Genderflexing:
A Theory of Gender and Socio-Scientific Learning

Ricki Goldman-Segall
MERLin, Department of Curriculum Studies
Faculty of Education, University of British Columbia, Canada
ricki@unixg.ubc.ca <<http://www.merlin.ubc.ca>>

Abstract: To better understand the problems preventing non-traditional science students, girls and some boys, from engaging in the study of the natural world, I examine how learners become active in studying scientific issues when the issues are relevant to their lives. To invite learners into thinking about science issues, we introduced the topic of a local endangered rain forest called Clayoquot Sound. For two years, students built a range of paper and multimedia artifacts. This community of investigators made extensive use of analog and digital video, multimedia analysis tools, and the Internet. The results of this ethnography indicate that digital media can become learning environments that support personal, narrative, and relational ways of knowing the world, especially when the content addresses real-world issues. One conclusion I have made is that gender identity is a more flexible construct than has been suggested in previous empirical studies. Both girls and boys need opportunities for "genderflexing" — for extending beyond traditional epistemological boundaries. While genderflexing, young people learn to cross over boundaries that have previously both defined and confined science education.

Young People's Investigations of a Socio-Scientific Topic

This two year ethnography focuses on issues of gender, science education, video ethnography, and networked digital tools for learning and thinking. My purpose is to shed light on various paths that may guide and excite educators and researchers with alternative approaches to the possibilities that lie within, around and outside the current boundaries of the current middle school science curriculum. I would like to challenge educators by presenting them with a pedagogical change that entails using emerging technologies as tools to extend traditional epistemological boundaries. I would like to challenge researchers to think about alternative methodological approaches by using video and multimedia when reporting about projects in schools. I would like to challenge us all to think about partnerships among young people, teachers, and researchers that would enable us to become a culture, a community of inquiry.

How do young people conduct socio-scientific inquiry in the light of emerging communications technologies? Many current educators recommend an approach that addresses the use of constructionist or advanced cognitive technologies. However, there is still little research in the computer constructionist community that addresses why young women stop studying science before they have a chance to see the deeper connections that science has to their lives (Fox Keller, 1985). Extensive gender studies describe the exclusion of female modes of thinking in the sciences (Manthorpe, 1982; Gaskell, et. al., 1992; Fox Keller, 1985 & 1992; Sampson, 1986; Shepherd, 1993); girls are indeed "counted out" in mathematics and science, as Walkerdine (1989) says, by traditional schooling methods that do not acknowledge the way they think about things. Should we revisit the question of how we can include all young people into a science curriculum? In this study, at the Bayside Middle School on Vancouver Island, young people investigated a socio-scientific issue that was relevant to their lives, encouraging them to relate to scientific inquiry in a highly personal and social manner.

This broad-based study has extensively used emerging video technologies. My particular involvement has focused on the methodological implications of using multimedia tools for building qualitative video-based descriptions of children's thinking. Thus, while I conducted a gender and science study, I also reflected upon the tools, techniques, and artifacts of my own methodology. At the Bayside Middle School, I videotaped the growth of the computer culture; in MERLin, the Multimedia Ethnographic Research Lab at the University of British Columbia, my team of researchers and programmers (Lawrence Halff, Will Pritchard, Akio Tanaka, Elizabeth Crittendon) and I designed two multimedia tools. One tool, called *Constellations* (Goldman-Segall, 1990, 1993), is used to analyze raw digitized video and text data. (This software can be downloaded from the MERLin site at http://www.merlin.ubc.ca). The other artifact is a CD-ROM computer program called "The Global Forest" designed for students in distributed locations to learn from our young people about the conflict at Clayoquot (Klak-wit) Sound, one of North America's largest temperate rain forests with intact watersheds.

Why Study an Endangered Rain Forest?

The issue we chose to investigate is the conflict surrounding Clayoquot Sound situated on the wild west coast of Vancouver Island. Clayoquot Sound has been the scene of extreme political dissent over clear-cut logging practices. During summer of 1993, the crisis had reached a head. BC newspapers featured the issues surrounding forest practices at Clayoquot Sound daily. Events escalated dramatically with protesters setting up blockades on the logging routes. Police jailed protesters; loggers continued to clear-cut; local townspeople in Tofino and Ucluelet worried about their livelihood; environmentalists focused on scientific claims that bio-diversity could be at risk; government leaders considered their coffers and constituents while trying to establish a framework for forest practices; and the rest of us, we wondered about how this issue could ever be resolved.

