Geeks and Nerds: Computers, gender and the mathematics classroom

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This paper presents some of the findings of a pilot study concerning gender differences in behaviour in a secondary mathematics classroom that used computers. Analysis of interactions between students and the teacher and engagement with the task, the computer and the mathematics suggest some evidence of gender difference. A number of factors were hypothesised as relating to behaviour and this paper discusses the preliminary findings in relation to students' experience with computers and their style of interaction with computers.

For a long time now we have been struggling to overcome the disadvantage of women and girls in mathematics. It would seem that the research and strategies that have been developed to encourage continued participation and success in mathematics for girls are starting to pay off (Fennema, 1996). In Victoria, recent data concerning ratio of females to males taking the "hardest" VCE mathematics subject shows a slight deterioration (38: 62 in 1992 to 34:66 in 1995). However, females are performing on average as well as, if not better than, males in VCE mathematics (Vale, 1993). On the other hand participation in VCE Information Systems has a marked gender difference in participation (12% female and 88 % male). This clearly demonstrates the masculine culture that surrounds and mystifies advanced technology. As teachers make greater use of computers for the teaching and learning of mathematics it is unclear how this will contribute to the classroom culture and to the gender differences which may characterise the complex nature of that culture.

The research literature is generally concerned with technical aspects of computer software and cognition in relation to computer enhanced mathematics programs. Little attention has been paid to affect or gender differences in changing mathematics learning environments. A few studies have reported on gender difference in achievement. Vale (1993) found that female VCE mathematics students who used computers to do the problem solving assessment task performed better than other groups of students. Rowe (1993) and Yelland (1992) found that primary aged boys performed better than girls on particular programming tasks using LOGO. In her study of the use of personal computers of primary children for learning across the curriculum, Rowe (1993) found that gender differences developed over time with familiarity and use. Males became relatively more confident and enthusiastic and used computers for a wider range of activities. Boys sought out the class expert or the teacher when in need of assistance whereas girls sought out their friends. Studies of classroom culture have found evidence to support the view that computer enhanced classrooms are male domains (Beynon, 1993; Elkajaer, 1992). A whole range of slang has developed to label people who are very interested and skilled in computers. Terms such as 'geeks' and 'nerds' are not gender specific but are generally assumed to apply to males. Some young women who are computer enthusiasts have adopted the name 'geek girls'. A few studies have explored individual differences in the way students interact with computers: Rowe(1993) reported on categories of effective users of computers, Turkle(1984) on types of interactors with computers and Turkle & Papert (1990) on types of programmers. These studies did not however report on gender differences.

This paper presents some of the findings of a pilot study concerning the culture of mathematics classrooms that used computers. The qualitative study was designed to investigate how boys and girls behave when they use computers for the learning of mathematics. Particular factors were hypothesised to be related to behaviour: the students around them, the attitudes and actions of the teacher, the nature of the task, their performance in mathematics, their attitude to mathematics, their experience with computers, their preferred learning style and their style of interaction with computers.

This paper presents results concerning gender difference in behaviour as it relates to experience with computers and style of interaction with computers.

The Study

The study investigated the behaviour of a class of year 10 students in a large Victorian co-educational secondary school, who were required to use computers as part of their mathematics program. There were 12 girls and 11 boys in the class. The teacher had 17 years of experience teaching mathematics and had begun using computers in the previous year. The topic was parabolas and quadratic functions and the teacher chose to use Graphmatica, the only graphing software available for use in the school. The teacher selected this topic and planned the unit of work, assessment tasks and the specific lessons that were used for the study. The students were required to complete two tasks for assessment: 'Graphing Project' and 'Problem Solving'. The teacher determined the timing of the study to coincide with the teaching of this topic. Special room allocations were made in order for the class to have access to a computer laboratory for four of the lessons that were observed. The computer laboratory contained 28 personal computers that were part of an entire school network of computers. Each student and staff member had a password for accessing the network.

Method

Six consecutive lessons of one year 10 class were observed. Data was collected in a number of ways: four lessons were videotaped and two were audio-taped, field notes were taken during each lesson and on informal discussions with the teacher and the teacher and four students were interviewed. These interviews were audio taped. The four students selected by the teacher had different levels of ability in mathematics: a girl and a boy who were above average (GK and BA) and a girl and a boy who were average or below average (GM and BD). Each of these students attended all of the lessons with the exception of one boy, BA, who was absent for the fourth lesson. The interviews of the students collected demographic data and data concerning attitudes and experiences of mathematics and of computers. During the interview the students also used the computer to repeat one of the problems from the 'Problem Solving' worksheet. The student interviews therefore collected a sample of work of each student using the computer for mathematics.

