0526 | A. Ave | | | | | |
| 17.3803 | Ave | * | * | | | |
| 22.3462 | B. Ave | * | * | * | | |
| 26.7826 | Low | * | * | * | * | |

*(*) Indicates a between group difference*

**Table 5:** Results of Newman-Keuls Test Computer Skill and Self Confidence

Van Lengen (1985) asserted that all teachers were willing to use computers, but that the problem was that many were either infrequent users or they didn't know how to use them. Infrequent users require structured opportunities to practice the requisite skills, while in 1996, those who do not know how to use them have successfully avoided the many basic staff development activities that have run over the years, indicating a need to monitor more closely the impact of staff development.



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| Mean | Skill | High | A. Ave | Ave | B. Ave | Low |
|---|---|---|---|---|---|---|
| 16.7000 | High | | | | | |
| 18.5263 | A. Ave | | | | | |
| 19.0423 | Ave | | | | | |
| 22.6923 | B. Ave | * | * | * | | |
| 25.0435 | Low | * | * | * | | |

*(*) Indicates a between group difference*

**Table 6:** Results of Newman-Keuls Test Computer Skill and Perceived Relevance

The higher means of the low and below average computer skill teachers and the resulting between group differences, suggests the low and below average skills groups see little if any relevance in using computers. A marked dichotomy appears to exists between 'low tech' and 'high tech' teachers. Given that the questions asked relate to the impact of computers on student learning, it is highly likely that the 'low tech' teachers engage in more traditional practices. As Honey and Moeller (1990) suggest, "low tech" teachers always display negative views towards the use of computers in their classrooms, perceiving computers to be a threat to their control of students and the completion of work. These teachers always have reasons not to use computers.

| Mean | Skill | High | A. Ave | Ave | B. Ave | Low |
|---|---|---|---|---|---|---|
| 18.9000 | High | | | | | |
| 19.8947 | A. Ave | | | | | |
| 21.0714 | Ave | | | | | |
| 24.0846 | B. Ave | | * | * | | |
| 29.8261 | Low | * | * | * | * | |

*(*) Indicates a between group difference*

**Table 7:** Results of Newman-Keuls Test Computer Skill and Pedagogical Practices

In relation to teachers' pedagogical practices, the higher means of the low and below average computer skill teachers and the resulting between group differences, suggests that the low and below average computer skills groups do not believe computer use will enhance student learning. Again, a marked dichotomy exists. The questions posed in this category relate to the ease of assimilation of computers into a teacher's teaching style, the ways they organise lessons and the additional tasks required of them in the delivery of those lessons. For this group, it appears as if other approaches to teaching have more to offer or that less innovative approaches are within teachers' comfort zones.

The very high mean of the high computer skill group suggests that teachers in this group perceive little scope for current staff development practices to improve their computer skills. However, for other teachers, there remains a need (perceived or otherwise). The basis of this need requires additional analysis with respect to other variables.

## Conclusion

The initial analysis of the data suggests considerable fluctuation in the way teachers feel about computers. These feelings manifest themselves within the skill base of teachers which in turn influences teacher intentions to use computers as tools for learning and discovery. The analysis has identified a pool of highly skilled computer using teachers within schools who could act as catalysts for the creation of a computer culture which could serve to promote motivation, cooperation and collaboration among faculty as a means of altering the ways teachers feel about computers.

Not surprisingly, most of this group of teachers are drawn from Mathematics and Technology faculties, which Wellington (1990) saw as a subtle obstacle to the spread of computers across the curriculum. If this group is to succeed it has to be aware that the appropriate culture is based on the use of computers for learning rather than learning about computers and computing. If the group is to be successful, they too will have to alter their practices to provide the role models Collis (1998) believes are missing.

The fact that there is diversity in teachers' computer skills simply serves to highlight the multiplicity of the problem faced by advocates of integrating computers across the curriculum. If there is to be any long term solution, then sufficient time must be provided for teachers to learn how to use technology in their teaching and to plan for its use.

| Mean | Skill | High | A. Ave | Ave | B. Ave | Low |
|---|---|---|---|---|---|---|
| 27.7000 | High | | | | | |
| 20.7895 | A. Ave | * | | | | |
| 18.3188 | Ave | * | | | | |
| 16.3462 | B. Ave | * | * | | | |
| 17.9565 | Low | * | | | | |

*(*) Indicates a between group difference*

**Table 8:** Results of Newman-Keuls Test Computer Skill and Staff Development

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