STUDENTS' PERCEPTIONS OF LEARNING EXPERIENCE AND LEARNING ENVIRONMENT IN A COMPUTER-MANAGED SELF-PACED MATHEMATICS CURRICULUM

by

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ABSTRACT

In this study, the perspectives of adolescent students who learned mathematics in a self-paced computer-managed learning environment in its inaugural year are examined. It was hoped that the self-pacing and individualized instruction inherent in a computer-managed learning environment might address the relatively poor mathematics achievement and consequent low graduation rates at Mountview Secondary. The school's multicultural student population presented a large number of "at-risk", poor, ethnic minority and newly immigrated English as a Second Language students. Because affective as well as cognitive issues play a role in students' mathematics achievement, this study reports how students perceived their mathematics learning in both traditional classroom environments and the computer-managed learning environment.

Students' perceptions were documented through recurrent student interviews, my journal reflections on observations and experiences, and students' term self-evaluations in which they elaborated on what was positive, interesting and negative in their learning environment. Adhering to the framework for naturalistic, qualitative research, my reflections, student self-evaluations and transcriptions of the student interviews were reviewed and analyzed with fellow researchers. In the final term of the year students completed a self-evaluation in which they agreed or disagreed with 43 statements synthesized from analysis of the year's data.

The computer-managed learning environment provided a mathematics learning environment in which students benefited from cooperative interactions with one another and teachers modeled a less authoritarian, more learning facilitating role. Students perceived and generally appreciated greater learning autonomy and more opportunities for mathematical meaning-constructing with their peers than they had in their previous mathematics learning. Most students enjoyed using the computers. Students evidenced improved mathematics attitudes and increased awareness of

effective attributes of self-regulated learning behaviors. Overall instructional quality may be improved through coursepath revisions, increased diversity in learning resources, lower pupil-teacher ratio, and more technical support. Computer-managed learning systems must continue to be sufficiently flexible to add, delete and modify learning resource elements to address individual student's learning needs. A computer-managed learning environment can provide an effective *alternative* learning environment within a secondary school setting.

DEDICATION

This thesis is dedicated to my family, students, professors, and colleagues, all of whom have encouraged me to pursue the challenge of mathematics for all.

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CHAPTER ONE

Introduction

The educational research community has generated a vast quantity of research on learning styles, learning disabilities, methods for teaching and the cognitive and affective elements of learning. The intent is clear: educators want students to experience success in learning in order to acquire the knowledge, skills and attitudes to lead productive, satisfying lives in tomorrow's world. The significant role mathematics achievement plays in enabling students to access the careers of tomorrow gives impetus to the *mathematics for all* movement (Damerow & Westbury, 1984). Educators can now test, analyze, label, prescribe and coordinate resources, learning styles and methodologies. Nevertheless, we address the ever evolving multiplicity of cultural, genetic, cognitive, affective and environmental variables that individual students bring to the school learning environment in the classroom. When students enter secondary schools, they enter classroom learning environments that decrease opportunities for student self-management and choice, promote ability evaluation and social comparison, are more formal and impersonal, and are less demanding cognitively. The typical secondary school learning environment is developmentally inappropriate because it is at odds with the physiological, psychological and cognitive changes of an adolescent (Eccles & Midgley, 1989). Indeed, it is the typical secondary school classroom paradigm that is a most significant factor in addressing the complexities of the affective and cognitive interactions that have kept "the patterns which were created in the 19th century still holding; advanced mathematics is a study for a few" (Damerow & Westbury, 1984, p.23). Damerow and Westbury (1984) indicate that it is the inherent curricular pacing and the structure of classroom interaction itself that create the achievement and ability differences that develop over students' years of schooling. Interaction quality impacts motivation, achievement, and future achievement (Johnson &

Johnson, 1985). Ames (1978, 1981), Covington (1984), and Weinstein (1989) also attribute learning achievement differences to the complexities of classroom dynamics. Both task-oriented and non-task-oriented coping strategies (i.e. ego defense coping and social dependence coping) are systematically strengthened in typical school-related interaction situations over several years. Research also indicates that teachers tend to interact with individual students in ways that increase students' initial maladaptive coping strategies (Lehtinen, Vauras, Salonen, Olkinuora, & Kinnunen, 1995).

Students' perceptions within classroom learning environments influence their motivation, attitudes and beliefs about themselves as mathematics learners.

> A simple but profound truth that emerges is that environments do not influence motivation in any direct fashion, rather, it is the perception of those environments that influences motivation. (Berliner, 1989, p. 317)

Berliner (1989) hypothesizes that students' perceptions will differ as a function of their cultural, ethnic, and social-class backgrounds. Reynolds and Walberg (1992) similarly attest to the impact of these perceptions in their conclusions that attitude persistence, prior achievement and home environment strongly influence subsequent achievement. Berliner (1989) laments the fact that there is a scarcity of genuine differences in learning environments available to address the diversity of student attributes.

For many students in our schools, failure and dysfunction characterize their daily school experience. My teaching and parenting experiences have led me to believe that students' negative perceptions of learning and schooling produce a negative affect that serves to disable many of the resources the system could bring to bear on their learning difficulties. Indeed, as McLeod (1992) states, "the U.S. reform movement in mathematics education clearly takes affective factors as an important area where substantial change is needed (p. 575)." Similarly in Canada, there is public pressure for school reform evident in

British Columbia's Year 2000 curriculum initiatives (Province of British Columbia, 1994) and its new mathematics curriculum[1]. Highly public forums such as Young's (1996) newspaper article, *The biggest failure in our schools is schools that fail kids,* where he espouses the need for continuous progress schooling without failure, further raise public awareness and pressure for school reform. Yet concurrently, the public demands content learning and skill mastery accountability from public schools to justify education budgets (Ryan, Connell, & Deci, 1985). Schools also serve the social function of sorting and classifying students to identify the "best students" (Berliner, 1989) to order access to post secondary education and career opportunities. Educators seem to be in a chronic struggle to keep accountable schooling and humane learning from being mutually exclusive events.

In seeking to address the very powerful negative affect created by schooling dysfunction and failure, educators have used the *"at-risk"* label to identify those students who are at-risk of failure or 'dropping out' of the school system. Berenson, Carter and Norwood (1992) conclude that individual characteristics of "at-risk" students are too widespread to apply a remedial template to predict which students will be successful and which will drop out. However, affective variables are related to the fact that low socio-economic students, ethnic minorities and females generally, are each under-represented in mathematics courses and activities (Hart, 1989). In the absence of evident reasons to the contrary, a teacher should consider students from any of the aforementioned groups, as potentially "at-risk". The perpetuation of certain mathematical attitudes, specifically mathematics anxiety, has been found to be more related to lack of persistence than strictly cognitive ability among Native American students, prompting Hadfield, Martin, and Wooden (1992) to conclude that, to improve participation of all minority groups in

[1] Since 1988, with the release of the Sullivan Commission's Year 2000 document by the British Columbia Ministry of Education, many working papers and curriculum revision documents have been produced. A most significant break from past secondary curriculum is a redirected focus on the learner, not just curriculum content. This redirected focus was repeatedly made evident at the *Secondary Schools: Success Within and Beyond* Conference held at Simon Fraser University. August 19-20, 1996.

mathematics, a significant national effort to reduce mathematics anxiety and improve attitudes to mathematics is necessary.

Addressing this lack of persistence related to mathematics anxiety and attitude, it may be argued that these students have not had appropriately mediated learning experiences (Feuerstein, Rand, Hoffman, & Miller 1980; Haywood, 1987). The perspective that both Haywood and Feuerstein et al. present, views students who are "at-risk", or who show serious cognitive function deficits, as retarded performers rather than retarded individuals; they have been *mediationally* deprived in their developmental experiences of both the affective and cognitive psychological tools for learning. Kozulin and Presseisen (1995) further argue that cognitive functions in formal schooling do not appear spontaneously; the education reform movement consequently requires a scientific theory that emphasizes a classroom design based on the metacognitive aspects of self-regulation. Concurring, I would summarize that students, and particularly "at-risk" students, require mathematics learning environments that respect and address each individual student's need to develop positive affective thinking and productive cognitive thinking, within an autonomous context and appropriate peer, adult, and teacher mediation.

The previously cited research implies that the currently common classroom paradigm is affectively toxic for many students. Teachers, however, have few alternatives to address this dilemma. Eccles and Midgley (1989) state, "Educators and psychologists have long recognized the need for a more personal, student-managed, task-focused learning environment for young adolescents (p.178)." Spector (1993) argues that the reform movement of the 1980s is becoming the restructuring movement of the 1990s based on an acknowledgment that education needs to be restructured in a way that is consistent with the restructured society. It is my belief that many of the descriptors in

Spector's *new paradigm* schooling may potentially be addressed by offering students their mathematics schooling in learning environments supported by computer-managed instruction (See Table 1). *New paradigm* schooling parameters that may be specifically impacted by an instructor mediated, computer-managed instructional environment include intended outcomes, school culture, teacher's role, student's role, curriculum, instruction and evaluation.

Table 1.1 New paradigm schooling parameters potentially influenced by an instructor mediated, computer-managed instructional environment.

Intended outcome of schooling
- learn how to learn
- construct understanding and meaning
- both academic and psycho-social achievement
- understand self and others

School culture
- based on win/win mind set (assumes everyone in a situation can gain something - no one has to lose for another to gain)
- caring attitude obvious (teacher / learner relationships incorporate personal concerns and develop through visible responses to each other)
- overtly protects individual's self esteem
- perceived to be risk free
- values connections, teaming, and collaboration, (a professional learning culture)
- values teacher / teacher, teacher / student interaction
- values inquiry and reflection
- requires thinking about thought (metacognition)
- values creativity and individualism: celebrates diversity
- values questioning as the vehicle for inquiry and construction of knowledge: rewards questioning
- considers answers to be the basis for new questions

Teacher's role
- conduct research on own and student's experiences as reflective practitioners
- responsible for meeting needs of individual learners
- responsible for enabling each learner to reach his/her own potential dictated by inheritance, culture, accomplishments, and experiences
- develop relationships with individual learners
- focus on student learning and subsequent growth
- co-learner posture
- model life-long learning
- facilitate experiences from which students construct their own knowledge
- create student-centered classrooms

Students' role
- rearrange, add to, or delete information from personal conceptual framework
- intellectually empowered as reflective learner to take responsibility for own learning
- develop knowledge and understanding of self: student self-realization

(...continued)

Curriculum
- builds on a constructivist approach to learning
- focuses on processes to develop connections forming conceptual frameworks into which new information may be integrated: emphasizes holistic concepts (theoretical and perceptual)

Instruction
- assumes students have different learning styles and different stages of cognitive and psychological development
- responds to questions with questions developing lines of questioning (patterns of reasoning)
- cooperative learning strategies dominate
- fosters collaborative environment

Evaluation
- curriculum specific assessment serves to improve instruction
- used in service of instruction
- embedded in instruction: lines blur between assessment and instruction
- fosters divergent instruction
- monitors for students' understanding
- self-assessment of learning progress is done by students

(Spector, 1993, p. 12-13)

Computer technology, generally, is associated with positive affect and is well received by students in educational environments (Askar, Yavuz, & Koksal,1992; Fahy, 1985, 1987; Francis, 1990; Jessup, Egbert & Connolly, 1996; Kaput, 1989; Keeler, 1996; Kluger & Adler, 1993; Kulik & Kulik, 1987; Okolo, 1992; Perez & White, 1985; Repman, 1993; Salerno, 1995; Signer, 1991; Terrell & Rendulic, 1996; Wepner, 1991). Most research however, relates to CAI, computer *assisted* instruction. Computer-managed instruction, CMI, is distinct from computer *assisted* instruction. Guthrie (1987) defines the functions of CMI as test generation, correction and analysis, record keeping and reporting, the routing of learners through a set of learning activities, and the charting of learner progress for a variety of purposes. CAI generally is interactive programmed learning whereby the computer teaches the student. With computer-managed instruction,

students interact, largely at their own discretion, with peers and teachers to mediate learning during the completion of computer generated assignments; the computer is only used to test, mark and generate assignments consequent to objective scores achieved on tests. Student progress is self-paced. Boblin and Gibson (1986) found higher achievement scores in CMI groups compared to non-CMI groups, as did Tennyson (1981), who also determined that high school students were able to make better judgments about managing their own learning when provided with their own diagnostic and prescriptive information from the system. The variety of learning resources available to the student is only limited by what diversity the coursepath or teacher programs into the system's assignments. A computer-managed self-paced learning environment may thus be a means to provide a personally interactive, technology-based alternate schooling experience and environment for adolescent students.

Use of a computer-managed learning system to address the needs of at-risk learners is supported in the work of Francis (1990), who claims that with individualized attention, CMI offers these students an efficient, non-threatening, supportive learning environment with real-life relevance and clearly stated learning goals. Nagarkatte (1989) similarly attests to the value of a combination of CMI, CAI, tutoring and instructor input, to address the needs of a heterogeneous group of adult learners, 85% of whom required mathematics remediation. Nagarkatte found CMI and CAI to be a necessary component of the students' curriculum because it offered immediate feedback and held the students' attention.

Several school districts throughout Canada and the United States currently use the computer-managed learning environment in alternate schools and adult learning centres (Pathfinder Learning Systems, undated; Buck, 1995). Some secondary schools are using computer-managed instruction to provide self-paced courses to individual students in locations where there is insufficient enrollment to run a full class of a course. Others use it

to enable the provision of alternate timetabling and alternate learning environments.[2] The West Vancouver School District has successfully used a computer-managed instructional system as part of its alternate school environment since 1990. Alternate schools are generally small, special program educational sites that exist within British Columbia school districts to comply with the legal mandate for availability of a public secondary school education for all students up to and including the year of their eighteenth birthday. Sites may have a particular program focus. Often, their raison d'être is to educate adolescents students who have been generally unsuccessful within the regular secondary school system for a variety of reasons. These reasons may include absenteeism, repeated failure, substance abuse, family problems, learning disabilities and physical, emotional and behavioral disorders. Attributes inherent to the instructor mediated, computer managed learning environment suggest these issues may be more flexibly accommodated by this type of learning environment.

Research Question

In an attempt to accommodate many "at-risk" learners and issues undermining mathematics achievement and graduation rates at Mountview Secondary School, a computer-managed instructional system was implemented. This study explores the students' perceptions of learning mathematics in the computer-managed alternate learning environment set within the regular secondary school learning environment of Mountview Secondary School. This research will attempt to answer the following question:

> **In what ways does a computer-managed self-paced learning program shape the learning experience and learning environment of "at-risk" students within the secondary school setting?**

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[2] Discussion with Ed Carlin and Tanya Northcott, representatives of Pathfinder Learning Systems, September 1996.

In Chapter Two I will present related research that reviews the role of affect, autonomy, motivation, and classroom interactions in mathematics learning. A rationale for a computer-managed mathematics learning environment follows. Chapter Three presents the historical context for this study and the research design. An analysis and presentation of eight students' perspectives on their learning experiences and the learning environment in the Mountview Secondary School Pathfinder Lab is presented in Chapter Four. The final chapter derives conclusions from all the data and defines the implications for the provision of satisfying and effective mathematics learning environments to students.