The story I am about to tell you is not about a group of young people saving the rain forest. Nor, it is a story about forging ahead to make recommendations to solve the crisis. It is a research story about gender and science education in the context of multimedia technologies. Young people investigated the controversies reaching their own conclusions about what should happen and what they should do about it. This study is also not about the "effectiveness" of young people's science learning with emerging technologies or about how to use technologies to teach science "better." It is an attempt to find alternative methods of teaching science so that the future of scientific inquiry is not an exclusive endeavor informed by a homogeneous group of people. My approach echoes Seymour Papert's belief that technologies enable different ways of thinking about things (Papert, 1980). Computers are not better pens. If we structure technology-rich learning environments as spaces of inquiry and diverse points of viewing, they are tools for a deeper engagement with the living world around us. They have the potential to open the discourse to a wider "audience."

Theoretical Premises: Interesting Content and Diverse Learners

Project-based investigations conducted in young people's locale have become one of the driving forces of change in teaching science in the schools. The *CoVis Project* focuses on science learning through projects using a telecommunications infrastructure, scientific visualization tools, and software to support collaboration between diverse schools in distributed locations (Pea, 1993; Pea and Gomez, 1992). In essence, the young people in the *CoVis Project* study topics in much the same way as professional scientists do. Project-based science learning has also been the core of the research and development of technology-rich learning environments at the TERC, (Tinker, 1992). However, there has been little research on using advanced cognitive technologies as a context to study gender and science.

This study is based on two premises. The first is that learning is enhanced when people study a subject that interests them (Tobias, 1994), in a challenging manner. (This statement does not imply that learning does not occur when the subject matter is not relevant.) Gabriel Salomon recommends that learning environments be relevant and authentic (Salomon, 1994). My approach builds on the premise that emerging electronic media can change the nature of inquiry by providing layers of interest by evoking and provoking the learning process, similar to the process ethnographers experience when studying "other." Multimedia learning, in this kind of learning environment, becomes a post-modern ethnographic encounter wherein researcher/s, the researched (the content), and readers negotiate multi-layered meanings. As Tyler points out:

> A post-modern ethnography is a cooperatively evolved text consisting of fragments of discourse intended to evoke in the minds of both reader and writer an emergent fantasy of a possible world of commonsense reality, and thus to provoke an aesthetic integration that will have a therapeutic effect (Tyler, 1986, p. 125).

The word "ethnography" could be substituted for the words "electronic learning environment" in Steven Tyler's comment and the meaning would not change. Most users of networked electronic media would call the "fragments of discourse" part of the spaces that engage readers/users and writers to communicate in virtual worlds, what Tyler calls the "fantasy of a possible world of commonsense reality." Learning in a constructionist multimedia environment is an aesthetic integration that blends the learner, the various media (including the teacher), and the message (or content) into one contiguous overlapping web. Therapeutic effects emerge with integration, Tyler says. Educators are also committed to positive outcomes for learners. They structure learning events to enable students to bring together the bits and pieces of their experiences into meaningful wholes that are unique to them; layering these events using diverse media forms deepens interest and engagement by providing a range of lenses.

The second premise is that learning is enhanced when young people are able to construct ideas in ways that are akin to their own approaches to learning. The existence of "thinking styles" (Goldman-Segall, 1990, 1991) or preferred approaches to how individuals and groups learn has not been a subject of much interest over the last ten years. Unfashionable as looking for broad patterns or "learning styles" may be, educators know from working with young people that strong marked differences lie in how people learn. My theoretical positioning lies in the negotiated structures that emerge through conversations with young people in longitudinal research studies. My epistemological focus starts with the things young people say about themselves as they move within learning spaces. It pans the connections they make through their individual and social constructions as they delve into a range of media forms and embedded knowledge structures. In this process, I build patterns about differences and similarities about how young people think about the things they are doing. As classroom teacher or researcher, the search for patterns that describe experiences of the diverse population of young people in classrooms is ever-present. Educators walk into classrooms composed of students with marked individual differences in how they learn; educators try to ensure that how they set up the learning environment will promote equal access for knowledge construction.

