INTRODUCTION

This study reports on research conducted over a eight-month period in four grade seven classrooms. The students and teachers involved took part in an electronic learning project aimed to provide students with a range of experiences in a variety of curriculum areas. From the perspective of the researcher, it was an interesting opportunity to study the effects of a greater-than-usual number of computers on the students' attitudes to computers and how these attitudes were mediated by the modus operandi of the teachers. The project provided additional interest in that two of the four teachers operated in a cooperative mode, whereas the other two operated independently.

The particular construct that was used to study the effects on students was computer anxiety. Montag, Simonson and Maurer (1984) defined computer anxiety as 'the fear or apprehension felt by an individual when using computers, or considering the possibility of computer utilisation' (p. 5). This psychological 'state' has received considerable attention in the literature. The major impetus for this interest has been to develop a better understanding of the construct in order that anxiety and negative attitudes might be reduced, since research has indicated that negative attitudes and anxiety affect performance and motivation.

A number of correlates of computer anxiety have been studied, including its relationship with personality, gender, prior experience including home use, mathematics anxiety and age. In terms of personality, intuitive and thinking individuals have been shown to exhibit lower anxiety than their sensing and feeling counterparts (Chu & Spires 1991). Studies on gender have produced mixed results, with a number of studies reporting greater anxiety in females and others reporting no gender differences (Bandalos & Benson 1990). Experience with computers and computer ownership have been shown to be important factors in reducing computer anxiety (Loyd & Gressard 1984; Hayek & Stephens 1989). McInerney, McInerney and Sinclair (1991) caution, however that complex situational and individual variables need to be considered when considering experience since '...for some individuals, greater computer experience in fact worsens anxiety.' Bandalos and Benson (1990) concluded that computer anxiety is a multidimensional construct with highly correlated factors.

Most of the studies of computer anxiety reported in the literature are characterised by short periods of duration and by a narrow focus on a particular computing activity. The interest here was to study the computer anxiety of students working in natural, uncontrived settings over a longer time span, and in settings where the teachers had control over the nature and timing of the variety of activities undertaken. Hence, the major research question concerned the effect of the presence of a greater-than-usual number of microcomputers on students' computer anxiety in typical classroom settings. Since time over which the computing experience took place has been identified by Honeyman and White (1987) as an important consideration, and as the duration of the present study covered most of the school year, it was predicted that the level of computer anxiety across all three groups involved in the study would decrease. Additional questions which emerged as the study progressed related to the causal factors of large shifts in computer anxiety of some students and the effect some students' initial predisposition for game software had on their later attitudes towards computers.

METHODOLOGY

The students involved in the study came from the four grade-seven classes in a large metropolitan primary school in a provincial city. Two of the teachers operated with 63 students as a cooperative unit (class C) at one end of a teaching block. One of these teachers was replaced by another during the
year without any disruption to the cooperative organisation. The other two teachers operated with 31 and 34 students independently of each other and the cooperative group at the other end of the teaching block (classes A and B). The cooperative group controlled six of the computers at their end and in the case of the independently operating classes, their six computers were positioned closer to the class whose teacher was also the computer coordinator of the school, an arrangement determined by the layout of the classrooms and facilities. It was considered that the students in the three groups were well matched in terms of previous experience of computers at school. One or two computers had previously been available at various times in each grade-six class during the previous year. Also the method used by the school to allocate students to classes at each year level was designed to produce an even distribution of ability and socio-economic groupings.

The instrument used in the study was the computer opinion survey (Simonson, Maurer, Montag-Torardi & Whitaker 1987) which generates a computer-anxiety index (CAIN). The possible range of scores for the CAIN is 26 to 156; with higher scores indicating greater anxiety. It consists of twenty six positively- or negatively-worded Likert-type items considered indicative of a person's feelings of anxiety toward computers. Examples of the types of items included on the CAIN are 'Having to use a computer could make my life less enjoyable' and 'I look forward to a time when computers are more widely used.' The CAIN was found by the authors to have high reliability estimates. It was also found to correlate significantly to the 'state' portion of the State-Trait Anxiety Index (STAI) score demonstrating its concurrent validity, as well as to a score based on the average of two observer's judgement of student anxiety when students were working with computers.