CHAPTER TWO

Review of Related Research

Learning experiences and the learning environment have a strong impact on what students bring to and acquire in their mathematics learning. The following will present the reader with an operative definition of affect in this study, how affect has an impact on motivation, achievement and self regulated learning behaviors, and the role of computer-managed instruction in addressing affect and learning.

Affect: its definition and role in mathematics achievement

The role of affect in its influence on cognitive growth and learning for all students is taking a higher profile in educational research. Mandler (1989) states, "affectless learning is not a possible goal for a theory or for the praxis of instruction" (p. 16). Affect is a nebulous concept and highly subjective term. The different dimensions of affect are evident in Williams' (1979) and McLeod's (1989b) distinctively different perspectives on the topic. Williams'(1979) recognizes affect in the interactive elements of pupil behaviors, curriculum, and teacher behaviors. Pupil behaviors evidence what Williams refers to as "cognitive intellective" and "affective feeling" components. William's "affective feeling" dimension includes the attributes that he labels, "curiosity / willingness", "risk taking / courage", "complexity / challenge" and "imagination / intuition". Willingness, perseverance and self-confidence are similarly key elements of affect recognized in the work of Grouws and Cramer (1989), Lester (1980), Lester, Garofalo, and Lambdin-Kroll (1989) and Reyes (1984). Where Williams focuses more on motivational outcomes of feelings, McLeod focuses on the intensity and quality of feelings. McLeod's (1989b)

theoretical framework for research on affect in mathematical problem solving, focuses on four aspects of emotion:

1. Magnitude and direction of the emotion.
2. Duration of the emotion.
3. Level of awareness of the emotion.
4. Level of control of the emotion. (p. 32)

McLeod attests to the role of affect in mathematical learning in his statement that all mathematics students, both low achieving and the strongest, "need to be able to deal with the role of affect in their learning" (p.33). He finds that the cognitive processes involved in problem solving are particularly susceptible to the influence of the affective domain and summarizes numerous research studies that indicate memory and representation processes, consciousness, metacognition, automaticity, emotions, instructional environments and belief systems each contribute to a complex interplay of affective and cognitive outcomes. McLeod (1992) concludes three major facets characterize the affective experience of mathematics:

> First, students hold certain beliefs about mathematics and about themselves that play an important role in the development of their affective responses to mathematical situations. Second, since interruptions and blockages are an inevitable part of the learning of mathematics, students will experience both positive and negative emotions as they learn mathematics; these emotions are likely to be more noticeable when the tasks are novel. Third, students will develop positive or negative attitudes toward mathematics (or parts of the mathematics curriculum) as they encounter the same or similar mathematics situations repeatedly. (p578)

> Therefore we can think of beliefs, attitudes, and emotions as representing increasing levels of affective involvement, decreasing levels of cognitive involvement, increasing levels of intensity of response, and decreasing levels of response stability. (p. 579)

For the purposes of this thesis, the meaning of the term *affect* will be that summarized by Blum-Anderson (1992):

> Mathematical affect is defined as the feelings that students hold about the subject of mathematics, about conditions that exist within mathematics classrooms, and about the self as a learner of mathematics. It also includes the perceptions students hold with regard to the difficulty, usefulness, and appropriateness of mathematics as a school subject and the reasons (attributions) that students give for successful or unsuccessful mathematical outcomes. (p. 433)

Reflecting Blum-Anderson's dimensions of affect, the reader will view students' comments exposing the affective attributes of learning mathematics in the self-paced, computer-managed environment.

Feelings serve as a selective filter in mathematical affect. This filter is tuned to incoming material that supports or justifies one's feelings.

> The filter admits material congruent with the perceiver's mood but casts aside incongruent material. Feelings cause congruent stimuli to become more salient, to stand out more, arouse more interest, cause deeper processing and greater learning of congruent material. This filtering is important insofar as it determines what gets stored in memory in the first place. (Bower & Cohen, 1982, p. 291)

The outcomes of this filtering may intensify affect, whether positive or negative, and interrupt and redirect behavior. This is affirmed by Scheier and Carver (1982): "When a schema that incorporates affective information is accessed in the process of perceiving a new stimulus, the affective-response information is evoked along with the other information (p.178)." Consequently, one can appreciate how both positive and negative mathematical attitudes among students can arise over time from albeit, similar initiating stimuli. Izard (1982) concurs with Scheier and Carver (1982), that affect and cognition are linked in influencing self-regulatory behaviors, but adds that:

> Behavior is continually influenced by affect, and the intensification of ongoing affect or the emergence of a different and strong affect results not simply in interruption of ongoing behavior but in the organization of new behaviors. Another way of saying this is that a change in affect state

> reorganizes and redirects behavior and mobilizes the energy to sustain it. (Izard, 1982, p. 233)

Readers will witness many student behaviors influenced by the emergence of redirected or reaffirmed affective states, both positive and negative. Where a positive affect occurs, students can be expected to demonstrate more willingness to persevere and take risks; positive affect influences the processes they use to solve problems and decide among alternatives (Isen, Means, Patrick, & Nowicki, 1982).

Negative affect perpetuates underachievement and failure

Negative affect is the root of mathematics anxiety and the precursor to failure (Tobias, 1978). Failure and underachievement, however, have their own affective dynamic of perpetuation. Nicholls (1984) describes how ego-involved students who believe their capacity is low, will avoid moderate normative difficulty levels or "realistic" challenges and perform at their worst if obliged to work on such tasks. He states that self-perceptions of competency become the dominant manifestation of the self-worth motive.

> The evidence suggests that individuals strive to maintain both private and public images that are not only internally consistent with one another, but also credible in the eyes of others. The research also provides a unifying theoretical and empirical basis for understanding a bewildering array of self-handicapping behaviors encountered in the classroom, ranging from procrastination, to cheating, to setting impossibly high goals for oneself. All of these actions can be seen as strategies in the struggle to protect a sense of personal worth. (Nicholls, 1984, p. 80-81)

As effort expenditure represents a potential threat to one's sense of worth because a combination of high effort and failure implies low ability (Covington, 1984), students perceiving themselves to be in a learning environment for low ability students are in a double bind and under an increased threat to their self-worth (Jones, 1974). The perpetuation of this personal affect for failure and underachievement can also be related to attribution and behavioral patterns.

> Success oriented students tend to attribute their successes to a combination of skill and effort, and their failures to a lack of proper effort. In contrast, failure-accepting students attribute their successes, infrequent as they are, to external factors such as luck, task ease or to the generosity of a teacher, while failure is ascribed to a lack of skill and ability. Because these students perceive success as beyond their control, they tend to withhold self-praise as being unjustified and also actively avoid success because it implies an obligation to succeed again, something they believe themselves incapable of. (Covington, 1984, p. 93)

My teaching experience has acquainted me with many students evidencing these behaviors and attributional styles.

Learning autonomy and motivation

Autonomy in one's learning provides a satisfying sense of control, facilitating the development of initiative, motivation and other self-regulated learning behaviors. Self-paced learning programs were popularized in the 1970s to address low achievement and individual student ability differences (Allison, 1975; Leuba and Flammer, 1975; McCollom, 1974; Schoen, 1977). The learner's autonomy in a self-paced course may offer a sense of initiative and control over one's learning activities that is generally less evident in the traditional, more teacher directed, mathematics classroom. Research findings indicate that although self-paced instruction may not demonstrate consistent superiority in raising standardized test scores, its use continues on the basis of its intuitive appeal, and student and teacher satisfaction. Students strongly preferred a self-paced format to a conventional format, feeling that they worked harder, learned more, and had more control over their grades in a self-paced course (Allison, 1975). Student motivation to learn has been enhanced by the provision of self-paced learning (McCollom 1974, Nagarkatte 1989). Both Nagarkatte and Reiser (1984), however, highlight the problem of student procrastination when a course is exclusively self-paced. More current research focuses on the development of self-regulated learning (SRL) behaviors (Alexander, 1995; Boekaerts, 1995; Pressley, 1995; Winne, 1995). The degree to which a student initiates productive

thought and learning activity in response to interests, learning challenges or classroom experiences reflects varying levels of self regulated learning behavior. Effective self-paced learning would offer to students, task conditions that develop SRL and are "designed, through social and other forms of support, to circumvent their inaptitudes long enough for success experiences to show (Corno & Rohrkemper, 1985, p.84)." Positive self-appraisals forthcoming from success experiences are prerequisite to an intrinsic motivation to learn (Corno & Rohrkemper, 1985).

Some elements of self regulated learning are metacognitive and metamotivational; SRL is guided by appraisals and affective states (Boerkaerts, 1995). Dominantly positive appraisals and their concomitant affective states motivate students to assemble available *learning* resources, whereas dominantly threatening appraisals and corresponding negative emotions motivate students to assemble available *coping* resources for protecting their well-being (p.198). I would emphasize that these appraisals and affective states are part of a complex and continuous feedback loop rendered from the student's cognition on his perceptions; cognition and perception that are all deeply influenced by the affect the student brings to the learning environment and the affect of the learning environment itself. The social interactions occurring within the learning environment generate the affective and cognitive foundations on which students construct their perceptions. These perceptions ultimately determine students' intrinsic motivation and quality of learning (Biber, 1981; Izard et al., 1965; Johnson & Johnson, 1985; Kloosterman, 1988; Leventhal, 1982; Scheier & Carver, 1982; Winne, 1995). Intrinsic motivation results when an interplay of classroom conditions promote student self-regulated learning and positive self-appraisals (Corno & Rohrkemper, 1985).

Classroom interactions influence student perceptions and motivation

A computer-managed learning environment generates teacher-student and student-student interactions that may differ both qualitatively and quantitatively from those of the typical mathematics classroom. Johnson and Johnson (1985) distinguish types of interaction contexts within classrooms, and their consequences for affect, motivation and achievement. These interaction contexts may exhibit positive interdependence, negative interdependence or no interdependence. The different interaction patterns of interdependence result in different motivational systems, consequently affecting achievement, which ultimately determines expectations for future achievement. Interdependence patterns within a classroom thus influence whether the overall learning environment is cooperative, competitive or individualistic. Johnson & Johnson conclude that *cooperative* learning situations promote greater intrinsic motivation, higher expectations for success, greater incentive for achievement, greater epistemic curiosity and continuing motivation to learn, more commitment to learning, and greater task persistence. The *competitive* classroom, created by such practices as bell curve grading and oppositional interactions, promotes a motivational element that includes extrinsic motivation to win, low expectations for success by all but the highest ability students, incentive to learn based on differential benefit, low epistemic curiosity and lack of continuing interest to learn, a lack of commitment to learning and low task persistence in most students. The *individualistic* learning situation promotes a motivational element that includes extrinsic motivation to meet preset criteria of mastery, low expectations for success by all but the highest ability students, an incentive to learn based on self benefit, low epistemic curiosity and continuing interest to learn, low commitment to learning, and low task persistence by most students (Johnson & Johnson, 1985). A computer-managed learning environment is individualistic in its self-pacing and learning objective mastery criteria. It is also, however, conducive to a cooperative learning environment to the extent

that peer and teacher mediated learning and problem solving occur during the completion of students' assignments and corrections (Pathfinder Learning Systems, undated). Fahy's (1987) students found using computer-managed learning modules more helpful, enjoyable, and less stressful, preferring the cooperative and print learning elements of their program to traditional instructor-centered approaches. Greater questioning opportunities with peers generated a satisfying and cooperative learning environment.

A successful computer-managed learning environment thus needs to be designed to offer opportunities for autonomy, meaning-constructing learning interaction, content mastery and self-pacing. A rationale supporting these goals is found in the work of Ryan, Connell & Deci (1985). They recognize the administrative trend and public pressure for prescriptive learning and standardized curricula, while expressing the difficulty in marrying these attributes with learning autonomy and intrinsic motivation. Their findings conclude that:

a) providing students with choice improves learning;

b) intrinsic motivation, achievement and conceptual learning are positively related;

c) circumstances that afford autonomy and support competence tend to facilitate intrinsic motivation.

Computer-generated feedback from a computer-managed instructional system increases intrinsic motivation and achievement, and supports the Cognitive Evaluation Theory's proposition that extrinsic, informational feedback will cause a positive shift in motivation with a corresponding change in achievement (Clariana, 1993; Terrell & Rendulic, 1996).

A basic precept to the computer-managed learning environment is that students will initiate peer and instructor mediation of their learning as the need presents. Offering the potential for a more personable teacher-student interaction than may be feasible in the typical mathematics classroom, this individualized learning mediation could be expected to

be a learning motivation reinforcer. Help seeking behaviors, however, are found to demonstrate an interesting paradox; those who need them most, practice them least (Karabenick & Knapp, 1988). Except among very young children, help seeking behaviors have been found to imply low ability to one's peers (Graham & Barker, 1990).

Indirect sources of low-ability information are also found in prevalent teacher behaviors, both in situations of success as well as in situations of imminent failure. Praise itself is often counterproductive and a questionable motivation reinforcer (Brophy, 1981; Dinkmeyer & Losconcy, 1980). Particularly among low achieving students, unsolicited help from a teacher is perceived by both the recipient student and the student's peers to be an attribution of low ability by the teacher. This attribution influences the student's self-perception of ability and has psychological consequences impacting affect and expectancy (Graham & Barker, 1990). Karabenick and Knapp (1988) conclude that poor performers thus face both cognitive and emotional obstacles to obtaining the help they need. Their study showed that help seeking behaviors occurred predominantly among students achieving in the B- to C+ range; that above and below that range help seeking behaviors decreased, approaching 0 at an overall achievement grade of D. Teachers are thus in a double bind with low achieving students because these students may not only avoid *seeking* help but also may avoid *receiving* teacher initiated help because both actions are perceived by students to infer low ability, and would further undermine their already fragile self esteem. When the low achieving student chooses to maintain an isolation in his learning he adds to his own difficulties by limiting his learning resources. Winne (1995) describes the shortcomings of solitary learning: "Solitary study lacks the dynamically responsive scaffolding and guidance that can be made available when learning proceeds in the context of social interaction or intelligently interactive media (p.186)." Where students perceive help-seeking interactions to indicate a lack of ability, rather than a positive demonstration of learning initiative to construct meaning, the students' major

preoccupation, the protection of a sense of ability and self-worth, becomes an unrealistic self-defeating aspiration (Covington, 1984). Readers will view several different perceptions that had an influence on individual student's quantity and quality of interaction in the Mountview Secondary computer-managed learning environment.