The question is: How do we incorporate these two premises about diverse learners and interesting content into a workable pedagogy? To answer this, I reflect upon the notion of thinking styles from the feminist perspective: learners becoming engaged in studying a subject that is relevant, concrete, and provocative. In the Clayoquot Sound Project, this approach to doing science is empirically studied as a way to open a window into the theory of gender differences (and similarities?). Studying Clayoquot Sound as a community of inquiry provided an opportunity for students to use their preferred styles of thinking to build artifacts and theories about a complex socio-scientific study subject. It also, to my surprise, enabled young people to think *beyond* their gendered identities and try on new approaches. Both boys and girls were able to more fully utilize a relational, tangential, and storytelling style of thinking and making things. Learning was neither "in" nor "out," but a situated, context-based interaction between the learner, her tools, and the environment as a whole (as first suggested by Brown, Collins, & Duguid, 1989; and, Lave, 1991 & 1993).

Research Site

The study emerges from a partnership that exists among the classes of two teachers, Jordan Tinney and Joe Grewal and the vice-principal, Keven Elder at the Bayside Middle School on Vancouver Island, Barry Carbol and Peter Donkers of the Distance Education Learning and Training Branch of the BC Ministry of Education, and MERLin, our lab at UBC in Vancouver. We have also begun to establish ties with the various communities living in Clayoquot Sound, including the Nuu-Chah-Nulth First Nations' band and First Nation's artists. Our research "sites" are both the actual school where the study is being conducted and future virtual sites with young people from other schools in distributed locations.

Ethnographic Method of Inquiry

Multimedia ethnography is the method of research used. In essence, I became part of the culture of the school and used a variety of conceptual and technical tools to support my inquiry. I conducted and videotaped regular one-on-one interviews at different phases of the study with a set of questions that were designed to elicit and provoke ideas about their own thinking. I also videotaped a wide range of their activities while they were conducting their video-based investigations at Clayoquot Sound and around the school. Moreover, young people were given cameras so they could videotape their investigations while I followed the progress of their building multimedia and text-based documents. In the first year of the videography (1993-1994), a grade eight class studied Clayoquot Sound outside the bounds of the formal science curriculum; from 1994-1995, with a grade seven class, we included the study of the Sound within the regular lesson plans.

I visited the school site approximately twice a month for two or three days a visit using video and textual notations written on my Powerbook; I kept these reflections available with my computer on and files open for teachers, young people, and parents to read. When the data were gathered (and while the data were being gathered), chunks of data were selected that best exemplified the approach used by the young people in designing their projects. These data were digitized and accessible to collaborative data analysis by myself and colleagues. At this stage, I looked for themes to gain a picture of the broader issues. Once these themes had been formed, I re-edited the video and build digital "vignettes" portraying the young people's thinking. The research tool, *Constellations* enabled me to access text, video, graphs, etc., and to browse through databases, collect and combine chunks into clusters, or "constellations," and annotate.

The project emerged as a community of inquiry with researchers from the University of Victoria, headed by Ted Reicken, and the University of British Columbia and school staff interested in the use of technologies in the classroom. Planning meetings with teachers and the vice principal took place in 1992 and 1993; implementation meetings were less formal and occurred throughout the project mainly over email and in and around the regular class schedule. My visits were usually made with a host of other researchers. Some of these visitors were visiting scholars, such as Lynne Scheverin and Gilda Segal from the University of Technology in Sydney and Tara Goldstein from the University of Toronto. Others were graduate students from universities who had come to study multimedia ethnography. Lawrence Halff, my research assistant throughout the study, spent most of his time working with the young people to solve technical problems. However, he also conducted interviews, hung out with kids on the field trips, and suggested many theories about how to think about young people's construction of their sexual identity. Although Halff's words are not included directly in this text, the spirit of those conversations permeate this study.