A large amount of qualitative data was generated and data reduction (Miles & Huberman, 1994, p. 50-89) was used as the process of analysis. The video tapes were transcribed and coded using codes adapted from the literature. These codes were descriptive and to some extent interpretative. The codes were grouped into five categories. The first category of codes concerned the participants of interactions, for example, B-G was used for an interaction between a boy and a girl initiated by a boy. The second category described the cognitive nature of interactions between members of the class including the teacher: informative, organisational, argumentational, exploratory or metacognative (Geiger & Goos, 1996, p. 231). The third category described the content of these interactions: mathematical, systems, software, task and off task. The fourth category interpreted the attitudes and feelings about people conveyed in their behaviour: positive socio-emotional and negative socio-emotional (Lee, 1993, p. 554). The fifth category interpreted the attitudes and feelings about the computer conveyed in behaviour: emotional verbal, emotional non-verbal, personalised and depersonalised (Turkle, 1984, p. 108). An additional category of codes was later included concerning the degree of collaboration: parallel activity, peer tutoring, collaboration (Goos et al., 1996, p. 238). Four additional codes for this category were created to make some finer distinctions in behaviour: peer demonstration, teaming, conspiring and peer takeover. A working definition of each of these additional codes is included in Table 1.

Table 1. Additional codes to describe the degree or nature of collaboration

Code	Working definition
peer demonstration	A version of peer tutoring, but in this case the student demonstrates by taking control of the mouse or keyboard to show how something is done.
teaming	Two or more students working together to complete the task sharing roles and assisting each other. Differs from collaboration because they don't necessarily have a problem with understanding the work, maths or software but are more efficient doing it together.
conspiring	Two people working together to give the appearance that each has done the work independently. One student benefits from thework of the other.
peer takeover	When a student rather than tutoring or demmonstrating does the work for another.

The student interviews were transcribed. A summary of each interview was compiled using categories which followed the set of questions used for the interview: attitude to mathematics, belief about mathematics ability, attitude to computers, experience with computers including personal ownership, use, activities, knowledge of software and finally opinions about using computers in mathematics. A summary of the student's work on a problem from the 'Problem Solving' worksheet included a description of the process followed by the student and a descriptive assessment of their knowledge of the mathematics content and the computer software tool.

Results

Whilst four students in particular were the focus of data collection during the lessons and through interviews, data concerning many other students was also collected. This section presents the results of a gender analysis of behaviour as it related to students' experience with computers and style of interaction with computers.

Behaviour and experience with computers

None of the students who were interviewed reported having previous experience of using computers in mathematics. The class had taken an information technology subject during the previous two terms, so they had been issued a password for accessing the network and had been introduced to a range of software. Three out of the four students who were interviewed (the two girls and one of the boys, BA) had a computer at home. The number of students in the class who had a computer at home is unknown, though the teacher believed that most of them did. None of the students who were interviewed reported using the computers at school out of class time.

All of the students who were interviewed commented positively on using computers for mathematics. For them, computers were familiar, easy to use or easier or better than writing. They also enjoyed using computers to play games, though they each played different types of games. One of the boys (BA) enjoyed adventure games and the other (BD) occasionally played sporting games at his friend's place. One of the girls (GM) said she played "Carmen San Diego" the other (GK) played a variety of games. The three students who had access to computers at home used word processing software for homework and one of the girls (GK) made use of reference material on CD-Rom. Of these three students, none spent long periods of time using their computer at home. The most was GK who spent about 7 hours per week and the least was GM at 3 hours per week. Each student remembered something different about what they did in their computing subject during the first two terms of the year. The more mathematically able students (GK and BA) recalled more examples of software used in the subject than the other two students who were interviewed.

Gender differences in relation to knowledge or expertise with software were not obvious. Three girls and one boy were observed to access the word processor to document their answers to the assignment questions (transcript and field notes, Thursday). Whilst both boys and girls acted as tutors during the lessons with the computer it was observed that two girls (GE and GR) moved around the room helping other students.

One of the boys (BA) spoke of his particular interest in computers, his recent work experience with computers and his desire to do a particular tertiary course in computer communication:

> went to work with computers for work experience.... I had to fix a few computers up... I had to install CD-Roms and configure the computers... (transcript, student interview BA).