Rationale for a computer-managed instruction learning environment

The rationale for a computer-managed learning environment is that it may provide a means to address the demands for both publicly accountable schooling and humane learning while enabling a recognition and utilization of Kuhs and Ball's (1986) dominant and distinctive views of how mathematics should be taught:

1. *Learner-focused:* mathematics teaching that focuses on the learner's personal construction of mathematical knowledge;
2. *Content-focused with an emphasis on conceptual understanding:* mathematics teaching that is driven by the content itself but emphasizes conceptual understanding;
3. *Content-focused with an emphasis on performance:* mathematics teaching that emphasizes student performance and mastery of mathematical rules and procedures; and
4. *Classroom focused:* mathematics teaching based on knowledge about effective classrooms. (Kuhs and Ball, 1986, p. 2)

The Pathfinder Learning System, which provides the instructional context in this study, is said to provide a learner focused and content understanding focused approach through its self-pacing, its ability to create customized individual coursepaths, and the interaction between students, teachers, and peer tutors to construct their knowledge and understanding (Pathfinder Learning Systems, undated). Content focus with an emphasis on performance ensues from the 80% mastery criteria that is required by the system before new material is introduced to students. Mastery percentage criteria can be changed to address individual student's learning needs. Positive changes in teacher role, a cooperative

and enhanced classroom climate and the creation of a more student focused learning environment were consequent to the computer based learning environment (using networked CMI and CAI) initiated in an urban school characterized by an ethnically diverse and low income student population (Keeler, 1996). Where the Pathfinder Learning System is individualistic in pacing, the intended autonomous and cooperative focus in mediating the learning experience suggests that the computer-managed instructional environment may, in many ways, be concurrent with research on effective classroom learning environments (Blum-Anderson, 1992; Corno & Rohrkemper, 1985; De Corte, 1995; Johnson & Johnson, 1985; Pathfinder Learning System, undated; Spector, 1993).

Freisen (1991) recognizes several positive attributes of the Pathfinder Learning Systems version of computer-managed instruction: placement and pace flexibility, individualization and immediate feedback, scheduling flexibility, management and reporting features facilitating individualization, modifiability and expandability of resources and paths, and the appeal of a simple interface computer technology. As adult basic education is Freisen's particular focus, he is concerned that an over reliance on the system may impoverish the quality of the adult basic education environment. He stipulates that the predetermined learning objectives increase a sense of disempowerment, depriving learners of opportunities for ownership and decision making. If this is the case, it may similarly be true for secondary level students as British Columbia Ministry of Education mathematics curriculum specifications generally oblige secondary school students to face predetermined learning objectives in each successive secondary school mathematics course, regardless of instructional delivery system.

A review of two decades of research on computer-managed instruction by Szabo and Montgomerie (1992) finds computer-managed instruction to be both effective and efficient. They conclude with the telling statement:

> Regardless of what we as instructors would like to believe about our work, many of our students will do anything to avoid our lectures, most of which do not contribute as much to learning as we instructors would like to believe. The data suggests that CMI can play a useful and productive role while satisfying student needs. (p.130)

Nagarkatte's (1989) nine year study concludes that computer-managed instruction used in conjunction with CAI, tutoring and instruction is an effective means to teach mathematics to college students of various abilities, learning styles and mathematics backgrounds.

In conclusion, although there is minimal documented research to support the specific use of the Pathfinder Learning System (self-paced, computer-managed instruction) with "at-risk" secondary school mathematics students, there is a body of related research that implies that CMI may have the potential to be an effective facilitator for the learning of mathematics in the secondary school environment. Because, "perception is reality", how these students perceive their learning experience and the learning environment using this system will be the subject of this research.

CHAPTER THREE

The Learning Environment Genesis : Research Context and Design

The genesis of this learning environment at Mountview Secondary School is rooted in my personal and professional experiences, a school accreditation report and the caring vision of the school's principal and staff. Following the events and experiences described below, the Mountview Secondary School Pathfinder Lab opened its doors to its student clientele in September 1995. The data collection for this research began simultaneously.

History of this Study

Budgetary cutbacks in June of 1994 concluded my career as an enrichment / gifted teacher at a Vancouver elementary school. Consequent to my teaching and educational experiences in this position, I had come to believe that any student's greatest potential would only be realized with strongly developed positive affective, metacognitive, creative and critical thinking skills. As a parent, I saw mathematics as the turnkey to my children's future educational, career and employment opportunities. While my eldest son excelled in his secondary school environment, acquiring many awards and scholarships, I witnessed my younger son grow to despise his secondary schooling, and particularly mathematics. When my younger son transferred to an alternative learning environment, that offered a self-paced computer-managed learning system, he was able to acquire his mathematics credits and graduate a year earlier than his age peers because the system had enabled him to progress at his own learning pace. I was amazed to watch my younger son, who had epitomized the concept of 'mathematics anxiety' (McLeod, 1992; Tobias, 1978), become a motivated learner. In discussing his change of attitude with him, I learned that he felt he was more motivated and worked harder because he was *in control* of his learning (and

consequently the amount of time he needed to remain enrolled to graduate); he suddenly seemed aware of a learning goal and no longer perceived his schooling as a year's sentence to a classroom and a teacher. I came to appreciate how seemingly non-educational, affective issues such as autonomy and freedom could so strongly influence learning. I realized that our educational system needs to address its students' learning needs without rejecting them from the mainstream. This pivotal experience in my younger son's schooling came to bear on the issues I addressed in my new mathematics teaching position at Mountview Secondary, September 1994.

As a teacher new to teaching Mathematics 8, 9 and 10A, I experienced frustration as I watched some of my otherwise capable students fall behind, struggle to learn, fail or enroll in modified mathematics courses, evidently due to reasons such as non-completion of homework, substance abuse, poor motivation or attitude, absenteeism, ill health, family and personal problems. For too many it seemed, the social and cultural context implied "Why bother?"; mathematics was a long way down their list of priorities.

Mountview Secondary had completed a British Columbia Ministry of Education accreditation in the 1993/94 school year. I welcomed the opportunity to act on many of the recommendations included in the *Final Report: External Accreditation Team, May 1994*, quoted below:

> * examine the failure rate(s) in courses and provincial examination scores and explore ways to help students become more successful;
> * explore ways to make all areas of the curriculum meaningful and relevant to students;
> * examine models of how students learn;
> * examine models to problem solve around the needs of students "at-risk"; (p8)
>
> * involve staff proactively in addressing key areas for school improvement (e.g. code of conduct, education change); (p.11)

The following recommendations were made in the *School Growth Plan Summary:*

> To provide students with opportunities to evaluate and direct their own learning:
> Strategy 1: develop an end-of-term form that teachers may use to solicit student feedback on the course;
> Strategy 2: investigate the implementation of teaching strategies that offer students opportunities for self-directed study units and self-evaluation.
> (Action Plan 1, Objective 3)
>
> To develop the academic confidence and self-esteem of all students:
> Strategy 2: extend to all students frequent praise for their small successes(accentuate the positive);
> Strategy 3: adopt a 'small-step' approach to teaching.
> (Action Plan 2, Objective 1)
>
> To work with the district to provide the school with more adequate and appropriate technological resources.
> (Action Plan 3, Objective 1)

As Mathematics 11 is a critical factor in both graduation and post secondary education opportunities, I reflected on my current teaching environment and the learning environment that had made the difference between graduating and not graduating for my son. The self-paced, computer-managed learning system software, Pathfinder Learning System, had been used successfully in several British Columbia school districts, but largely in the 'alternative education' site format. Evidently, because Pathfinder is self-paced and individually peer and teacher supported, many learners with a diversity of learning and personal problems have found success using this system, despite the variety of educational disability labels they previously acquired[3]. I became strongly motivated to pursue a self-paced computer-managed learning environment for my students.

[3] Tanya Northcott, representative for Pathfinder Learning Systems and John Blain, principal of Sentinel Work Alternative Program in the West Vancouver School District, have both described Pathfinder's successes in discussions with me. They told me of many students who, with a diversity of learning problems and negative schooling histories, have experienced success and secondary school graduation using Pathfinder. Pathfinder Learning System 1995 marketing brochures elaborate on this.

The logistics of implementation

Mountview Secondary's principal, went to great lengths to source funding and support my, and my colleague Peter's efforts to explore and initiate an alternate learning system environment. Despite unsuccessful applications for funding through various foundations and government programs, our principal creatively assembled sufficient school resources to purchase the Pathfinder software. A donation of used computers from Chevron Canada enabled the provision of the necessary hardware for the system.

Funding the staffing for the Lab was also a challenge. The Vancouver School Board contract with its teachers designated pupil teacher ratios of thirty to one for a secondary level mathematics class. Most learning centres using the Pathfinder Learning System usually function with a twenty to one or lower pupil teacher ratio. Vancouver's thirty to one ratio may be lowered by up to three students for either multiple grade groupings and/or the enrollment of identified special needs students with British Columbia Ministry of Education label numbers. In order to enable the individualized instructional assistance that typifies the Pathfinder learning environment, the principal designated staffing by combining the school's Skills Centre and the Pathfinder learning within one large room. In this manner, the Skills teacher, with a maximum fifteen to one pupil teacher ratio, and the District Resource Teacher (employed to enable the integration of students with British Columbia Ministry of Education special needs identification numbers) both worked in the Lab with a mathematics teacher who would enroll a class of up to twenty-eight students. As the District Resource Teacher was assigned to individual students and not a classroom, she did not work in the Lab on a full time basis. However, she was usually present Monday through Thursday and did work with many Pathfinder Lab students while concurrently accessing many of her special needs designated students during the periods in which they were enrolled in the Pathfinder Lab. This meant that with

an enrollment cap of forty for the room, the Lab was then staffed with at least two, and frequently three, teachers working in the room each block. Additionally, there were up to five Community Service 11 or Peer Tutoring 11 students assigned to the Lab each block to act as monitors and peer tutors.

The typical enrollment of forty in the lab in any given block would thus be composed of a range of twenty to twenty-eight mathematics students in various Mathematics courses; the remainder was composed of Modified English 8, Communications 11 or Skills Program students. In order to address our academically most needy students and provide sufficient pupil enrollment to warrant the staff assignments, the school's entire enrollments for the *modified* mathematics courses, Mathematics 9A, Mathematics 10A and Introductory Mathematics 11, Communications 11 and Modified English 8 were assigned to the Pathfinder Lab. Some ESL (English as a Second Language) transitional mathematics students were also enrolled in the lab for their mathematics course. Throughout the year, when any block's enrollment fell below forty, counselors would transfer students who were facing imminent failure in their regular mathematics class into the Pathfinder Lab. This happened several times through the year because counselors found that student absenteeism generally increased when a student perceived himself to be obviously failing; it was hoped that access to the individualized, self-paced instruction in the Pathfinder Lab would maintain the student's potential to acquire a mathematics course credit and serve as an effective way to reduce absenteeism.

During the first year of operation the Pathfinder Lab thus functioned as a self-paced, computer-managed learning centre offering Mathematics 8 through 11, Mathematics 9A, 10A , 11A and Introductory Mathematics 11, English 8, Communications 11, and Skills. As other computer labs in the school could be accessed through connecting cables, both computer-managed and some computer assisted

instructional resources were available for student use in the Lab. The Pathfinder Lab's first few months of operation were plagued with technology problems. The school board's commitment to maintain and service donated computers was soon withdrawn as network problems ensued. Several months into the school year, poor quality cables and excessively long cable installations between the computers (which extended the network beyond its maximum distance range), were found to be the root of many of our problems. Computer based learning is heavily dependent on the quality and availability of technical support services.

The Pathfinder Learning Environment

Pathfinder Learning System is a computer-managed instructional system with a mastery learning orientation. Students are each enrolled in a coursepath that offers the learning objectives for their particular mathematics course. Coursepaths are a sequence of objectives, each of which is composed of a set of learning outcomes. The student completes a computer generated pre-test on one objective, composed of a small set of outcomes; it is computer marked. Assignments are then computer generated for each outcome where the student scores less than 80%. In completing assignments, students are directed to a diversity of learning resources and may receive individual instruction from teachers and peer tutors. After assignments have been completed, marked and corrected by the student, the student then completes a computer generated post-test on the studied objective. Scores below 80% on any outcome within the objective will result in further assignments. When a student scores 80% or higher on the objective post-test, the student then receives the pre-test for the next objective and thus works his way through the coursepath to acquire course credit. The 80% mastery level is commonly used but can be revised for individual students by the supervising teacher. Other individualizing potential is available through the system's ability to allow teachers to create altered or new

coursepaths for students, and add or delete assignments, test items and learning materials within coursepaths.

In purchasing a Pathfinder system, Mountview staff had to choose the type of system desired, *Delivery,* or *Delivery and Development,* and appropriate coursepath software. Where the *Delivery* system would allow us to modify or create coursepaths from existing coursepath elements, both adding and deleting assignments, test items and materials as desired, a *Development* system would have allowed us to create entirely new courses. Financing availability dictated Mountview was able to purchase only the Delivery system. Mountview's coursepath software was acquired from three different sources. Mathematics 8, 9 and 10 coursepaths were from the Pathfinder Learning System Corporation. Mathematics 10A and Introductory Mathematics 11 coursepaths were purchased from Belmont Learning Centre in Victoria where teachers use a Development system and have created several coursepaths, written to British Columbia Ministry of Education Mathematics curriculum objectives and their own available learning resources. Mathematics 11 courseware was acquired from the British Columbia Pathfinder User Consortium, of which Vancouver is a member. The Consortium has created, and is updating, coursepaths for most British Columbia Ministry of Education Grade 11 and 12 courses. Thus each coursepath, although written to specific curriculum and instructional objectives, logically reflects the individual professional beliefs of both its author and the authors of the various learning materials that are designated for use in the coursepath assignments. Just as most currently used mathematics textbooks may designate learning activities that would not necessarily be fully compatible with the NCTM Standards (1989), it is my belief that the various coursepaths may similarly reflect some shortcomings that could be corrected by coursepath and assignment programming that is more consistently oriented to addressing these standards. Each Pathfinder learning site is obviously unique in that each environment will reflect the blending of its components: its coursepaths, its

clientele, its funding, its physical layout and the professional perspectives of its teaching and support staff. Consequently, the reader is cautioned that the term, Pathfinder Mathematics, refers to *all* of the mathematics courses using computer-managed instruction that were taught in the Lab, and that the term, Pathfinder Lab, simply refers to the room. The learning environment characteristics evidenced in the Mountview Pathfinder Lab are attributable to only that site and are not be attributed to Pathfinder Learning System sites in general.

Mountview Pathfinder Lab Site Description

The Pathfinder Lab runs 10 computers networked on Novell - I Class from a Business Education Lab server in another classroom. This server runs Pathfinder *Delivery system* and the various coursepath software. Other than one classroom of Mathematics 11A and a Modified Mathematics 8 class, the Pathfinder Lab enrolled *all* of Mountview's Mathematics 9A, Mathematics 10A, and Introductory Mathematics 11 students. As the Lab also enrolled Skills, Communications 11 and Modified English 8 students, the *remedial* nature of most of the room's course enrollments proved to play a negative role in influencing many students' perception of their learning environment.