The 26-item CAIN was administered to students in April, four weeks after the microcomputers were first used. The four teachers were given a semi-structured interview during the same week designed to promote discussion about the use and organisation of the computers. A random group of eight students from the three class groups were also interviewed on the same day. The computer-opinion survey was administered again in late November of the same year, after a period of eight months. Teachers and selected students were re-interviewed. For the student interviews, two groups were used; those who had exhibited low anxiety, as measured by the CAIN, and those who had exhibited strong shifts to high anxiety. It was considered that by this means, causal evidence for students' change in anxiety about computers would be more apparent.

RESULTS
Computer anxiety data
The design used to analyse the CAIN scores was a balanced repeated-measures analysis of variance, with gender, and class as between-groups factors. The repeated measure was represented by the pre- and post-test CAIN scores. Means for each individual cell in the analysis are plotted in figure 1.

The difference between the pre-test and post-test average CAIN scores was significant (F = 8.04, df = 1/78, p < 0.01) indicating a general increase in computer anxiety across the three class groups for the period of the study. Figure 1 illustrates that only the boys in class B achieved a reduction in computer anxiety as a result of their eight-month experience. Pre- and post-test means for the combined group are listed in table 1. The difference between the means for the three class groups from the pretest to the posttest was also significant (F = 3.44, df = 2/78, p < 0.05). Means for each class are also listed in table 1. A post-hoc test indicated that significance referred only to the means for classes A and B. This provided evidence that influences within the two independently operating classes had affected the CAIN results.

The main effect for gender was not a significant factor in the analysis. Pre- and post-test means for males and females are listed in table 1. For the four possible interactions between variables in the design, only the interaction between class and gender was significant (F = 1.13, df = 2/78, p < 0.05). This is illustrated in figure 1 by the high means for the class B females and the relatively low means for the class B males compared to those for the other two classes, whose pattern of means was similar.

INITIAL INTERVIEWS
The initial interview with the teachers revealed a general concern about equipment reliability, the lack of printers, loose cords, faulty disks and an initial lack of suitable software, necessitating a greater initial reliance than intended on educational games. Similar access to the computers was given to students in classes A and B as for class C, the larger cooperative group, although class A and B students accessed the machines in pairs whereas class C students worked individually. Access was also provided before school as well as during the lunch hour. Teacher B indicated a problem with noise when direct teaching was being undertaken, whereas there was less
Concern in the cooperative group about machine placement and noise as class C were not constrained by the need for two separate teaching spaces. A concern was expressed about the need for inservice on computing with teacher B indicating that she was 'an absolute novice', whereas one of the cooperative teachers felt 'very confident with word processing.' The class A teacher indicated that he was the computer coordinator for the school. It became evident during the interview that teacher knowledge and attitudes about computers varied considerably in the group.

Other teacher concerns included the differential access of students to the machines. This was a particular problem in the mornings when the same students ‘hogged’ the machines.

Fixed rosters had to be drawn up in class time and students became very upset if they missed their turn, for whatever reason. As one teacher explained ‘...if you want to withdraw a privilege, if you withdraw a computer, it’s like their throat’s been cut!’ Extracting students from machines was a particular concern for one teacher who, at times, had to threaten to turn the machine off. At the point at which the interview had taken place, the cooperative group had mainly concentrated on word-processing, whereas teacher B indicated that the game program Grocery Store had also been used for thinking-skill development. Teacher A indicated an equal emphasis on word-processing and Logo.

Eight students were selected at random from the three groups to gain their perceptions as to the use of the computers at this early stage. Games were the most popular activity on the machines with word-processing least popular. This appeared to relate to problems with typing and ‘finding the letters on the keyboard.’ No systematic keyboarding activity had been undertaken. All students indicated a preference to work on their own for greater control of the machine and the activity undertaken. About half of the students had some reservations about their confidence at this stage and all expressed a desire for more access.

One class B student indicated that her teacher ‘doesn’t really like us on the computer because we’re missing out on a lot of work.’ All agreed that boys were accessing the machines more than girls. Accessing the colour monitors appeared to be a particular concern.