Both girls and boys built portfolios about the issues using both primary and secondary sources. Text-based information came from: the Ministry of Forestry; logging companies; environmental groups; WWW servers; and the usual resources in encyclopedias and school textbooks in the library. However, these young people had first-hand experiences from which to draw their understandings. We went on field trips, talking to people in the towns of Tofino and Ucluelet (situated in the heart of Clayoquot Sound). We slept in the only school in Tofino in sleeping bags on the school gym floor and got to meet the local kids — playing a basketball game with them. We videotaped interviews with locals and attended special lectures from experts in related fields, scientists working in Clayoquot Sound. Visitors to the school back in Brentwood Bay provided a range of up to date information. The Dean of Law at the University of Victoria, David Cohen, spoke to them about First Nations' rights as the founding nation. (First Nations were not recognized by the British Crown as being legitimate peoples. He also told us about the meaning of Crown Lands and Tree Farm Licenses. He encouraged them to think about themselves as being members of the "commons" and to understand that "we" lease these lands to the logging companies in contracts for the benefit of the people of British Columbia.) Leading environmentalists such as Vicky Husband from the Sierra Club and Valerie Langer form the Friends of Clayoquot Sound also spoke to the young people, explaining the potential dangers facing the planet from clear-cut logging methods. Logging companies took us on trips local sites showing us their attempts to reforest the land. We learned about tree farming and harvesting. In the meantime, the young people built multimedia representations as they delved deeper into the web of discourse surrounding the dispute at Clayoquot Sound.

In short, the young people:

- investigated issues from as many perspectives as possible and through as many recorded media as available.
- discussed these issues in class on a semi-regular basis as part of their science classes.
- visited the site conducting interviews using video, tape, pen and paper, and portable computers.
- assembled the text, sound and video data.
- conducted school surveys about attitudes and ideas for change.
- used human expert resources at various locations in British Columbia and elsewhere.
- became resource persons for others interested in the rain forest issue in BC.

Research activities that took place included:

- co-ordinating the methodological approach for analyzing the data about the process.
- conducting in-depth studies of the young persons involved in the project.
- conducting interviews and observations of events.
- developing a more relational approach to reporting our findings.
- becoming part of the student research team.

Young people analyzed video data we all collected from our videotaped interviews and field trips. They were given copies of the videotapes to take home and watch on their VCR's. We asked them to select a few minutes that best conveyed the topic they were focusing on. For example, if they were concerned with animal life in the forest, they were asked to find data on that subject. However, that is <u>not</u> what they did. The young people chose video that best reflected the highlights of the field trip for them! The scenes of them wading into the low rolling waves at Cox Bay were more interesting to them. Although it was a typical cold autumn day, at least twenty young people were frolicking in the waves, fully dressed. Another favorite event was the scene they called the "Bear Scare." Jordan, their teacher, told them how bears like to live in the empty spaces that are caused by trees growing on nurse logs. As the nurse log disintegrates from its use as the source of sustenance for the growing cedar, a huge hole is left at the base of the tree.) Then he encouraged a few of the girls to go explore the mossy hole. As they entered and were having their picture taken, he ran around the tree and came into it from behind, growling like a bear. We all screamed in shock. An odd story to be the pinnacle of the year. But, there it is. Young people constructing their icons for describing events.

Young people were shown how to digitize movies using *Adobe Premiere* on a Power Mac. Four girls seemed to take this task most seriously. They logged all the data onto logging sheets they designed and named specific chunks. Newspaper clipping, photographs from the field trip, and maps were scanned into the computer. Electronic journals were also entered as part of the database.

My analysis of the video and text data occurred throughout the investigation. Categories were constantly being developed and shifted as opportunities became available. Videotaped interviews were less formal in the first year while the project was developing its structure. These interviews took place with individuals or groups in the classroom or out on the school playground when the moment was right for videotaping. In that first year, I "hung around" more, shmoozed more, got to know the school and the children through a range of activities including baseball games and other school events. In that first year, Kelli got hit in the nose with a ball playing baseball and we rushed her to the hospital in my car. Her nose was broken. It was painful to see her in pain. As she once said to Jan who was videotaping us, "Ricki and I are going to sole-to-sole," after she and I had discovered we wore the same size Birkenstock sandals by trying each other's style of sandal. It was also in the first year, that Amber asked me how much money I made! And I told her. That was the year of establishing bonds within the culture of young people. Of letting them know that I was interested not just in my research project, but in their lives as young women and men in their school culture.

Thus, this study was conducted as a community of inquiry. We didn't try to find solutions the Clayoquot Sound dispute. Rather, we examined it and kept it as "a tool to think with," as Papert would say. We turned it around in our hands and on our computer screens, looking for ways to make sense of our experiences with this "object." What we found was that it was our relationship with it, how we turned an object into a subject of interest for us all, that kept our interest levels high. At no point did the study become "boring," for them or for me.