The *Mentor Mathematics* coursepath software, written to offer academic Mathematics 8, 9 and 10 course curriculum, was used with transitional ESL (English as a Second Language) students and some Grade 8, 9 or 10 students who wanted to acquire regular academic mathematics course credit. As many of our students were already committed to a modified mathematics stream, many used the Mathematics 10A and Introductory Mathematics 11 coursepaths from Belmont Learning Centre to enable them to acquire a British Columbia graduation mathematics course credit before the end of Grade 12, i.e. Introductory Mathematics 11, Mathematics 11A or Mathematics 11. Belmont software was of particular value to Mountview in that the coursepaths were

written in units and came with unit tests covering several objectives. These unit tests would be comparable to chapter tests in a regular classroom . The tests were kept in locked file drawers and were teacher administered, not computer generated. The Mentor software did not have teacher administered unit tests, thus we created our own unit tests that were given at designated points in each coursepath. Lab staff felt that to ensure course credit credibility equivalent to a regular mathematics class, unit tests, not the computer generated Pathfinder tests, would be the major source of marks for report letter grades.

The Pathfinder Lab staff agreed initially upon a philosophy that student learning was to be self-paced; believing as we did that given sufficient time with individualized attention, students could master regular academic mathematics courses. Whereas some students chose to enroll in the academic Grade 8, 9 or 10 coursepaths in order to graduate with Mathematics 11, most of the modified mathematics course students continued in the modified stream completing Mathematics 10A, with the intention to graduate with either Mathematics 11A or Introductory Mathematics 11 and possibly Mathematics 11. Pathfinder Lab students were not given a time schedule for the completion of their coursepath. They were told that the courses were self-paced and students were encouraged to set progress goals and aim to complete the coursepath within the year. It was up to them to determine what they would do each class for homework. All students had a copy of their particular coursepath, on which they marked their objective test scores and the respective dates that they mastered each objective. Thus it was always clearly evident what had been accomplished and what objectives were still to be learned. They were encouraged to seek instruction and help from teachers, tutors and other class members, in constructing their understanding of the topics they studied. Their report card marks were to be primarily determined by their achievement on their unit tests, not their Pathfinder tests. Letter grades were based on the term's cumulative total of the unit tests

completed, 70%, and the remaining 30% was based on the students' maintenance of their course binder (assignments, Pathfinder tests, corrections, coursepath records). Consequently, if students had not completed at least a Unit 1 test for their coursepath by the end of first term, they received an "Incomplete" on their report cards.

Failure to complete the coursepath by the end of June resulted in an "In Progress", for the final report. This is a new letter grade that the B. C. Ministry of Education has allowed schools to pilot to allow students to complete a course's requirements by no later than the end of first term the following school year. At the beginning of the year, staff had been under the impression that the " In Progress " did not have a deadline. Perhaps naively, we believed our students had an opportunity, allowing an individually appropriate amount of time, to master regular academic mathematics courses instead of modified courses. Later in the year, Vancouver School Board drafted a response to the use of the IP that would have precluded its use on a final report. We were very concerned about the discrepancy between Board and Ministry directives, and about having mislead our students. We successfully sought permission from the Board to use the "IP" and postpone a final mark in June to the end of first term the following school year. However, a few students whose absenteeism, poor behavior, and negligible progress indicated the learning environment did not appropriately address their learning needs, received a "Fail", and either enrolled in summer school to acquire course credit or failed. This self-paced policy gave the students some degree of independence and personal control over how they learned in the Pathfinder Lab. Students' affective response to this autonomy varied significantly as this research will show.

Classroom Setting: The Physical Environment

The Pathfinder Lab was located on the third and top floor of the north side of the school in a classroom that was originally built to function as a Home Economics sewing

room. There was consequently more than the usual classroom number of electrical outlets, a larger than usual physical space, a sink, sideboard with large drawers and ten wall cupboards each housing twenty-four small drawers. These ten cupboards served to store the students' binders, two students assigned to a drawer. Students were requested to leave their binders in the drawers between classes and only take home the immediate papers they were working on for homework in order to avoid the frequently experienced problem of losing or forgetting their binders. Along the north windowed wall were located the ten networked 386 IBM compatible computers on computer tables. An instructor's computer area and desk was set up at the north west end of the room. It overlooked a carrel and sideboard area used for unit testing and included a small area where students could work individually or in small groups with the teacher. Also located in the west end of the room was the Pathfinder Lab library of resources and a Macintosh computer that ran tutorial mathematics and word processing software. At a desk by the Pathfinder Lab library, Community Service 11 or Peer Tutoring 11 student monitors were stationed to monitor the distribution, record keeping, collection and shelving of the library resources, monitor the hall pass board and record sheet for students leaving the room, and assist with peer tutoring. Pathfinder Lab library resources were distributed from the monitors' station as class members requested them during class, returned them at the end of the period, and borrowed them after school for overnight use or for use in the teacher supervised after school study block provided each day. Four foot high room dividers and book shelves separated the computer area from the table area where students worked on their assignments and tests. The availability of a counter outlet and a sink in the classroom enabled the staff to make coffee and tea in the room. Consequently, the usual presence of one or more Pathfinder Lab staff members meant the room was supervised and kept open for student access before classes commenced in the morning, during most nutrition breaks and lunch hours, as well as after school.

In this physical environment, six different teachers and over three hundred students, experienced a self-paced computer-managed learning environment during the 1995/96 school year.

Research Design

The Pathfinder Lab is a unique entity among our school district's secondary schools. My review of the research paradigms lead me to believe that the most thorough and valid information would be forthcoming from a qualitative, naturalistic inquiry.

> The mandated search for statistically significant cause-effect relationships often blinds evaluators and clients alike to more diffuse but also more powerful social forces operating within a given context, program, project, or site. And, most certainly, ascertaining what people think exists and why they think so is at least as important as verification of some a priori postulate about cause-effect relationships *that the evaluator thinks exists.* (Guba & Lincoln, 1989, pp. 231-232)

This research thus employed a naturalistic, "fourth generation" design (Guba & Lincoln, 1989). To comply with the quality criteria for "fourth generation" research, negotiation, data analysis and interpretation occurred continuously throughout this evaluation. Consequently, emphasis is *not* on a quantitative, cause-effect relationship. While not being shaped to meet the agenda of any player in the education community, this research study acknowledges that values within this community's players exist and influence perceptions. I recognize that my own values may reflect aspects of the traditional educational community in that I accept that the parameters for mathematics course credit implies a student has indicated functional competency and knowledge of a specified group of skills/objectives to at least a fifty percent level. I also respect the concept that the public school system's existence is funded and dependent upon the tax-paying public who, in general terms, expect secondary schools to produce the competent and responsible student product that secondary school graduation implies. The implementation of the Pathfinder Lab at Mountview was an attempt to allow more students to access, within their own secondary school community, the pacing and individualized instruction in their mathematics curriculum to enable them to accomplish the traditional parameters of mathematics achievement and the necessary mathematics course credit for graduation.

Credibility attributes of prolonged engagement, persistent observation, peer debriefing, negative case analysis, progressive subjectivity and member checks have each been incorporated. *Prolonged engagement,* is defined as:

> Substantial involvement at the site of the inquiry, in order to overcome the effects of misinformation, distortion, or presented "fronts", to establish the rapport and build the trust necessary to uncover constructions, and to facilitate immersing oneself in and understanding the context's culture. (Guba & Lincoln, 1989, p. 237)

Persistent observation offers the evaluator sufficient observation to:

> identify those characteristics and elements in the situation that are most relevant to the problem or issue being pursued and to focus on them in detail. The object of persistent observation is to add depth to the scope which prolonged engagement affords. (Guba & Lincoln, 1989, p. 237)

Prolonged engagement and persistent observation thus occurred as data was collected throughout the entire 1995-1996 school year from many sources. Indeed, as I continue this year to work in the Pathfinder Lab with many of the same students from the 1995-1996 school year, I view my own and my students' daily experiences with ongoing reflection and consultation with my colleagues. Persistent observation was maintained in the form of teacher-evaluator journal keeping, individual student-generated term evaluations and repeated interviewing. Progressive case analysis occurred through my presentation of transcribed student interviews at regular thesis-group meetings attended by Dr. W. M. Roth, of the Simon Fraser University Faculty of Education, and a group of masters and doctoral graduate students. Peer debriefing with my thesis-group, colleagues and family served to maintain, mold and challenge my developing views. Each provided me with different perspectives on the student input and various incidents occurring in the Pathfinder Lab. The views of one interviewed student, Penny, and those evident in a few of the individual student-generated term evaluations will present negative case analysis. Member check, "the process of testing hypotheses, data, preliminary categories and interpretations with members of the stakeholding groups from whom the original

constructions were collected (Guba & Lincoln, 1989, p. 239-240)", has been provided in two ways. The use of repeated interviews allowed me to clarify and validate my interpretation of interviewed students perceptions with them directly. Also, the final term's individual student-generated evaluations included a list of students' comments derived from the previous two terms' student-generated evaluations and interviews. Students were asked to agree or disagree with these comments for purposes of a member check, in addition to generating their own evaluation comments on this final term evaluation instrument. Throughout the study there was "continuous feedback and feedforward" (p. 249), thus a hermeneutic, dialectic process was maintained.

I do appreciate that an interplay of a multiplicity of variables and values influenced both my students' and my experiences. Naturalistic, qualitative inquiry will, through the students' perceptions, more thoroughly access and expose the operative variables and values within this learning environment.

Student Participants

An appropriate evaluation of a computer-managed learning environment requires the contribution of its participants' perceptions. The validity of utilizing student views to study variables in learning environments is evident in many other studies, specifically Jones (1974), Lucas and Roth (1996), Morstain and Gaff (1977), Roth (1994), Stodolsky (1991), and Weinstein (1989).

> Teachers and researchers must keep in mind that the most important version of reality is not the task we think we set for students (nor as in Weinstein's work, is it the communication we think we direct to students), rather, the important version of reality is the student's perception of the task (or of the communication). That is, the student's perception of reality should be the one that counts the most for those who study the effects of teachers, classrooms and schools on students. (Berliner, 1989, p.326)

The extensive students' comments in this thesis are present to provide the reader with a true and thorough access to the student's perceptions.

Due to prolonged engagement and frequent enrollment changes, the specific number of students did not remain constant during this study. Data was collected from students enrolled in Pathfinder Mathematics. One particular student, Billy, was included as an interview source because, in addition to his enrollment in my Communications 11 course taught in the Pathfinder Lab, I had also taught him in my previous year's Mathematics 10A class and knew that, for various reasons, he was an "at-risk" student. Two of the female students included as interview sources provided perspectives from students successful in completing their coursepaths. As previously stated, the students involved in the study were enrolled in the modified secondary mathematics courses, Mathematics 9A, Mathematics 10A, Mathematics 11A and Introductory Mathematics 11 and a small number of students were enrolled in regular Mathematics 8, 9, and 10.

Students in modified mathematics courses typically have experienced minimal success in previous mathematics courses (Burns, 1994). My teaching experiences have also led me to respect the likelihood that many modified mathematics course students have negative attitudes to school in general and to mathematics in particular. Behavior and concentration can also be significant learning issues for some of these students. Despite my continued efforts to provide a cooperative learning environment evidencing mutual respect, it was not uncommon for me to hear a few of these students make negative remarks about one another's intelligence. Significant cultural, familial, economic, personal and social issues influenced their lives and learning to varying degrees. Enrolled ESL (English as a Second Language) students faced significant challenges in their understanding of English and although some had previously acquired competent mathematics skills in their homeland, mathematics problem solving often posed them difficulty.

Daily classroom experiences and the individual student-generated term evaluations contributed input to my students' and my perceptions of how the Lab environment shaped their learning experience. A deeper query of this influence was sought in interviews with eight "at-risk" students. "At-risk" students composed a majority of the students enrolled in Pathfinder Mathematics as most met two or more of the following criteria (Berenson et al, 1992; Hadfield et al, 1992; Hart, 1989; Meyer & Fennema, 1988; Schulz, 1973; Schwartz, 1988):

- previous mathematics course failure
- modified stream mathematics or Introductory Mathematics 11 course enrollment
- low socio-economic background
- female
- ethnic minority
- attendance problem history
- learning disabilities
- social or behavior problem history
- history of personal, health or family issues having a negative impact on student's learning.

Although I consulted with the counselors for information on whom they would consider "at-risk", I take sole responsibility for choosing the students selected for interviewing in this study. My selection most evidently reflects a professional and somewhat maternal concern for the selected students; it does not reflect a diminished opinion of the students' ability, character, or expectations for achievement.

Teacher Participants

The school's computer-support teacher, Peter, shared the responsibility for managing the Pathfinder Lab with me. Peter managed the hardware and software technology whereas I managed the classroom organization, coursepaths' content and learning materials availability. Consulting with Peter and the other teachers in the lab afforded support, insight and various personal and professional perspectives on what

transpired in the Lab. With approximately 40 students enrolled in each of the eight blocks of the timetable, assigned staff included myself and three other mathematics teachers, a Skills-English teacher, and the District Resource teacher for special needs students. While up to twenty-eight students were enrolled in mathematics each block, the remaining students of the forty were composed of Modified English 8 students in two blocks, Communications 11 students in four blocks, and Skills students who were interspersed over five of the blocks. In addition to my four blocks of mathematics, I also taught two blocks of Communications 11 in the Pathfinder Lab while another teacher enrolled mathematics students concurrently. Having two to three teachers in the Lab each block was intended by the school's administration to provide a team teaching environment to enable more students to receive individual instruction.

Data Sources

A major portion of the data developed from a student self-evaluation tool that I had created and previously found successful in revealing student perceptions and values about their learning. The concept for this tool was derived from Edward DeBono's (1985) PMI, (plus, minus, interesting) thinking strategy. The PMI thinking strategy is a particularly useful student self-evaluation tool, and program-evaluation tool, because it subjectively exposes the students' perceptions on their experiences and the learning. It also lends itself well to subsequent goal setting by both the students and teacher. I introduced this tool to the students in the Pathfinder Lab under the acronym, PING (positive, interesting, negative, goals), and requested its completion each term (See Appendix A for each term's PING). The PING instrument functioned as an integral part of the students' program, allowing the students to reflect on their learning, formulate goals and communicate with the teacher about their learning. As such, I believed that it did not intrude on their learning experience as a more obvious research tool or questionnaire

could. Students were, however, generally unfamiliar with reflecting on their learning in this manner. Their comments suggested that most were more accustomed to attributing the responsibility for evaluating their learning entirely to the teacher. Each term a few students did not submit a completed PING. This was generally due to absenteeism on the date of its distribution or collection. A few others neglected to finish it and/or forgot to hand it in. The third term PING was completed anonymously and incorporated the member check questionnaire, to clarify and validate perceptions gathered from student comments in the two previously completed PING's, interviews and the daily class experiences recorded in my log. A total of 75 students were present and completed the Term 3 PING out of a total enrollment of 112 students in my four mathematics blocks.

Absenteeism is an ongoing problem at Mountview Secondary; it consequently influenced the consistency of participants in data collection. Table 3.1 indicates the number of students in each of my mathematics blocks who were absent 10% or more of the year (10% equals approximately 11 periods out of an average total per block of 111) and of those students absent more than 10 periods, the range of total days absent. It would be incorrect to attribute the absenteeism indicated in Pathfinder Lab Mathematics classes to be representative of the entire school; it is however, similar to these same students attendance in their other classes. This information was acquired from an attendance printout of each block's enrollment in the Pathfinder Lab that was provided to me by the school's Records Clerk. Daily absenteeism and excused absence totals between 20% and 30% of each class enrollment were not uncommon.