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<th>Table 1 Pre- and post-test means and standard deviations for combined sample, class samples and gender samples</th>
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CONCLUDING INTERVIEWS

Teachers were again interviewed in late November at which time they were shown the initial and final CAIN scores and were asked for comment on the large shifts for some students. There was some concern that the survey questions used to generate the CAIN may have been difficult to interpret for some students as some questions were deliberately asked in the negative. The class B teacher identified three of the female students with large upward shifts in the CAIN as her students, whom she described as being ‘very capable.’ Other comments related to the questions not being ‘user friendly’ and the behaviour of one boy who had experienced much frustration with syntax while using logo and whose CAIN had nearly doubled.

Some of the management concerns expressed during the first interview were still present, including problems with machine breakdown and loose cords. Class size was also seen to be a significant constraint on access. However, there was evidence from teachers’ comments that students had made considerable progress in their use of the computers as indicated by fewer interruptions to the teachers when they were working with the rest of the class and in terms of progress individual students had demonstrated. Some teacher comments suggested that a number of students had outstripped them in their ability to use the machines. In some cases, they were using the more able students as peer tutors for other students having difficulty. The over-assertiveness of the boys was a continuing problem, particularly in relation to games. Games had been banned in one class before school for this reason.

One class C teacher indicated that there was a markedly different approach to the use of computers in their area because of ‘...a totally different system of imparting knowledge between their group and the independent groups.’ Comments of the class C teachers indicated that they had accommodated the presence of computers to their satisfaction, whereas the class A and B teachers appeared to experience continuing tension between direct teaching and computer use. One class C teacher suggested: ‘A computer room is the answer for them.’

The final interviews with students were conducted in two groups. The first group included five students who had obtained ‘low-anxiety’ scores on the CAIN of between 27 and 31. Possible scores range from 26 to 156. All these students expressed a preference for software tools including combinations of word processing, certificate maker and database software. Games barely rated a mention. Responses indicated that they felt very comfortable with using the computers and that most tasks were easy. They preferred to work on their own in order to maintain ownership of the output and to retain control of the activity. They were aware of the differential access enjoyed by the boys, particularly in relation to colour-monitor access. Speed of production and neatness of output were the main advantages of using computers for this confident group.

The second group included six students who had exhibited large upward shifts in the CAIN and whose scores were in the range of 91 to 110. This group was distinguished by less certainty in the software they had used...
during the eight-month period and by a greater concern as to the access they had achieved. All volunteered games as their preferred software choice and responses as to the utility of word processing were equivocal. They varied in their preferred mode of working. Working in pairs was seen by one student as helping a bit more when the task was difficult. They were quite open in expressing their lack of confidence or lack of liking for the machines, but the reasons for this appeared to relate to either insufficient access to the machines or a basic dislike for the task set. This was more evident when they were asked whether they would have liked more access. Some indicated more access would allow them to learn more, whereas others indicated a desire for greater access only if they could play games. None indicated that the presence of the computers had worried them. The only 'worry' expressed related to difficulty in responding to the tasks set. Neutral or negative comments were forthcoming when they were asked if school had improved since the computers had arrived. When asked whether their feelings towards computers had changed, it was interesting to discover from their responses that these students had retained their initial strong association of computers with games. Since they had used them at school for other purposes, computers had become 'boring' or 'too hard,' too much 'like work' or simply 'not enjoyable.'

**DISCUSSION**

The major research question in this study related to the effect of the classroom availability over an extended time span of a greater-than-usual number of microcomputers on the level of computer anxiety of students. The prediction that the level of anxiety would decrease over the eight-month period was not borne out in this study. This finding contradicts the common finding in the literature, namely that computer anxiety decreases with computer experience. However, it does support the comment by Mehnemy et al. (1991) that greater computer experience for some individuals worsens anxiety. Several reasons for this apparent increase in anxiety may be formulated from a comparison of the test and interview data.

Firstly, figure 1 indicates that all class and gender groups except class B boys contributed to the increase in the CAIN from the pre-test to the post-test. While the class of the computer coordinator, class A, exhibited the lowest-upward shifts overall, the additional enthusiasm and expertise of this teacher was not sufficient to reverse the trend. Nor was the class C teachers' sense of accommodation of the computers relative to the other two classes sufficient to mediate the anxiety of their charges.