This boy demonstrated his knowledge of specialist computer terms or jargon during the interview by interacting with the icons on the screen to show his understanding of the term 'configure'. During the lessons he was observed demonstrating features of the software to a neighbouring girl and answering questions asked by boys.

Other boys in the class also demonstrated knowledge about hardware and systems during the lessons. Boys talked more often than the girls about issues concerning access to the computers; they also used more jargon associated with computers (eg. virus, configure). Two episodes, recorded in Table 2, demonstrate boys' knowledge and their interest in accessing the network. In the first one boy (BJ) persisted with investigating the network to discover the reason for the inability of one the boys (BD) to log onto the network. The second episode involved the teacher. The teacher had decided to solve BD's access problem by using her own password and five boys were around her watching what she was doing. This episode illustrates the teacher's fear that she did not know enough about the system and did not like to be dependent on other people (teacher interview, p.1-2). She was pressured and challenged by the boys and had to defend her knowledge and skills.

Table 2. Boys knowledge and interest in hardware and accessing the network.

Problem with logging on	The teachers' password
BJ: R are you logged in? BD: Na...?.. BJ: Someone's logged in with your name. BD: Why? BJ: Someone's in with your name. BT: No wonder you couldn't get in. BD: How do you know? B?: Most likely in the other room or the library. BJ: Two people have your name. B?: Yeah it'll be in the other room. BD: How do you know? BJ: It says it here. BD: What?..?.... BJ: That's you yeah? BD: Yeah J. (video transcript Thursday, p.7)	BT: Miss is that ? your own one. T does not respond. BT: ?..why don't you just try to log in first maybe that might help you. T: ?..why...? BT (shaking his head in his hands): No but you shouldn't. You do have to. T: ? BD: Now log in....?.. BD: Now log in again. BT: Don't you have to write star first, cos we've got to...? T: No, no I don't. BD: You can't log in you can only log in like that. BR arrives to watch what the teacher is doing to log in. BB is also looking on. BD: ..?... Now write it now. BT: You've done it wrong all the other times because you forgot the y. T: ? BT: Na, you did. T: Yeah but I did it intentionally to ....?... (video transcript, Thursday, p. 6)

The boys also showed a willingness to back up their mates who had less experience with computers. BD, who had the least experience with computers of the four student interviewed, finally completed the first task by 'conspiring' with another student to use his work and change the name on the graphs to indicate that it was his own work:

BD is leaning over BB's keyboard.
BB: We'll change the name. You got to go to title.
BD backspaces to remove BB's name and then types in his own.
(BB tries to shield this from the camera.)
BT: Who done it?
BB: He's getting my work.

(video transcript Thursday, p. 6)

Girls also encountered technical problems. In one episode two girls were unable to get a computer working and they resolved the problem by choosing to work together as a team and share one computer. If girls had knowledge of the computer system and hardware it was not evident in the discussion recorded during the lessons.

Behaviour and style of interaction with the computer

The students were task orientated, that is there were many interactions between students or between students and the teacher that were concerned with the organisational details of getting the work done. Furthermore, most students appeared to view the computer as a tool that they were required to use to do the work. The students made comments such as "just make it easier" in much the same way as they might see calculators as making arithmetic easy or word processing as making writing (the physical task) easier. The teacher commented that it is difficult to get the students to use pen and paper, whereas they had been motivated to use the computers to do the work. A view of computers as a tool was probably enhanced by the teacher's view of computers. The first task required the students to use the computer as a tool for graphing rather than as a medium with which to engage and explore mathematical concepts.

There was some evidence to suggest that girls in particular, viewed computers as a tool. Three girls (and one boy) accessed the word processor to document their answers to the assignment questions. One girl (GK) who had a broad experience with software and was above average mathematically, worked independently through the tasks set by the teacher. She did not interact with other students but successfully used Graphmatica to find turning points and intercepts for other questions on the assignment sheet (rather than use symbolic reasoning as intended by the teacher). (One boy (BT) had wanted to do this but had been redirected by the teacher. His response was off task behaviour.) GK also successfully interpreted the screen and used the features of the software to solve the real problem. By contrast another girl (GM) who was very task orientated adopted a methodical approach to completing the tasks, using the software without interpreting the mathematics. She requested information from other students around her and she worked in parallel with the girl beside her. She personalised the computer, talking to it, making emotional respondes (especially when things went wrong) and talking herself through the processes.