Table 3.1 Absenteeism: Number of students absent >10% of year's total periods.*

Block	Number of Students Absent >10 Periods	Range >10 of Total Periods Absent
E	17	14 to 58
F	15	11 to 31
G	10	14 to 66
H	15	11 to 37

*Does not include "off-campus, in-attendance" absenteeism. (e.g. early dismissal, field trips, work experience, assemblies, off-campus sports or arts participation)

In addition to the issues raised by absenteeism in terms of data collection, there is also the issue that a significant number of students transfer in and out of both classes and the school during the school year. It was not feasible to assume that all the data could be generated from the same student participants for the entire year. I made the decision to include data from all sources, as available, throughout the year in order to give the study the scope and depth that persistent observation and prolonged engagement can offer.

For a more detailed, in depth, qualitative and individual data collection, eight "at-risk" students were individually interviewed. Cassy was enrolled in Mathematics 8 and had previously failed Mathematics 8 three times. Daleen and Nan successfully completed the Introductory Mathematics 11 course. Allison, Penny, Steve and Dino, also enrolled in Introductory Mathematics 11, were interviewed on two or more occasions throughout the year. Billy was enrolled in Mathematics 10A in the Pathfinder Lab with a colleague. I chose to include Billy and Steve for repeated individual interviews because both had been in my Mathematics 10A class the previous year and had, for different reasons, received administrative transfers out of Mountview mid-year. I thus considered both boys to be seriously "at-risk" and meriting close monitoring. As Billy was also enrolled in my

Communications 11 class, I had opportunities to learn more about Billy's perceptions than those of the other students. This information is included because I considered these perceptions to be an integral component of Billy's learning experience, a component that is not typically within the reach of a secondary school mathematics teacher-researcher.

Interviews were used so that students could elaborate on their learning experiences, the learning environment, their PINGs and to suggest possible improvements to the functioning of the Pathfinder Lab. The interviews also served to member check my perceptions of the learning environment throughout the year, as well as to broaden my knowledge and understanding of the individual students. To gather student data on particular issues and enable student fluency on the different topics, I encouraged the students to elaborate on the following questions:

- In what ways is learning mathematics in the Pathfinder Lab different from learning mathematics in a regular classroom?
- In what ways is your own learning different using Pathfinder?
- In what ways is the learning environment different from other mathematics classes?
- How has the learning environment influenced your learning?
- What problems or benefits are there in learning in this manner?
- What suggestions would you make to improve the learning in the Lab?
- What suggestions would you make to enable you to experience more success learning mathematics in the Lab?

In addition to the student data, I kept a personal log to note my observations and reflections from our day to day classes. The entries in this log served to document events and observations, my emerging perceptions and understandings, and contribute to the establishment of the study's quality (Guba & Lincoln, 1989).

Data Analysis

It was my intention to provide through naturalistic inquiry, "as complete a data base as humanly possible in order to facilitate transferability judgments on the part of others who may wish to apply the study to their own situations (Guba & Lincoln, 1989, p. 242)." As each of the first two terms' PING was completed by the students, I read them repeatedly looking for emerging themes and indications of cognitive and affective impact related to the learning environment. The third term PING served as a summary and quantitative member check, as the students either agreed or disagreed with student comments assembled from the first two term PINGs and interviews. Although not a designated option, some students circled both choices or marked between the choices; these I included as undecided in the tally. I also incorporated questions about the students' perceptions from their PINGs in my interviews. The interviews were transcribed in their entirety, and presented, analyzed and discussed in regular thesis-group meetings. The student *voice* of the eight interviewed students, as constructed in this thesis, has removed only the interviewers' questions, exchanging brief connecting phrasing where necessary to allow the reader to perceive the student in one continuous voice for ease in readability. This type of presentation of the student voice was requested by Dr. Roth and supported and preferred by all members of the thesis-group as a more readable and powerful means to present each student. Previous studies employing this style of voice presentation include Lucas and Roth (1996), Roth and Alexander (in press), and Shostak (1981). Extreme care was taken to ensure that the individual integrity and quality of each student's voice was maintained, that the connecting phrasing was minimal and included no additional value-laden wording.

All data was reviewed repeatedly to thoroughly analyze and determine elements of commonality, emerging themes and insights. Commonly noted attributes of the learning experience and environment were related to one another, other educational and

psychological research, student behaviors, affect and achievement. Computer generated hierarchical cluster analysis was used to expose possible relationships among the items from the Term 3 PING member check device.

Consequent to the progressive subjectivity and peer debriefing opportunities I experienced within the thesis-group meetings, interview questioning technique changes were suggested to elicit greater elaboration in the interviews. The thesis-group met regularly for the specific purpose of providing appropriate negotiation, analysis and interpretation of data.

The naturalistic process of this research allowed its investigation to be flexible, open, responsive and thorough. To expose the diversity of issues that arose during this research, the following chapter will introduce the eight individually interviewed students. The subsequent chapter will draw conclusions about the learning environment attributes exposed in the students' PINGs and interviews, and implications for future learning environments.

CHAPTER FOUR

The Students

Five of the eight interviewed students did not finish their coursepath by the end of June. Two students received Standing Granted, two received In Progress and one received an administrative transfer out of the school in April. The three other interviewed students completed their coursepath and final test with B or better achievement. Although none of these students' stories are without negative attributions to the learning environment, their comments indicate that their experiences in this environment influenced their sense of autonomy and responsibility for their learning, their attributions for successes and failures, their awareness of their own learning and self-regulated learning behaviors, and their sense of constructing meaning and understanding of mathematical concepts. Readers can witness students who are metacognitively, affectively and cognitively involved in mathematics learning; learning that they distinguish from their previous mathematics learning experiences, and learning for which a positive personal ownership is expressed.

Allison

Allison was a Grade 11 student. Although she had maintained average marks in Mathematics 8 and 9, she had failed Mathematics 10 the previous year. Her attendance was sporadic due to health reasons, her Career and Personal Planning course's work experience demands, and many off-campus commitments consequent to her active involvement in the school's musical arts program. Her comments include remarks about both the conceptual and social aspects of the peer interaction occurring in the learning environment. As she felt she had failed to understand much of her work in Mathematics 8 and 9, she had chosen to complete the Introductory Mathematics 11 coursepath instead of the Mathematics 10 coursepath in the Pathfinder Lab. Introductory Mathematics 11, while

offering a graduation level mathematics course credit, is a course that exists to enable students who have completed the modified stream of mathematics, Mathematics 9A and 10A, to re-enter the academic stream and access Mathematics 11. Allison required Mathematics 11 for university entrance. Allison received an IP on her June report and attended summer school to receive course credit.

Allison's voice:

October:

> After everything was straightened out, I'm beginning to understand mathematics a little better. I'm taking the time to get all the stuff I missed earlier; I'm amazed at how much I didn't know before and I'm glad I'm learning a bit more now. The negative thing is this is the Pathfinder Lab's first year. We feel kind of like guinea pigs. The first month was kind of wasteful, because we didn't do much that pertains to our course right now. Now it's straightened out. The computer system always breaks down!

January:

> I had regular mathematics up until the end of Grade 10. I skated through the entire thing and just now I've found out I actually knew nothing because, I'm serious, I had C's right through the entire thing until the end of Grade 10 when I got Standing Granted or something. Only this year I'm actually learning the stuff I should have known for the last three years. I do not know how I scraped through with C's, because truly, I didn't understand. I understood a little but I didn't understand that much. But I got through it, I kept passing it until last year; there was a little bit of disruption in the course and then I just didn't take the time to look at it or memorize it I guess. I guess most of what I was doing was memorizing. I didn't really understand it; I understood the basis of it but I didn't understand all the components to it. But now I understand stuff; there has to be a *reason* for it, but I just did it automatically before. I don't just sit down and do it now, I'm taking the time to learn *how* to do it and *why* I'm doing it. I didn't used to ask why before. No, as long as I was passing that was fine; that's all I did before. My mathematics understanding now, it's increased dramatically, I swear.
>
> I even find myself defending Intro Mathematics 11 now. Like I have enriched classes as well as Intro Mathematics, right? So it's like one side of my brain works, one doesn't. As far as I'm concerned at least, my mathematics side does not work. And you know, if anyone says, "Oh you're in Intro Mathematics 11", I say, "Yea, but I'm *learning* about it," so that's fine. I don't really care. There's definitely a stigma attached to Intro Mathematics 11; there's a stigma attached to everything that's remedial in any way. And it's not so much now, but like, a few people here and

there have said it. I've got A's in everything else, French Enriched, Biology, Socials 11, English, Computer Music and Choir. It's just the mathematics side; that artistic and mechanical type of thinking thing, I just never bothered to develop it. Mathematics has never interested me. I never bothered to look at it as anything but a course I am forced to take. The basics of mathematics are great. I mean you're going to need dividing and stuff like that for the rest of your life. I just have never thought, really thought to myself, "Well gee, I'm going to use quadratic equations in the near future," 'cause I'm just not. That's just not what I'm interested in.

I think it would be more beneficial to people in the Pathfinder Lab if certain grades were stuck together instead of having so many 8's, 9's, 10's 11's and 12's all in the same classroom. Like I think it gets a little too loud and stuff like that. There's too much of a separation between maturity levels; it's not a united classroom atmosphere. I know that 'cause we're all doing our separate little thing. If you bring the people's ages closer together I think that probably would be more helpful. Then most people would be doing the same kind of thing and they could even help each other. Our table is entirely Intro 11 and we do help each other.

When I'm starting a new topic I usually ask people at my table if they're at the same stage that I am, or else I ask one of the peer tutors; Vicki's quite helpful and she helps us understand. I go to a teacher if I still don't understand. The teachers are usually quite busy in here. I prefer to see if I can figure it out myself and then if I need to, I go to the teacher. I think students have different ways of looking at it so it's always helpful to have someone who looks at it a different way than you, because their way might be better, depending on what they've learned from past teachers. Sometimes it's not good, and you realize that, and you move on to someone who knows what they're doing. But just to have the different perspectives on the topic, I think that's helpful. You can find quicker ways to do it, slower ways to do it, everyone's got their own style. I feel I'm understanding mathematics now. I never did before. I find it thrilling to pass a test now. Absolutely thrilling. I don't know why, but it is. You know, getting it done and all, that's what I need. Like if I run into a new topic, I'm very stubborn and so I like to look at it first to see if I can do it, instead of running for help right away. Yea. I *have* to look at it first, because I just can't depend on other people to tell me what to do. But if I don't know it, then yea, I'm going to ask for help.

Most days in here I'd usually come in, get my work, maybe Vicki would help me. I need to do everything, step by step. Other people try to show me shortcuts but I need to do it step by step to see where and how I make mistakes. If I didn't understand something I would save it and ask about it in the next class. I'd be able to tell when I'd done enough of an assignment when I could do it backwards and forwards. I would go through the examples. On some things I would have to do more repetitions, but I would repeat them until I understood it, backwards and forwards. What interfered with me working at my own pace was other priorities; there were other assignments in other subjects that needed to be done so I often would put off doing my mathematics. I suppose that if I were required to maintain a certain level of progress each week, I probably would come in after school to keep up my pace.

If I could change things in the room, I'd have everyone on the same coursepath; that would probably be helpful, but even just a similar age group, that would be just as helpful. I can tune out the noise in the room pretty well. I mean, I do band, I tune that out half the time, but it gets a little much sometimes. I don't really know what you could do about the noise in here. There's so many kids, there's ESL students, younger kids, kids with not the same attention span as other ones, and I think just that much noise is automatically generated by that many bodies in that size room. And the different mentality levels and stuff like that. It's not a matter of if you were to say, "Nobody talks, everybody sit by themselves and work through their coursepath on their own."... I don't think that could happen. If you were to try to impose that kind of environment on the room I think it would be negative because you do need to talk to people about what you're doing. You do need to have another person's perspective. You can work through it together, instead of sitting here trying to work through on your own, looking at the back of the book, seeing that the answer's wrong, getting all frustrated, erasing, whatever, ending up tearing your page or something. If you work through it with someone else then you both benefit because you both understand what you're doing.

I'm going to try to speed up my pace a bit. I have to finish it this year, no matter what. Personally, I have to have it done. I need Mathematics 11 for university. I don't know if I'll take Mathematics 11 in a regular class or here; I'm still debating whether to take it during summer school. I don't think it's the "teacher in the front of the room" in a regular mathematics class that makes the difference. I sat there for 3 years having a teacher at the front of the room. It didn't make any difference to me. I mean it's not even individual instruction, I don't think. I think it's just having smaller groups. I mean if a teacher's going to stand there and dictate to you for half an hour, you tune him out. I tune them out automatically. I'm not going to sit there and listen to someone just tell me what to do. I need to know how to do it and why it works that way. Well, I hope to be taking Mathematics 11 this summer, if all goes well.

April:

The lab got better as the year progressed. It got quieter. There were more people doing their work. I was at a table with people I hadn't known before, so I spent a lot of time getting to know them. Some of them were wanting to graduate this year so they got down to work. There was both mathematics talk and social talk; I enjoyed getting into both. It was a choice I made, it was important to me. My success this year was that I understood my mathematics. Even though I'm going to summer school to finish Intro Mathematics 11 my family supports me on it because now I understand my mathematics. We've all wondered how I could previously have gotten C's in mathematics and would pass. I don't really feel it didn't work for me in here. I don't think it's the program. I'm understanding the mathematics. I understand it better than I have. It's just that I don't do it at home. I just find that I can come up with all these other things to do, whether it be my writing or whether it be the newspaper or a ton of other stuff, I just can't make myself do it. Even if I'd been told, say, that I'd have to be finished Chapter Three by November; I don't

know if even that would have made a total difference because it's more relaxed up here than it is in a lot of other classes. There's just so many people. It's more relaxed and I just didn't make myself do it; I have to deal with that now; whatever, that's fine.

