WINDOWS ON PRACTICE: INVESTIGATING EQUITY IN TECHNOLOGY BASED MATHEMATICS CLASSROOMS

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The strengths and weaknesses of using ethnographic research to investigate equity in a study of a grade 9 class that used a dynamic geometry program with laptop computers will be presented. It will be argued that research approaches that involve "windows on practice" provide understanding of not only who is advantaged and disadvantaged in technology-mediated classrooms but how this occurs. The way that other paradigms such as reflexive methods may enhance qualitative research will be proposed. Studies that involve "windows on equitable practice" will provide mathematics educators with models for advancing equity in mathematics learning when teaching with technology.

Research findings regarding gender equity in mathematics cannot be generalised and girls and boys cannot be essentialised. Lower achieving girls, girls from working class backgrounds and girls of minority groups have not improved their achievement and participation in mathematics (Fennema, 1995; Teese, 2000; Tate, 1997). It is not clear that findings concerning gender will also apply to classrooms in which advanced information technology is used. Studies of classrooms have shown that gender differences in mathematics vary according to the teacher and how teachers structure their mathematics classrooms to favour boys and their learning (Fennema, 1995).

Feminists who argue that gender is socially constructed use ethnographic or phenomenological research approaches to interpret social processes. The study of discourses that make up social institutions and cultural products is central to a post-structuralist approach where theoretically power exists in all relationships and gender identity is complex and changes according to particular contexts. Ethnographic research is concerned with meaning, that is, how people through their social interactions make sense out of their lives and fit in with the culture. Ethnographers describe the beliefs and behaviours of the group and how the various parts constitute "shared meaning" within the group. Observation of a natural setting is the primary research method used by ethnographers. In education studies this concerns observations of selected groups of students in typical school or classroom settings. Metaphorically such research can be described as a "window on practice". The findings may be limited to what is observed within the window frame. Just as mathematics students 'zoom in' or 'out' on graphic calculator screens to gain a better understanding of a graph, ethnographic researchers are able to 'zoom in' and 'out,' to focus on individuals or sub-groups and the setting, to gain a better understanding of the social processes and discourse. This may be achieved by gathering data directly from participants, for example, through interviews and by drawing on findings from previous studies.

The study presented briefly below, used ethnography to investigate gender in a mathematics class that used technology. It was part of a larger study (Vale, 2001).

WINDOW ON A GRADE 9 LAPTOP CLASS

A grade 9 mathematics class, in which students owned or leased a laptop computer for their learning in all subjects, was observed. The students chose to join the laptop program in the year prior to the study. There were 18 boys and 7 girls in this class. The data were collected with as little interference to the mathematics program as possible. The class was observed and video-taped over a period of four weeks. During each lesson the camera 'zoomed in' on different groups of girls and boys.

The students used dynamic geometry software on their laptop computers for five of the lessons on the topic of geometry. For these lessons the teacher used exposition and teacher directed tasks to familiarize students with the software, set a guided investigation on exterior angles of a polygon and a project to draw shapes that were geometrically accurate. Two examples of field notes that described the classroom and student engagement and four examples of transcribed interactions between students are presented in Table 1. The codes used during analysis are also shown. Data collected by interview and questionnaire are presented elsewhere (Vale, 2001).

Table 1: Examples of data collected.

Examples of field notes	**Codes**
What was noticeable as students started to use the software following [the teachers'] instructions was the variety of activities that the students engaged in... Some made random drawings (boys and one girl). One girl started to draw a triangle using the line segments. Some drew abstract designs (one boy drew a "tunnel" of circles). Some of them drew pictures - 2 boys working on one laptop drew a house and another boy drew a robot bird/man character... The class was dominated by the boys. There were more of them: 18 boys & 6 girls. They were louder... The girls seemed peripheral to the lesson. They sat at the back and at the edges. Two spent part of the lesson doing a test...	*Off task -exploring software* *Situation- dominance (boys)*
Once again I was struck by the large number of students who did not do any work on this task.... Two boys and one girl have broken computers. One girl left hers at home. Another girl, who was attending for the first time in days, did not have a laptop and quite a few students did not have the program installed or claimed that they had some problem with the program. Only in one case (girl) did a student without the computer attempt to do the work with another.	*Engagement - no computer/ software.* *Collaboration - teaming (girls).* *Teacher –no strategies for collaboration.*
Examples of transcribed student interactions	**Codes**
Che: Yeah, um, go to construct, construct (*pause*) …[inaudible] (*points at his screen)* Lawrie: Aaargh. Che: Um, (*waits*) No. No. Lawrie] Che:] (*Together.*) Animate. (*They both smile at the effect of selecting animate on the screen and Darren looks on.*) Che: Animate makes it go. It's good.	*Off task - exploring software.* *Attitude software – aesthetic (animation)* *Collaboration - tutoring.* *Attitude software – pleasure.*
Ellen: Are you enjoying this maths thing? (*Reads from the sheet*) 'Move parts of the pentagon to see if the sum changes. See if the sum changes. Make sure the pentagon remains convex.' How are we meant to know what to do when we don't even know what the words mean? Convex? Conjecture?	*Collaboration –parallel activity* *Attitude task – negative* *Teacher - no scaffolding.*
Ian: Ya think ya good Ellen but ya not. Ellen: I know I'm not good.	*Collaboration - competitive*