GM: Oh shit I didn't label em.
BT: Didn't you label them?
GM: Na.
BT: Have fun.
GM: I'll have to start all over again. Oh you turd.
BT: (inaudible)
GM: It is hard actually. Very.

(video transcript Wed., p.2)

She used the same methodical approach to solving the real problem during the interview. Rather than interpreting relationships between the maximum value of the turning point and the values she was trialing from the screen, she made small adjustments to the value to reach the solution.

The interaction above also supports the notion that girls are more likely to personalise their interactions with the computer. One other girl (GV) used emotive language to describe her successes and difficulties. She made sounds and signs of shock or delight as the computer behaved unexpectedly or as she had hoped. They were some episodes when boys showed emotional responses, these were normally physical (for example, BT hitting himself on the head) and were responses to their own mistakes rather than to the computer. Boys also were public with their announcements of success (BB, BD, BT and BJ) whereas girls did this privately (GV, GF and GM).

The behaviour of two of the boys, BJ and BA, perhaps points to a particular style of interaction with computers. BJ in his attempts to discover the reason why one of the students couldn't log on demonstrated engagement with the computer and its information system in way which may be described as 'hacking' behaviour (Turkle, 1984). BA appeared to engage with the software and system by moving around in it. He used the mouse and the keyboard to demonstrate to others rather than articulate instructions from a knowledge of the features of the software and the design of the interface system, that is the tool bar. This student successfully interpreted the screen to develop an understanding of parabolas and solve the real problem efficiently (video transcript Friday and BA student interview). The following episode depicts him in the role of peer demonstrator.

> GV (to BA): You know how (inaudible) makes the thing bigger or ..
> (BA takes the mouse and starts to change the range.)
> GV: Mate, oh (she holds her hand to her head in surprise, GE arrives to watch what's happening on the screen)
> (BA continues to operate the mouse. Then GV takes over operating the mouse and says something inaudible.)
> GE (BA watches on): OK go to view (she points to the tool bar). No that's (pause she watches as GV operates the mouse) Range! Now you change this one (points to the screen) (inaudible)... five and that (inaudible).
> GV (typing): Negative one.
> GE: Now we change the four to six. (pause and then inaudible, points to the screen and then moves off).
> (video transcript Wed., p. 11)

This episode show that the female student (GV) was more comfortable with the instruction given by the girl (GE) rather than demonstration given by BA. This boy's use of demonstration may reflect his style of interaction with the computer and perhaps be derived from or related to his interest in adventure games and computers themselves. It may also be a display of control or power.

Discussion and conclusion

The students appeared comfortable in the computer surroundings; it was familiar territory for them and they were motivated to complete the tasks. In general a lot of the behaviour that was observed was common to both girls and boys in the class. However there were some gender differences observed in the way the students engaged with the task, interacted with each other or the teacher, interacted or engaged with and used the computer and software and engaged with the mathematics. The boys were dominant in the computer classroom: they were larger, louder, took up more space, more negative, more demonstrative and public, but this may not be any different to normal behaviour in mathematics lessons. The content of boys' interactions in general revealed their interest and pre-occupation with hardware and the networking system and their knowledge, experience and expertise with hardware and software systems. There was some evidence to suggest that girls were more likely to view computers as a 'tool' and more likely to personalise their interactions with the computer (Turkle,1984). Whilst some of the characteristics of computer interaction, knowledge and interest displayed by at least two of the boys in the class might be considered 'nerdish', the behaviour of girls who were competent users of software is probably not 'geekish'. It remains unclear however, how differences in behaviour related to experience and style of interaction with computers relates to a student's interest or performance in mathematics.

The episode where the boys challenged the teacher's knowledge of accessing the school network suggests that some female mathematics teachers will need encouragement and support to 'take on' boys with superior knowledge of computer systems. It also suggests that the shift in power in computer enhanced mathematics classrooms may not only concern democratisation of learning (Rowe, 1993; Thomas et al, 1996) but also concern a realignment of power in terms of gender.

These conclusions are tentative and will need to be tested in a more thorough ethnographic study. Students need to be observed for a longer period of time in order to confirm patterns of gender difference in behaviour. A more thorough study would involve the observation of a class where students used computers for a variety of mathematical tasks and/or used a variety of mathematics software. An appropriate set of codes for analysing styles of interaction with the computer would need to be developed. It will need to be born in mind that the nature of the hardware may be a factor influencing behaviour in the classroom and that the nature of the mathematics tasks will determine the parameters for such a study.

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