June:

I think I'll do Mathematics 11 in a regular classroom but I don't think it's a regular classroom that will make a difference. I think a lot of it depends on who I get. I don't even know whether a regular classroom will work, I haven't been in one for a year. And last year wasn't much of a regular classroom either.[4] I haven't really been in a regular class for two years, with constant teaching, like the same person. If I take it in summer school and get a C+ and I want to upgrade it, I could upgrade it in here. I could upgrade in a regular classroom but I don't know if it would make that much difference; it might be stricter in there. It used to be that in a regular mathematics class, the teacher came in everyday, taught a lesson and after 10 minutes I found myself tuning out. I think a lot of it depends on who the teacher is. I think if I find them interesting, then I'll listen, and if I don't, I can just as easily tune them out. I lucked out this year with most of my other classes, it's been interesting. I found a lot of stuff that I didn't know I liked and that's been good. So I've done well because I paid attention, and they haven't made me sleep. It's been a bonus this year. If I'm interested in something I can concentrate on it. I don't think you could have done anything to make it more successful for me; it was me. I didn't want to do the work, so I didn't. And that's that. I mean, you can't force a kid to be interested in mathematics. I've become more interested in mathematics, which is better, 'cause I hated it before; and it's OK now. I don't mind it. I mean, maybe I was just goofing off, but I think that because I spent so much time reviewing it that it's become second nature. So, it's OK that way. I still need to look at my notes and stuff to review it, 'cause I don't always remember it. I haven't gone all that quickly, but I absorbed it. What I have done in here, I've understood better. In a regular class I'd have homework assigned every night and I know it's going to become repetitive but it's also going to make me do it. Depending on who the teacher is, certain teachers will totally freak out on you if you don't have homework done, others don't. But I think if you have someone who can tell you what to do every night or whatever. I don't even know whether that would make a difference. Maybe it's just that I want to do well for graduation; that could be just what it is. Last summer I had 2 jobs. I think I grew up a lot and had a change of attitude. My grades have soared in other subjects. The Catch 22 in Pathfinder Mathematics is that it gives people time but it makes you responsible for your learning. I don't blame Pathfinder for me not finishing; I understand what I'm doing now. I consider myself personally responsible for not completing my coursepath. It's as if when you *can* put something aside you'd put it off 'til later because of imminent demands in other classes and extra-curricular stuff.

[4]Allison's Mathematics 10 teacher had died suddenly; there was a short period of time with substitute teachers before a permanent teacher replaced him)

Analysis:

Allison symbolizes the challenge facing many adolescents. Lines from a poem she wrote express it so well:

I seem to choose
to do things the hard way.
Like I'd rather
walk blind
than see what's there.

Though saddened that I couldn't give Allison credit for Introductory Mathematics 11, her conversations with me left me feeling very proud of her, and her learning. She clearly had not mastered a sufficient number of the Introductory Mathematics 11 course objectives to pass her into the curricular demands of Mathematics 11; but by her own account she was finding satisfaction in her mathematics achievement and had acquired more mathematical understanding than in her three previous years' mathematics classes. Allison embodied the fallacy that because a student passes a mathematics course it means the student *understands* the mathematical objectives of the respective course. When she did not understand what she was doing in Grades 8 and 9, she passed. When her growth in understanding mathematical concepts had significantly improved, it was unfortunately necessary to deny her a Pass because she had not acquired a sufficient mastery of *all* the skills prerequisite to Mathematics 11. Considering the impact of failure on affect (Hart, 1989), Allison's failure to receive a Pass in the course, despite her significant growth in mathematical understanding, raises the question of what marks should reflect in mathematics classes.

Allison's October comments highlighted the numerous technology problems in the lab during the first few months of its operation. Her comments shed light on the impact of insufficient technical support in a computer based learning environment.

Allison was an "A" student in her other classes. In her January interview she indicated she was understanding her mathematics better and was becoming more aware of how she learned. She favored her quality of learning in the Pathfinder Lab to her previous mathematics learning. Her comments also exposed the school social culture that attached a stigma to the Pathfinder Lab because *all* the Mathematics 9A, Mathematics 10A and Introductory Mathematics 11 students had been enrolled in the Lab. She attributed her placement in the class to "her mathematics side" of her brain that she had never "bothered to understand" and "never bothered to develop". When she reflected on her current, previous and future mathematics learning, she expressed an awareness that both intrinsic motivation and extrinsic motivation affected her total schooling experience. Allison distinguished her mathematics learning style from her general learning style in other subjects; this supports the research of Kelly-Benjamin (1992) finding that high school seniors' mathematics and general learning styles differ. As do many students, sometime between elementary school and leaving secondary school, Allison had come to believe that higher level mathematics was not relevant to her life (Blum-Anderson, 1992). Allison viewed mathematics as just a course she was "forced" to take. Was Allison's belief that quadratic equations are something she'd never use rooted in fact, or a failure of her learning experiences to have exposed their relevance? Although she claimed that her mathematical understanding increased through her Pathfinder Lab experience, this experience did not appear to influence her belief about the relevance of the topics she was studying. Where she appreciated the autonomy and interactive elements of the learning environment for the opportunity it provided her to improve her understanding of mathematical concepts, her perception of the content itself was not included as an area of personal interest or relevance. Her slow progress and avoidance of doing homework would suggest that this lack of interest and evident relevance influenced her motivation.

As Zimmerman (1995) concludes, there is a complex interactive process involving social, motivational and behavioral components that influence one's ability to self-motivate.

Allison elaborated on her typically adolescent aspirations for independence; an independence that this learning environment indulged. This autonomy allowed her to participate in an ensuing mathematical enculturation at a level and intensity of her own making, an issue stressed by The Commission on Standards for School Mathematics (1989). The independence and social context of the learning environment encouraged her to develop a positive affect regarding her mathematics learning. She experienced cognitive and affective opportunities to enculture mathematical thinking. Exploring her classmates explanations and perspectives involved her in higher level thinking: analysis, synthesis and evaluation (Bloom, 1956). Her comments from her perceptions imply that she had not experienced an active involvement in exploratory and constructivist mathematics cognition in her previous mathematics learning experiences. Given her achievement orientation and self-concept consequent to her other subjects' achievement, I would suggest that Allison demonstrated task orientation and ego-defensive coping strategies (Lehtinen, Vauras, Salonen, Olkinuora, & Kinnunen, 1995) that would preclude a psychologically safe participation in a typical mathematics classroom.

Allison's comments have led me to believe that she found the learning environment of the Pathfinder Lab to be less competitive, more meaning-constructive and more cooperative than her previous mathematics learning environments. This had enabled her to be more *available*, cognitively and affectively, to pursue a goal to *understand* mathematics rather than to superficially memorize mathematical algorithms in order to *pass* the course. Visibly competitive mathematics classrooms, have served to affectively alienate many students over years of schooling (Tobias, 1978). Significant changes in students' perceptions of the emotional safety of their learning environment are necessary before they may be available for learning mathematics.

Allison did not like the multi-grade and multi-course classroom grouping. She suggested it contributed to the noise and congestion in the room. She did however, very much appreciate the peer support and social context of the learning environment for its ability to generate a satisfying social experience while facilitating and giving depth to her understanding of mathematics. Throughout the year, the staff of the Pathfinder Lab struggled to keep the environment sufficiently open to subject discourse amongst the students while minimizing the "socializing noise". The paradox was, if a quiet environment was maintained to enable students' concentration on their mathematics, their equally important need to discourse to fully construct mathematical concepts was prevented, and would thus impede students' progress. Indeed, the improved understanding available from the diversity of perspectives presented in small group discourse (Newman, Griffin , & Cole, 1989) is to what Allison attributed her improved understanding.

She attributed her success in her other subjects to the "luck" of her class enrollments, indicating the significant role the teachers had played in holding her interest so she wouldn't "tune out after ten minutes"; something she claimed she had done in her previous mathematics classes. Clearly, mathematics class attendance per se does not necessarily have learning as a consequence. As teacher-student interaction was largely individual and student initiated in the Pathfinder Lab, Allison may have perceived this interaction as a visible and negative indication to her peers of her mathematical inability and dependence, two attributes that would conflict with her ego defensive and task orientation coping style (Karabenick and Knapp, 1988; Lehtinen et al., 1995).

In addressing her failure to be sufficiently motivated and/or capable of completing her coursepath within the year, I would be remiss in not considering the content presentation within the coursepath. The system's introduction of new topics via text assignments and/or pre-tests may, for many students, not provide a sufficiently dynamic or motivating presentation of new material. Although coursepath assignments were

predominantly print oriented, I had programmed into the Introductory Mathematics 11 coursepath, a number of additional CAI tutorial assignments from other mathematics support software so that students could choose an alternative medium for their learning. As time and resource funds permit, the provision of various video support program choices are now being offered to students to provide some needed variety to the content presentation. Although Allison never specifically raised the subject of content presentation, I question to what degree Allison's failure to complete her coursepath was consequent to what she may have perceived as a monotonous subject presentation, largely from the same textbook. This aspect of mathematics class monotony may be inherent to the mathematics classroom paradigm that depends heavily on one textbook for course learning material. Other coursepaths offered more assignments from various texts, but other than using the texts during class, students generally would not borrow the alternate texts for overnight assignment completion.

Although Allison had initially been very clear that she intended to complete the Introductory Mathematics 11 coursepath in order to take Mathematics 11 at summer school, by mid-April, she was faced with the dilemma that she would likely need to attend summer school for Introductory Mathematics 11 credit. Her attendance had been inconsistent and she had only completed approximately one-third of her coursepath. She alluded to needing the assignment deadlines given in other classes to motivate herself:

> What interfered with me working at my own pace was other priorities; there were other assignments in other subjects that needed to be done so I often would put off doing my mathematics. I suppose that if I were required to maintain a certain level of progress each week, I probably would come in after school to keep up my pace. (Allison, January)

Students were not *required* to maintain a *minimum pace* of progress through their coursepath because the lab staff had agreed that the Pathfinder program was to be self-paced in order to allow students to fully construct mathematical meaning before being required to address new learning and applications. Allison clearly appreciated the time to

explore, discuss and fully understand the mathematical concepts she was learning. But as Allison later pointed out, the "Catch 22" is that the *student is responsible* for how she chooses to use that time. Taking her time to fully understand her mathematics obligated Allison to attend summer school if she was to be able to enroll in Mathematics11 in September. The time element for course credit was thus not removed by offering self-paced learning; it was only made somewhat more flexible on a day to day basis. In as much as Allison recognized and valued her improved attitude and understandings in mathematics consequent to her Pathfinder Lab learning experience, this experience may also influence her future mathematics learning (Hart, 1989). That she stated she took full responsibility for her slow progress is also noteworthy as an indication of a growing awareness and empowerment of her self-regulated learning behaviors:

> I don't blame Pathfinder for me not finishing; I understand what I'm doing now. I consider myself personally responsible for not completing my coursepath. It's as if when you *can* put something aside you'd put it off 'til later because of imminent demands in other classes and extra-curricular stuff.

By the end of June, Allison had discovered much about herself and her learning style in the Pathfinder Lab environment. In her earlier description of a typical day for herself in the Pathfinder Lab, Allison's commitment to finish Introductory Mathematics 11 and take Mathematics 11 in summer school had been hedged with a "probably", and she had "hope(d) to, if all goes well". Failure to take a desired goal from the *probably-hopefully* stage into a visibly committed, personally empowered action plan of successful events was a learning attribute that many of our students exposed. Attributing their failure to luck, distraction, disorganization or other events and priorities was a *safer* excuse than recognizing a personal lack of commitment. This is not to suggest that the personal issues many of these students faced would not confound the most capable, motivated and organized of adults. However, this element of the students' affective thinking skills and self-regulated learning behaviors may be the significant hurdle that distinguished those

students who were successful in completing their course in this environment from those who were not. Despite my efforts to maximize what Ryan, Connell and Deci (1985) consider the most important factors for intrinsic motivation, the experience of participation and choice, they were not sufficient to motivate Allison's completion of her coursepath. Ryan et al. further affirm the difficulty in producing attention, performance and achievement in those areas that are not spontaneously engaging to students. It is my perception that the hard and often well hidden facts for educators to address are that other, more personally pressing issues, keep students affectively and cognitively engaged. The significance of *other more personally pressing issues* will surface as a common theme among the low achieving, "at-risk" students at Mountview. Rather than trying to impose or *teach* an antidote to this learning crippler, my experiences in the Pathfinder Lab suggest that the students' experiences inherent in this type of learning environment may encourage the development of more responsible and effective self-regulated learning behaviors when offered with a teacher's supportive yet subtle individual mediation of the student's metacognitive and affective learning through their cognitive learning. The multiple forms of self-regulation, metacognition and metamotivation (Boekaerts, 1995) require a holistic, mediated and experiential approach for their development.

Allison chose the external discipline of the pacing inherent to a regular Mathematics 11 class for the following year. She acquired Introductory Mathematics 11 credit through summer school to change her In Progress final mark to a Pass. Her perceptions indicate that her mathematics anxiety was reduced and her self concept as a mathematics learner evidenced improvement. Her work habits indicated that she continued to struggle to develop the persistence necessary to achieve mathematically (Hadfield, Martin, & Wooden, 1992). The absence of the extrinsic motivation of a teacher-paced classroom, as in her other classes, influenced her ongoing motivation in the Pathfinder Lab. Although her previous teacher-paced mathematics classes were not described

positively, her lack of understanding in her previous mathematics classes may stem from many possible causes including the classroom learning environment, her personal predisposition against mathematics, and the quality of teaching. Allison had struggled between the responsibilities, benefits and shortcomings of an unfamiliar autonomy in the Pathfinder Lab, and her acquired comfort zone of the extrinsic motivation based traditional school culture; a culture where she perceived she could compliantly rely on a teacher authority assuming the greater responsibility for her learning, piquing her interest, telling her what to do, when, and how to do it.

Steve

Steve, a Grade 11 student, played football well on our school team. He had been in my Mathematics 10A class the previous year and left the school mid-year after much absenteeism and late attendance in classes. Watching one of his games one Saturday, I enjoyed the opportunity to meet his parents who told me he was having a much better year this year, "less depression and much better work habits; seems to finally know where he's going". In discussing his first term PING, Steve explained how his Pathfinder Lab experiences and his extra curricular activities empowered a positive self-concept; when football season ended, having more time on his hands appeared to undermine his motivation. Steve's experience exposes the very great value of, and necessity for, diverse and extensive extra-curricular activities within the secondary school community.

Steve's voice:

October:

> It's interesting how now I'm more self-positive in my learning, I do stuff by myself, I figure it out by myself. I feel good about myself. That usually never happened before this year. Before I used to get depressed and all that kind of stuff.

January:

I think it's all because of football. Once football's over, I don't know, I just don't feel like doing anything. I get real bored fast. I have nothing to do after school anymore, 'til next week when rugby starts. When rugby season ends, it's not that very long, I hope I'm not going to slack off. I think I'll be coaching a team or something. You see, if I'm involved in sports, it's easier for me to be involved in my studies because I have the pressure all the time. Like now I have so much time to do everything I say to myself, "I'll do it in an hour, I'll do it in an hour," and by then I'm tired and I want to go to bed.

Learning in here is different because you get to go at your own pace and you can teach yourself more than being taught and being told like, "you have to do it this way". And you don't get homework every night, so it's like you can catch up whenever you have to. You're not as divorced[5], everybody's not on the same pace as you. You work at your own pace; that's mostly what the difference is 'cause in the other classes you always had to do the same as everybody else, at the same time. I like this better, 'cause I guess sometimes I feel like working and sometimes I don't. When I feel like working I'll get a lot done but when I don't I just get a little bit done. I don't have to fake, or really catch up; like if I'm behind in something I don't have to rush to get it done so I don't learn anything. Everything I do, I take my time so I can learn it better and like get it a bit soaked in and so on. My study habits have changed. Now I study by myself at home, usually I just did it with music and all kinds of stuff went on, watching TV and football games and anything. But now I just do it myself, I just figure out things by myself, bring home the notes and go over the notes and everything. And for all my subjects, too.