Discussion

Becoming Fluent Users of Mediated Socio-Scientific Investigations

The girls from the first year of the project (1993-1994) did not seem to identify with the notion that what they were doing was a scientific endeavor even after they completed quite successful projects on Clayoquot Sound. Those young people did not work with multimedia and did not use video cameras as their main tools of investigation. In the second year of the project (1994-1995), the young people used more video, digitized data, and used the WWW. They also visited Clayoquot Sound on an intensive four day field trip. Activities were diverse. Although this study does not "prove" that the non-traditional science students are becoming more competent in their perceptions of themselves as young "scientists," I am able to show young people, especially girls and some boys, speaking about themselves and about their activities in ways which show that they are becoming more fluent about complex socio-scientific issues. One young person in the beginning of the project when asked "Where is Clayoquot Sound?" answered that Clayoquot Sound was a clacking sound that was "in the air"!

By concretizing their experiences around an intellectual theme connected to their lives, young people began to add levels of understanding about fundamental social and scientific principles (Perkins, 1993). Their comments reflected a moving from pre-judgment to informed opinion that grew (1) with experience of primary and secondary sources, (2) with an opportunity to balance differing points of view, and (3) with the use of diverse expressive modes of representing what is learned.

Genderflexing

Both girls' and boys' attitudes toward science changed as their engagement with a subject that captivated their imagination grew, keeping their interest levels high. One thirteen young old boy, Matt, told me that "science became his friend." This interview surprised me. I didn't expect to find that a number of boys who were never highly engaged with studying science would began to get interested by telling me how "you have to see it, smell it, feel it" and make it a friend! Terri-Lynne, another young person, told me she enjoyed every aspect of the project, interviewing people, going to Clayoquot Sound, digitizing the video, and doing her reports. As Tobias (1994) points out, "working on interesting, compared to neutral, materials may engage deeper cognitive processing, around a wider, more emotional, and more personal associative network, and employ more imagery" (p. 37). These girls and boys spoke differently about their thinking after our collaborative investigation took place; they spoke with authority, sincerity, depth, and maturity. Being partners with teachers and university faculty in a project where they had opportunities to study science as ethnographers might study a culture — by becoming participant observers of a socio-scientific issue — heightened their level of connection.

Role of Technology in the Studying Socio-Scientific Issues

The use of advanced technologies enables us in the research community to look at how studying the world as a member of that world builds an alternative paradigm for doing science—one that is personal, multidisciplinary, and respectful of diverse ways of making meaning from what is observed and understood. This shift provides girls and young women with opportunities not only to adapt to changes in science and technology but to be the inventors of that cultural change in the making of science. By sharing perspectives, a new ways of looking at what we thought we knew emerges. As Hammersley and Atkinson so aptly put it, they become "part of the world [they] study" (1983). When a topic is relevant to the lives of girls, then it stands to reason that they will be more willing to engage in the investigation. What emerges is a conceptual framework that strongly suggests that what makes the study of science meaningful and interesting for girls is when scientific problems are embedded in a relevant topic that they can examine as a web of complex ideas. In short, they see the topic as being integrally tied in with their own understanding of the world and its complexity.

The Curriculum

Should the curriculum change? How can making connections and seeing relationships among seemingly diverse points of view be appreciated as a valid form of scientific inquiry in schools that is distinct from measurement and breaking things apart to understand causal links? How can young people study topics that deeply and personally relate to them so that they can put together themes from emergent groupings of data? Should we stop emphasizing repeatability and generalizability, and devise theories that are grounded in the manner a large number of living things on this planet carry out their activities instead? Obviously, I would say yes. The barrier is not just the will to address these concerns but it is the ability to understand what prevents us from doing this. As we know from those young people who are active in home schooling, a critical aspect of following through on a large project is being able to have the time to work for long periods on one topic. Until we address this "scheduling" problem we be caught in the circle of small tasks that cannot produce in-depth studies.

Science education needs to include a network of human relationships focusing around topics that involves young girls and boys, topics that are broad enough to contain many points of viewing issues so that individual and group concerns can overlap and interrelate. It seems reasonable to pose as Rosser has suggested (1990) that as more young people become engaged in studying science, the way science is currently studied in schools and in our research centers will also change. Moreover, as Susan Harding (1991) suggests, the nature of doing and defining science will change only when we address the questions "whose science?" and "whose knowledge?" Once we have addressed this feminist question about the nature of knowledge, then perhaps we can move to what Donna Harraway calls "an earth-wide network of connections, "including the ability partially to translate knowledges among very different – and power-differentiated – communities... in order to live in meanings and bodies that have a chance for the future" (Haraway, 1991, p. 187).