The class B result from figure 1 is aberrant in the sense that the average CAIN for the girls soared above that for the other two classes for both the pre-test and post-test. This, combined with a slight drop in the average CAIN for the boys in class B, explains the significant interaction between class and gender for the three groups. As the post-hoc tests indicated that the significance was related to the differences in the class A and class B means, one explanation for these differences may lie in the differences in attitudes towards computers of these two teachers. The interviews painted a picture of the class B teacher as a 'most absolute novices' who indicated that she 'hasn't got the time, and hasn't made the time [for computers]' and who relied on the class A teacher for the necessary expertise. It was the class B teacher who identified three 'very capable' girls who exhibited high upward shifts in the CAIN as having come from her class, and a class B student who suggested that: 'Our teacher doesn't really like us on the computer because we're missing out on a lot of work.' The teaching style of this teacher, which required whole-class direct teaching and focussing lessons, appeared to clash with the organisational arrangements for the use of computers to the point where access of class B students to the computers was affected. It appears then that some combination of access frustration and teacher role model affected the CAIN results for the class B girls, as indicated in figure 1.

In terms of the differential effect on class B boys, Todman and Dick (1993) found a positive correlation between the attitudes of students and their teachers towards computers, and that the relationship was stronger at the grade-seven level for girls than for girls. This provides a possible explanation for the relative immunity of the class B boys to an increase in their mean CAIN score. The stronger relationship for girls also helps to explain the results in class A where, unlike class B, the girls demonstrated lower mean CAIN scores than the boys (figure 1). In terms of Todman and Dick's finding, it could be argued that the class A teacher, being the more positive and enthusiastic computer coordinator, influenced the girls to a greater extent than the boys in the direction of lower anxiety. Hence teacher attitude appears to have been a significant factor, not only in the way computer anxiety changed over time, but also in its gender construction for these two classes.

The second factor bearing on the increase of computer anxiety with experience in this study is the validity of the measure itself. The concluding interviews with students provided a picture of two contrasting groups, a 'low-anxiety' group and a purported 'high-anxiety' one. In terms of the definition of computer anxiety used by the authors of the CAIN, it can be reasonably argued from the interview evidence that the 'low-anxiety' group demonstrated those characteristics which indicated a lack of 'fear or apprehension' about computers. The CAIN appears to have validly identified them.

On the other hand, the 'high-anxiety' group, while exhibiting frustration about the level of computer usage they had obtained, and lacking enthusiasm for the 'tool-type' software they had used, expressed little anxiety about computers per se. Their 'anxieties' were all about lack of access and lack of games. This apparent 'sour grapes' reaction has been previously reported in a study by Lever, Sherrod and Bransford (1989) in which a control group of boys exhibited an increase in computer anxiety. It was suggested in their case that the prior expectation of computer use was unfulfilled when allocated to the control group. A similar effect relating to level of access and type of access appears to have been an important factor in the present study. This casts doubt on the validity of the CAIN at the 'high-anxiety' end of the scale as a measure of 'fear and apprehension.'

The group of students used in this study were younger by about a year compared to the youngest group (junior high school, USA) for which the CAIN has been normed by the authors of the test. It may well be that as students become younger, factors like access and expectations of computers become increasingly dominant in their responses to questions about attitudes to computers and that the CAIN is not appropriate.
for students below high-school level. Nevertheless, this study has served to highlight the need to accompany psychological indices like the CAIN with additional qualitative data to help validate what is being measured.

CONCLUSION

The outcomes of this study may help inform teachers of the effects of the introduction of a greater number of computers into typical classroom environments. These effects are not necessarily all positive. The study highlights the influence that access frustration has on determining student attitudes. Even a greater-than-usual ratio of ten students to a computer was not sufficient to satisfy the access demands of all students in this study. Further, teachers should heed the powerful effect their attitudes about computers have on the attitudes of their charges. It is apparent that the successful introduction of computers into classrooms will only be assured when there has been adequate preparation of the teachers involved. Attention to the attitudes of teachers to computers must be a primary concern of inservice and preservice programs focussing on this area. More attention needs to be given to how this can best be achieved.

Research attention also needs to be directed to studying the effects of computer game playing on student cognitive style. It appears that, for some students, computer games encourage an impulsivity of action which serves them poorly when confronted with 'tool-type' software requiring a measure of reflectivity for its effective use.

REFERENCES