	Attitude peers - negative
Cherie: I don't know, you do it. Brenda: Just do that. (*She takes over the mouse.*) Cherie: Ohhh. (*Cherie now tries to draw another ray and continues on her own. Brenda looks over to check.*) Brenda: I told ya. You say I can do it all. Cherie: [inaudible] (*She pushes the laptop toward Brenda.*) Brenda: No I can't do it that's why he [the teacher] wants you to do it.	*Collaboration - teaming Collaboration –tutoring* *Attitude self - negative*

These few examples of data illustrate the gendered patterns in off task behaviours, level of collaboration, attitudes to the software, mathematical tasks and peers, and self-perceptions that were inferred in this study. For the boys the laptop computers were a source of pleasure and relevance in the mathematics classroom. The use of computers brought opportunities for them to be creative and to learn more about the software. The boys (for example, Che and Lawrie) cooperated and collaborated more often than the girls (for example Ellen, Brenda and Cherie). They shared their knowledge of the software, computers or the mathematics imbedded in the tasks. The girls wanted the computer to assist their learning and success in mathematics but the interactions involving Ellen, Brenda and Cherie illustrate that this did not happen for them and other girls in the class.

The boys, such as Ian, competed over achievement in tests, completion of tasks and possession of software products. The boys also dominated the class. There were more of them. Girls were often not visible in the class. They were normally quiet and private in their interactions. The girls described the boys as "rowdy" they felt "over-powered" by them. Individual interactions between boys and between boys and girls (such as between Ian and Ellen) illustrated hegemonic masculinity.

The computers as much as the mathematics, appeared to shape the patterns of interactions within the classroom. Data concerning teachers' behaviours and attitudes have been presented elsewhere (Vale, 2001). Analysis revealed that the teachers' strategies and interactive behaviours and attitudes accorded advantage to the high achieving students, especially boys in this classroom. The learning environment in this class was a culture where boys interacted with each other and with computers for their own enjoyment, and where the girls felt dominated by hegemonic masculine behaviour (Vale, 2001).

REFLEXIVITY

The limited amount of data presented here shows what it is possible to view through a window on practice and how it may be used to describe the culture of the classroom and so reveal issues about gender equity in mathematics when using computers. Others have argued that qualitative research ought to be carried out in tandem with positivist approaches. There are also criticisms of ethnography within the interpretative research literature. Alvesson and Skoldberg (2000) argued that the findings of ethnographic research are hardly surprising and they criticise post-structuralist research as narcissistic. They present an argument for reflexivity in qualitative research. This involves also interpreting the data using critical theory and reflecting on text production and language use: “The whole idea of reflexivity … is the very ability to break away from a frame of reference and to look at what it is *not* capable of saying” (p. 246).

In the current study some aspects of the social context were investigated but the feminist frame of reference used did not allow for a thorough investigation of social capital and race-ethnicity. Data were collected to show that students came from both technologically rich and technologically poor homes and these differences were evident in students' behaviours (Vale, 2001). Analysis of interactions between the teacher and the only indigenous student in the class (Che) showed that the teacher did not praise or recognise his knowledge or collaborative learning behaviour. The only recorded interactions were disciplinary. Also outside the window frame in this study was the political context of the classroom within the school. How did it happen that a grade 9 class in a coeducational school located in a relatively low socio-economic area could have such an imbalance of girls and boys? I could also have included an emphasis on the political context of the teacher and the discourse of ‘new’ mathematics curriculum. Others have argued that a cultural and political focus is necessary for the advancement of equity (Tate, 1997; Teese, 2000).

The feminist framework that was used for the study did straddle both social constructivist notions of the learning of gender and the notion of complex, shifting and situated femininity and masculinity argued by post-structuralist researchers. Such a theoretical perspective may have obscured a finding that the poorest students in the class or the students from indigenous or minority ethnic groups were marginalised and disadvantaged in this classroom.

In this paper I have presented, very briefly, a window on mathematical teaching and learning practice that involved the use of advanced information technologies. I have illustrated some concerns regarding gender equity and indicated that other dimensions of social disadvantage complicate these concerns. These findings ought to be of concern to those who imagine mathematics changing through the use of advanced technology. The intent of this paper though, was to focus on the strengths and weaknesses of ethnography. Ethnographies that provide a window on equitable practice when using technology for the teaching and learning of mathematics are needed. However the limitations of ethnographic research design mean it will be necessary to more thoroughly account for class and race-ethnicity, that is the socio-political context, to create a tapestry of equitable practice that may guide teachers in diverse settings.

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