I know I used to have a lot of absenteeism but I've gone to this class more than I used to go to mathematics. 'Cause like you can show up to class and you just take out your books and get your stuff ready and everything, and then you just start working at your pace. It's not like the teacher says, "You have questions 1 to 5 to be done in 10 minutes" or whatever. You can have it done in a couple of periods. I like that better. You can teach yourself a lot more than a teacher standing up there giving a lecture and everything. Taking notes and everything, it's just in one ear and out the other. When you teach yourself, it makes what you learn a lot more permanent in your mind; you can just remember it. Soon as you see a question you'll know how to do it . Like if you learn it yourself, and you put all that work into it, you don't want it to go to waste, right? That's how I see it.

When I need to get help from you, like when I'm trying to do something new, don't tell me how to do it. Just show me some examples 'cause I like to figure it out myself. When I actually figure it out by myself I feel better about myself. In the book I just see how the first question is done and if I don't know how to do it, I'll look at the answer and see how the first one was done. I'll just like figure out ways of how I

[5] Steve did not elaborate on what he meant by the word "divorced". From his demeanor in our conversations, in classes this year and last, I believe he means that he had felt alienated and in competition with other students in his previous Mathematics classes.

could have had the answer like that. And then I'll just do the next one and if I get it right I'll stick with that way or if I don't get it right, I'll ask for help. So if I'm not sure how to do something, I don't want you to show me how to do it. Give me some questions that would help me to, like, discover how to do it, like step by step stuff. I do better that way, I know.

I usually ask for help when I need it on something new. Sometimes all the teachers are busy; then I just probably wait. That's one of the problems, like there's not enough help in there. You should have another teacher in there or something. Mr. Jones is teaching Communications, Ms Peel is doing Skills, the monitor Betty helps a lot. We need more peer tutors like Betty. I usually ask for help if I need it. Some kids don't, but I usually do. I guess they might think they're even dumber if they're like in a transitional course and they have to ask for more help, 'cause like everybody in the school calls Pathfinder Mathematics 'Retard Math'.

I've learned to correct my mathematics. If I've made mistakes on a test, I go back now and correct them because then I learn how to do it properly. I didn't do that before in other mathematics classes. If it was wrong I just left it. I don't know why, I just didn't bother. But doing my work in class here pays off. I don't have time to do it at home. Now I ask for help instead of trying myself and then giving up. I used to give up, then I'd go write the test and I'd fail. Felt awful, it got me down. Then I'd just say, "I'll ask for help next time" but I usually wouldn't. It's that "Retard Math" thing. I guess in some ways the kids are afraid to ask for help.

Sometimes it's pretty noisy in here, especially Ava at our table. You know, people take advantage of the course; they think it's like, well it's just a free block. You can do the chapter test at the end right before the report cards go out and you don't have to worry about anything. Well, that was all we *had* to have done, just that one unit to get a mark for the first term. Now it would be like a couple of units, right? Hopefully, I'll be there, yea.

It's more laid back and relaxed in here. I don't know if the tables are the best furniture in here because you can't fit in too many. Desks wouldn't be any better. People will try to talk anyways. We sort of help one another too when we're tackling new topics. It's not just an opportunity to talk. No, I like it because, like Stewart and Ava ask me a lot of questions about this stuff, right? Like if you put it total to them, it 'd just go in one ear and right out the other because you'd use all the technical terms. 'Cause like teenagers have their own language and stuff, we just tell it to each other. It's weird, I don't know how to explain it. Like if they don't understand something, and I know how to do it, I'll just like show them how to do it and then they'll say, "Well why don't you just do this ?" and I just say, "Because it has to go with the other one, something like that." It just interrupts me a little bit but I don't mind. It actually helps me to understand too. I suppose most of the noise is social noise but you can't really change that, unless you tell everybody, "if you talk, you get a detention," or something like that. But then kids just won't show up to class.

May:

> I would do better in here if I stayed focused, so I'm not talking like about what I did the night before and stuff. What slowed me down? Trouble is sometimes I put it off if I don't feel like doing it. I don't have any pressure to do it. I do homework about once a week; well, most weeks. I guess if I was told that I had to come in after school if I didn't finish say 50 order numbers per week, I probably would.

Analysis:

Steve expressed a preference for self-paced learning and noticed significant differences between his current mathematics learning and his previous mathematics learning. He found the learning environment more flexible in coping with his ups and downs. His desire to "figure it out by myself" and the satisfaction and understanding he ascribed to learning in this way evidenced growth in the personal responsibility factors of intrinsic motivation:

> These include such factors as obtaining accomplishments through one's own efforts, delaying gratification for valued rewards, a gradual loss of self-consciousness or reduction in fear of failure, and a growing sense of personal control or awareness of one's ability to influence events. (Corno & Rohrkemper, 1985, p.58)

That Steve *independently* constructed meaning from his mathematics learning experiences enabled him to enhance both his cognitive and affective thinking: his mathematical understanding and skills, his self-concept, his sense of self-efficacy and personal agency (Zimmerman, 1995). Enhancing his beliefs about himself as a mathematics learner allowed him to make himself cognitively available to learn mathematics. Steve was even empowered to explain to me how he wanted to be taught in order to effectively construct meaning for himself in his mathematics learning:

> When I need to get help from you, like when I'm trying to do something new, don't tell me how to do it. Just show me some examples 'cause I like to figure it out myself. When I actually figure it out by myself I feel better about myself. (Steve, January)

Steve made some positive changes in his learning habits consequent to his learning experiences in the Pathfinder Lab, changes that evidenced an increased intrinsic motivation to learn. He claimed that he had acquired new study habits that were influencing his other courses. He expressed a knowledge of productive learning behaviors and an awareness of what had been detrimental to his learning. However, as Steve took positive steps to practice effective SRL (self-regulated learning) behaviors (initiating new learning, generating help seeking behavior, correcting and analyzing errors), he was constrained by the school's social culture that attached the "Retard Math" stigma to the Pathfinder Lab because of its current clientele (i.e. predominantly modified mathematics course students). Steve did not frequently seek instruction or help from teachers despite his comments to the contrary. My observations of my classes revealed Steve was not unique in his reluctance to ask for help. Likely due to the "Retard Math thing", several students, would not initiate help seeking behavior. This behavior concurs with the findings of Graham and Barker (1990), that help seeking behavior implies low ability to one's peers. As Steve said:

> I usually ask for help if I need it. Some kids don't, but I usually do. I guess they might think they're even dumber if they're like in a transitional course and they have to ask for more help, 'cause like everybody in the school calls Pathfinder Mathematics 'Retard Math'. (Steve, January)

When a teacher or peer tutor was otherwise occupied at the time of a student's need, a pivotal moment passed where the student's positive learning initiative was thwarted and a negative mathematics self concept would be reinforced. With the noise level in the room, it was not difficult for Steve, and other students, to then distract themselves with social conversations.

Steve illuminated the necessity for, and the difficulties inherent to, offering an alternative learning environment within a traditional school culture. Steve remarked, as Allison had, on the futility of trying to control the significant noise level, seeing value in the mathematics discourse amongst his tablemates (Newman et al., 1989). He also

described the futility of creating authority issues in trying to control the noise: "I suppose most of the noise is social noise but you can't really change that, unless you tell everybody; "if you talk, you get a detention," or something like that. But then kids just won't show up to class" (Steve, January). Despite the fact that Steve could view the entire year's course requirements in his coursepath every time he entered a test score, and that he, and his classmates, were encouraged to set timeline goals for completion within the year, he and others seemed to see enrollment in the Pathfinder Lab as simply an opportunity to take a break from the demands and controls of the typical classroom. Steve had avoided an imminent Incomplete on his first report by completing the Unit One test by the end of first term. Finishing the first three units of the coursepath's ten would have been a logical first term goal, but Steve had perceived the avoidance of an Incomplete as a deadline goal rather than an indication of an absence of data from which to generate a mark, or as a signpost to change his study habits.

Steve raised my awareness of an emerging paradox. Offer a curriculum with learning autonomy, self-pacing and the classroom freedom to interact to learn, and the traditional school culture conditioned students may take advantage of any opportunities to 'slack off' and socialize. Control the classroom noise so students can concentrate to maintain progress in their learning, and students resent the control and won't learn because they won't attend. Steve was speaking for himself, not only his classmates, when he said, "But then kids just won't show up to class." Steve was one of the students identified by his counselor as "at-risk" due to absenteeism. Over the year, Steve missed 26 classes. But by his own account, "I know I used to have a lot of absenteeism but I've gone to this class more than I used to go to mathematics" (Steve, January). In the Pathfinder Lab, his absenteeism slowed his progress through his coursepath, but it did not mean that he completely missed tests, or content, or that he was "left behind the class", as his absenteeism had the previous year in Mathematics 10A. In Pathfinder Mathematics,

whatever work or content he was avoiding by being absent from class was always waiting for him when he returned. The consequences of absenteeism in Pathfinder Mathematics were thus somewhat different for Steve.

In his May interview Steve was relatively noncommittal on the amount of homework he was doing but had said it would "probably" be of help to him if I were to obligate him to come in after school if he didn't pass a certain number of order numbers on his coursepath each week. He believed that he needed the pressure of deadlines, that visible teacher control of his learning pace, in order to motivate himself. The Pathfinder Lab's computer-managed mathematics instruction evidently did not provide Steve with this pacing demand or sufficient motivation to maintain an appropriate pace of learning progress.

Steve did not finish his Introductory Mathematics 11 coursepath by June; he received an In Progress and attempted to complete it in the fall. He didn't complete the course by the end of first term, which is the British Columbia Ministry of Education designated time limit for an IP. Steve received credit for Mathematics 11A for his work to date. Rather than starting Introductory Mathematics 11 over again in a regular class, with a pace, attendance, and work commitment he hasn't yet mustered, he is continuing on his coursepath to complete Introductory Mathematics 11. I appreciate that the Pathfinder Lab provided me with the flexibility to not give Steve a failing grade.

Penny

Penny was only seventeen, held a job, attended school, and lived on her own with a roommate. She had a sister who lived in a nearby suburb and parents who lived in central British Columbia. She was a Grade 12 student and enrolled in Introductory Mathematics 11 in the Pathfinder Lab for her mathematics graduation credit. From the beginning of the year, Penny was aware of problems challenging her learning. Although she was always

pleasant when speaking with me, she described mood swings, depressed periods she labeled "snowfalls", and difficulties motivating herself to work. Penny's October comments reflect a brief period of optimism she acquired after she had recently been to a motivational speaker's presentation with her sister. She made very little progress through the year in the Introductory Mathematics 11 coursepath. She very seldom would seek or accept any instruction. As she hadn't taken any mathematics courses in the previous year, it became evident as the year progressed that her mathematics skills were weak; Introductory Mathematics 11 was not the appropriate course for her. At the beginning of third term, I transferred her to an easier coursepath in order to enable her to acquire a Mathematics 11A credit by June. Another Grade 12 student, Garry, was transferred to the Mathematics 11A coursepath shortly afterwards due to similar slow progress and poor motivation. Where Garry seemed to suddenly find his motivation and was even in the Lab a few times a week at lunch or after school to speed his progress through his path, Penny still completed little work, made minimal progress and was late or absent from several classes. Garry received an A in June for excellent achievement in Mathematics 11A; Penny received an In Progress.

Penny's performance at school may have been significantly influenced by the other issues in her life. I understood that Penny didn't live with her parents in central British Columbia because her father was "sick". In third term Penny's mother was diagnosed and required medical treatment in Vancouver for cancer. Penny also lost her job that term. In June, she planned to leave school and take the remaining courses she needed to graduate at night school in order to hold a full-time job. As her future plans did not demand a mathematics course prerequisite I gave her a Standing Granted in Mathematics 11A the following September. Penny had very conflicting views on Pathfinder Mathematics; she provided negative case analysis and helped me to understand shortcomings in this learning environment for students such as her.

Penny's voice:

October:

There's many positive things about my learning. I make sure when I do assignments I complete them in full. I always keep organized and write down what must be completed. When I do assignments I always do the best I can and if I ever have any questions I always ask. When doing assignments I have the ability to fully understand. Therefore, I'm more focused and more interested than before. Now I realize the power and value of knowledge. I think this is interesting because last year my outlook and mentality about learning was practically the opposite. I congratulate myself on how far I've come. But sometimes I wake up late and I arrive to school late. This bothers me because it's a bad habit. It's rude and shows unprofessionalism. Sometimes I get in a lazy, procrastinating mood. This bothers me because it reduces my potential. I sometimes go through high/low periods where I always do my work, which is great, but then I go through a period where I don't do my work. This bothers me because I should always be consistent with my work and on the ball. My goal is to wake up early so my body gets used to it. I will do this by waking at the same time everyday, even on weekends, at 6:00 a. m.; I'll put my alarm on really loud and across the room so I have to get up. When I get in a lazy mood I will look at a list on my wall that tells me why I should be consistent with my homework and why I should do it at all! And then I'll write down something to really motivate me. I want to have Chapter 1 completed by the end of first term.

January:

In a regular mathematics class when you have the teacher to tell you what to do, it's a lot easier. If you're away, you can get it from somebody else and you keep on moving along. I like Pathfinder, it's something different. It's good discipline for self-motivation, to like progress and do your work. It just depends on your motivation I guess. If you don't have very much enthusiasm for mathematics then you're going to be left behind; but if you're having problems there's a lot of people there to help you. It's also encouraging as well because you know that you're independent; this is your path, you get to go at your own pace and that just gives you your responsibility for that. In a regular class though, you don't get behind because you just keep on moving along in the chapters. You don't go at your own pace, you just go along with everybody else in the class. But Pathfinder is also good because a lot of people have problems in mathematics. They may get behind a lot but this way they can go at their own pace. I remember that sometimes in a regular mathematics classroom it would be too much for me, because everybody would be ahead. I wouldn't understand but the teacher would have to keep moving on. Then I'd just not do very well. I'd try to get help but after awhile, and I've noticed it with other people as well, once you feel that you're really behind, it feels impossible to catch up with the stuff you missed plus the stuff that they're working on. It's

different in Pathfinder. You can go at your own pace. And if you have any problems with anything, then right there on the spot can ask somebody, rather than ignoring it. Sometimes in a regular mathematics class, the teachers don't have time to help everybody individually There's no problem asking for help in Pathfinder Mathematics; there's a lot of people that like walk around and just ask if you need help.

Pacing myself, that's where the pushing myself comes in. I was really "gung ho" at first but I slowed up. I guess it was just before Christmas holidays and sometimes you just don't feel like doing your work. Then you start noticing that you're behind and you start panicking and then it's like, "Oh my god, I have to catch up so much." Then it's like, "I can do this whole Pathfinder before June? I don't think so." That's the difference between Pathfinder Mathematics and regular classes where you always keep moving along with the rest of the class. But Pathfinder allows you to go at your own pace and ask questions but that's where you have to really push yourself. It's independent. I like that, because you can get a lot of help and just having that independence, you want to move along; unless you're just a little bit behind. Now that it's already January and I still have so far to go, it feels impossible. I already wrote down long term goals but I need to do short term goals too. If I write them for a short term then I'll know what I have to do within a week. I think that would probably work, because I don't really notice how far behind I am until I really look through the whole Pathfinder coursepath; it's a lot easier not to look at it if I know I'm behind. I guess I just ignore it because it just freaks me out when I look how far behind I am. But if I know and become aware of it, then I don't have to be afraid to look down at where I have to be.