References

Brown, J.S., Collins, A. and Duguid p. (1989). Situated cognition and the culture of learning. Educational Researcher 18 (1), 32-42.

Fox Keller, E. (1992). *Secrets of Life, Secrets of Death.* New York: Routledge.

Fox Keller, E. (1985). *Reflections on Gender and Science.* New Haven and London: Yale U. Press.

Gaskell, P. J., McLaren, A., Oberg, A. & Eyre, L. (1992). *The 1990 British Columbia Mathematics Assessment: Gender Issues in Student Choices in Mathematics and Science.* Report Submitted to the Minister Of Education. Victoria, B.C.: Ministry of Education.

Goldman-Segall, R., (1993) Interpreting video data: introducing a significance measure to layer descriptions. *Journal for Educational Multimedia and Hypermedia,* 2 (3), 261-282.

Goldman-Segall, R. (1993). The growth of a multimedia school culture: a multivoiced narrative. *The Electronic Journal on Virtual Culture,* 1 (7).

Goldman-Segall, R. (1991). Three children, three styles: A call for opening the curriculum. In I. Harel & S. Papert (Eds.) *Constructionism,* Norwood, New Jersey: Ablex Publishers.

Hammersley, M. & Atkinson, P. (1983). *Ethnography: Principles in Practice.* London and New York: Routledge Publishers.

Harding, S. (1991). *Whose Science? Whose Knowledge: Thinking for Women's Lives.* Ithica, NY: Cornell University Press.

Haraway, D. J. (1991). *Simians, Cyborgs, and Women: The Reinvention of Nature.* New York: Routledge.

Keller, E. (1989). The gender/science system: or, is sex to gender as nature is to science? In Tuana, N. (Ed.) *Feminism and Science*. Bloomington: Indiana University Press, 33-44.
Lave, J. and Wenger, E. (1991). *Situated learning: legitimate peripheral participation.* Cambridge University Press.
Lave, Jean (1993). The culture of acquisition and the practice of understanding. In J.W.Stegler, R.A. Sweder and J.H. Herdt (eds.), *Cultural psychology: Essays on comparative human development.* Cambridge University Press.
Manthorpe, C. (1982). Men's science, women's science or science: Some issues related to the study of girls' science education. *Studies in Science Education*, 9, 65-80.
Papert, S. (1980). *Mindstorms: Children, Computers and Powerful Ideas.* New York: Basic Books.
Pea, R. (1993). The Collaborative Visualization Project. *Communications of the ACM*, 36 (5), 60-63.
Pea, R., & Gomez, L. (1992). Distributed multimedia learning environments: Why and how? *Interactive Learning Environments*, 2 (2), 73-109.
Pea, R. (1985). Beyond amplification: using the computer to reorganize mental functioning. Educational Psychologist, 20, 167-182.
Perkins, D. (1986). Knowledge as Design. Hillsdale, NJ: Erlbaum.
Rosser, S. V. (1990). *Female Friendly Science: Applying Women's Studies Methods and Theories to Attract Students.* New York: Pergamon.
Salomon, G. (1994). American Education Research Association (AERA) address to AI in Education Sig.
Sampson, E. E. (1986). The inversion of mastery. In R. Knisely, B. McIntosh, P. Pangaro, and P. Trachtman (Eds.) *Cybernetics* 2(1), The American Society for Cybernetics, Virginia: Joe Mason University.
Shepherd, L. J. (1993). *Lifting the Veil: The Feminine Face of Science*. Boston, MA: Shambala.
Tinker, R. (1992).*Thinking about science*. CEEB, 57.
Walkerdine, V. (1989). *Counting Girls Out.* London: Virgo Press.

Acknowledgments

The paper was written while the author was on academic study funded by the *National Academy of Education's Spencer Postdoctoral Fellowship, 1995-1996*. The multimedia research software development was conducted in MERLin, the Multimedia Ethnographic Research Lab at the University of British Columbia, supported by grants from Oracle Corporation, the *Natural Science and Engineering Research Council* and the *Social Sciences and Humanities Research Council of Canada*. The author also wishes to thank the Bayside Middle School, the Distance Learning and Training Branch of the BC Ministry of Education, and the UBC Teaching and Learning Fund for their support.