A way to deal with this falling behind might be to check our order numbers at the end of each week. That would give you the chance to see who's really not doing anything. Then at the end of the year nobody could make excuses saying, "I didn't realize how far behind I was." So at the end of a week, if they haven't made any progress, they should probably stay in afterwards and get some stuff done. I don't know why I'm saying this because maybe I'd probably end up staying. I think the option of staying in after school helps a lot but many people don't really know that. They probably think, only a few people come in, instead of that it's really, really open. Or they may feel that most of your attention's on them and they'd really have to do a lot of work or something. That's what comes into your mind about staying after school. Because, you know, sometimes in the classroom a teacher might say, "you have to stay in after school," and it's really intense. That's how I see other people could feel.

So for the people who are falling behind in their path, you could tell them once a week they have to come in after school and do their work. That would get them going more. At first I could see how they'd go, "Ohhhh, misery," but they wouldn't resent it when they looked at their report card at the end of the year. That's probably why people are behind, because they're not getting pushed enough. You'd think they wouldn't want to be pushed but they're so used to that. You get used to being pushed in mathematics classes. They're not used to this way. You just have to be the type of person that wants to do it for yourself, and can keep on constantly being

consistent with it. You have to learn, but there's certain periods when you do and you don't. And if you're behind in your other subjects and have a lot of work to do, you can kind of put off Pathfinder Mathematics.

Sometimes it's noisy, and because everybody else is talking I can't really concentrate so I just talk too. I get bored easily. I guess the talk at our table is usually about mathematics. But I've heard a lot of people throughout the class saying things like, "I don't understand this," about something on a pre or post test, and they'll ask the person beside them. And they don't understand either. It's because it's not being taught to them and it's so easy to not pick up the book and just look through it. I think once a week everybody should be evaluated with questions like, "How do you feel about this work? What do you find difficult? Is there something that you don't understand?" Because maybe they don't want to come in after school but if they start getting evaluated then maybe they'll start asking for help more often, but maybe they're afraid to ask too. I know sometimes when you offer help or go to explain something the kids will say "It's OK, I'm working," when they really aren't. It's because with the way things are here, it's so much easier to just *act* like you're working because you don't *have* to do a certain thing. I know you have to do the work technically to pass the course, but you don't *have* to do it *at that moment.* We're not thinking ahead of time. We're just thinking about right now, what we feel like doing, right now.

Actually I think if there was more quiet then people would really work, there's no other choice then but to do your work. Unless you're doodling or something, but then somebody, a teacher or peer tutor, would notice when they're walking around. I don't think you should be splitting friends up at the tables though. I find that the people at my table are really helpful with each other if they have a problem. In Pathfinder you may be ahead of somebody and therefore it feels good to help somebody else. Or if you're behind, and somebody did something, then you can ask them to help. And if they're your friend they can explain it to you in their language, the way they talk and stuff like that. That's more comfortable.

April:

OK, I've been working on the mathematics, though I still see that I have a long way to go and it seems quite impossible. I hate using that word because nothing is impossible. At the beginning of the year, I just looked at the path and thought, "I have so much time to do this". So, slowly, I worked on it. And I was working on it, but I guess, everybody, in my opinion, has times when they're going through their ups and their downs with working. And I felt like that before Christmas, therefore over the Christmas holidays I didn't do much of my mathematics. Now coming back into it, I see how much I have to do and it seems like, wow! I know that it's a student's responsibility to do it, but I can also see how if it was differently organized, how a lot of the students could have been further along the path then they are. If the teacher had broke the path into sections and said, "You should be at this point by this certain time." Then if anyone wasn't there on the due date, they'd just have to start on the new thing, as they would in a regular mathematics class. Because if you stay too long on one thing, then your brain kind of shuts down; you just don't want

to do more. And then you just get more and more behind. If you have a due date, then have a mark on that, and then move everyone along to the next thing, when it comes to the final year end, we'd have a basic idea of everything, rather than some people just knowing one section, and not knowing the rest. I know I can work really hard and do a lot of my path, but by the end of the year, realistically, it won't all be done. I'll just know half of it and the other half I won't know. I suppose it's not realistic to think that I could go on and do the next section without knowing the material, but that's where my own self discipline comes in. We need a bit of guidance and pushing, but not total self responsibility because I don't think the majority of high school students can do that. They can't self-discipline, not unless they're not real.

I know help's available from the teachers and peer tutors, but if you ask for help you have to wait a long time before you actually get help. I always seem to be the last one; it takes so long. I know I don't really hang around and wait. I guess I don't come up to ask for it very often either. It's not that I don't know how to do the material, ~~it's~~ just that I'm stressing out that I have to do so much before the end of the year. And now that so many of the class calculators were stolen and we're not able to borrow calculators any more, it's a bit more difficult. I know we're supposed to bring our own calculators; maybe kids just don't want to, or they forget. Actually, I know a lot of kids don't have one. They're expensive, those scientific calculators. I've failed, where I am at this point, now it's so close to the end of the year. It's like I learnt what I learnt, but now I'm just going to fail it anyways. I think that maybe there should be some exceptions for students, whether they're going to go on to a higher mathematics or if this is just going to be the end of it.

I think that offering us Pathfinder Mathematics and your thoughts about the whole are *really, really* good. Like your whole idea here; don't be discouraged on your idea or think that you're failing or anything like that, 'cause that's not true. You see self-paced is really good, it's really educational, it's good for self discipline; but if there were no deadlines in this world then nobody would ever get anything done. Nobody would do any work, because time wouldn't exist really; it just wouldn't matter. Everybody has deadlines in life, whether you're seventeen or forty-two or thirty one. I think people need more extrinsic motivation in Pathfinder Mathematics, meaning people telling them what to do. Teenagers like to call their own shots to a certain point. Just a balance in between what teachers are doing and what you're doing here right now, that would be fine. Because maybe the regular class teachers give too much extrinsic motivation and therefore it doesn't create much intrinsic. Yea, you have to have a balance. To help kids develop that intrinsic motivation you need acknowledgment and basically what you guys are doing here. Right. There's a lot of extrinsic motivation here too, because there's tutors helping around, you're always there to help and basically you acknowledge people when they're doing really good, which is good. But we need that extrinsic motivation of deadlines too. Like, "We've broken the course up into this amount to finish by first term" Yea, that'll get them to do it, and also get them to do it because they also *want* to. You see, with regular class teachers, they almost give too much extrinsic motivation; that makes

students feel that they *have to*. It's that they *have to*, therefore they're not intrinsically motivated to do it.

I guess I got snowed under around Christmas. It could be a mixture of stuff; it just depends on the person. Well, it's that intrinsic stuff. People need to see more of the value in school. I think, that at least once a year, there should be people to teach this kind of idea, this concept, *self*-paced. Or even you, you talking to help people understand about that *snowfall*, so people don't think that it's *just them*; but it's probably better, if somebody else were to come in because it's somebody different to look at. So people don't think that it's *just them*, "oh it's *me*!" When they think that it's just them, their confidence goes lower, and therefore they don't feel like doing anything . But if somebody comes in and says "Hey, this is how it is," and then people will go, "Oh, then, I'm not the only one who feels this way," and then they'll just get back up again rather than taking a long time by doing it themselves, *thinking*. Like the motivational seminar I went to with my sister. It helped a lot. But the feeling doesn't last very long. With a seminar, you go to it and you're like "wow!" so refreshed, and then after a little while you get back into the same old thing. It can help people get out right away, and get back into it. And especially if they learn it at school, they'll keep it; they'll keep it in their heads forever.

June 20, 1996

(Penny came in today to return her books and told me she plans to return next year to finish her mathematics. We chatted for a short while, and she signed my annual.)

"Ms Warner, It was a pleasure knowing you (*all crossed out*) It is a pleasure knowing you. I just made the decision to come back and finish mathematics. You are the sweetest teacher I've ever had. I find it so inspiring! Thanks for being a role-model, teacher and friend. Good luck to you in the future. May all your goals and dreams come true! Have a GREAT, RELAXING, REJUVENATING SUMMER! Penny."

Analysis:

What mathematics Penny learned in the Pathfinder Lab was obviously minimal. She lacked the support of living with her family and was responsible for her own welfare. I believe that her comments suggest that the conversations we shared, because of her enrollment in the Pathfinder Lab and involvement in this study, did contribute to her learning and well-being. The "snowfalls" she spoke of are not unlike those of Steve, Cassy, Billy, or any other adolescent who feels depressed and alienated. A learning environment that positively empowered students through these periods could make

significant differences in the outcome of their secondary school experience. The Pathfinder Lab provided an environment that facilitated some mediation of Penny's snowfalls.

Previously, as a regular mathematics class teacher, I did not have the same opportunities for individual contact with students that teaching in the Pathfinder Lab afforded me. It was my perception that Pathfinder Lab staff enjoyed a somewhat different image from regular classroom teachers. I felt much more satisfaction in my teaching in my Pathfinder Lab role; I felt more like a *learning facilitator* rather than a *teaching authority*. Penny made a very good case for establishing a quieter environment and more visibly accountable short-term-progress parameters. Whether attempting to enforce "deadlines" would be productive or counter-productive to students' motivation and overall affect in this learning environment is debatable. Many of our clientele struggled with authority issues in their lives. I believe we all appreciated it when they left them at the door.

Penny's perceptions of her motivation consequent to the learning environment were conflicting. She liked the independence of self-paced learning for the self-discipline and intrinsic motivation she felt it encouraged, but claimed that she and her peers needed more deadlines and extrinsic motivation to demand performance from themselves. She suggested that teachers in her previous regular mathematics classes used too much extrinsic motivation and concluded that this undermined the development of intrinsic motivation:

> You see, with regular class teachers, they almost give too much extrinsic motivation; that makes students feel that they *have to*. It's that they *have to*, therefore they're not intrinsically motivated to do it.(Penny, April)

She provided the impact of this on students in her statement:

> You get used to being pushed in mathematics classes. They're not used to this way. (Penny, January)

This suggests that some students become conditioned to *doing mathematics* because of an extrinsic motivation upon which they become dependent, rather than *learning*

mathematics because of an intrinsic motivation to understand. Penny vacillated between wanting a traditional schooling paradigm, that dictated the *what by when* for *how many marks*, and valuing the opportunity for self-paced learning. Ironically, because students had to meet deadlines in other classes, it meant that their mathematics progress would become even slower. As Allison and Steve similarly attested, Penny too, would "kind of put off mathematics". They, and others, could on occasion be found studying for a test or finishing up homework for another course. When this happened I chose to look at it as optimizing their learning time to support their achievement in other subjects. I would ask them to compensate for the time lost in class by doing more home study that night or coming in to work on their mathematics at lunch or after school. I didn't pin them down to a time and date as it usually resulted in a long litany of excuses; I felt my time was better spent working with the students who were motivated and waiting for my help at the moment.

Penny exemplified an affect that I witnessed in many of my low achieving secondary school students. Maehr (1984) describes this affect as an outcome of the socio-cultural factors in schooling: "One's culture appears to affect achievement not only by defining what success and failure means but also by delineating how success and failure should be pursued" (p.139). Because they had become accustomed to schooling experiences based on extrinsic motivation, an affect and culture was generated that dictated that to be perceived as worthy by one's peers, the only initiative one shows in school is to do the bare minimum amount of work, to do the work only if it's unavoidable and only if it's for marks. The perspective was that school is for marks and socializing; what one learns is of dubious value. Interest and learning satisfaction went by the wayside long ago for this group of students.

> It's because with the way things are here, it's so much easier to just *act* like you're working because you don't *have* to do a certain thing. I know you have to do the work technically to pass the course, but you don't *have* to do it *at that moment*.

> We're not thinking ahead of time. We're just thinking about right now, what we feel like doing, right now. (Penny, January)

Describing her previous regular mathematics class experiences, she recalled the discomfort of the class moving on to new material when she hadn't understood what had been taught. The panic she described when she recognized that she was unlikely to complete her coursepath indicated that her learning experience in Pathfinder Mathematics was ultimately not able to offer her a mathematics course that was any less discouraging. As Penny confronted the likelihood of not finishing her coursepath, she attributed the cause to noise, a lack of deadlines, a lack of available help, and feeling overwhelmed and stressed. Although she valued the Pathfinder Lab environment for its philosophy and supportive environment with friends and staff, being self-paced was a responsibility that she felt adolescents could not handle.

> We need a bit of guidance and pushing, but not total self responsibility because I don't think the majority of high school students can do that. They can't self-discipline, not unless they're not real. (Penny, April)

For many, she was right. Voluntary help seeking and remaining after school could be threatening to self-esteem. She also highlighted the negative social consequences of being perceived by peers to need help (Graham & Barker, 1990; Karabenick & Knapp, 1988). Covington's (1984) self-defeating failure-avoiding behaviors are evident in Penny's attributions, avoidance and self-criticism.

Corno and Rohrkemper (1985) describe developmentally able students as having the processes that define self-regulated learning (SRL) within their cognitive repertoires. Penny's comments indicated she could define such processes but she exemplified those students who then fail to coordinate and control the use of those SRL processes necessary for intrinsic motivation because of related motivational difficulties (Corno & Rohrkemper, 1985).

Penny described *both* ease and difficulty in getting help when she required it.

> There's no problem asking for help in Pathfinder Mathematics; there's a lot of people that like walk around and just ask if you need help. (Penny, January)
> I know help's available from the teachers and peer tutors, but if you ask for help you have to wait a long time before you actually get help. I always seem to be the last one; it takes so long. (Penny, April)

She appreciated the opportunity to have "comfortable" mathematics explanations from friends but said she would have progressed more if the room were quieter. She stated the content was "not being taught" but she avoided the learning environment's means and opportunities to be taught. Penny's comments often referred to how other "other people" in the class behaved or would have behaved in different circumstances. I believe she used them as a vehicle for her own perceptions to remove the focus of our conversation from herself.

Penny avoided mathematics. Her behaviors suggest she suffered from mathematics anxiety and couldn't risk the self-esteem exposure of asking questions in both Pathfinder Mathematics and her previous mathematics classes. When I initiated contact with Penny or other slow-progressing students, I would often get an "I'm working" response from these students who, by evidence of their slow progress, clearly needed instruction. Visible student discomfort and a few overheard snickers, suggested these students didn't want me helping them in front of their friends. It made them too vulnerable, perhaps exposing their lack of understanding and ability, or an unacceptable compliance with teacher authority. Among these students suffering poor ability self-concepts and/or authority issues, it seemed socially safer to chat with friends and count themselves among the "cool, capable but bored underachievers". Having to wait for a teacher's assistance near the teacher's desk was similarly highly visible behavior. To the teacher it indicated a responsible learning initiative but to one of these students, it was advertising one's incompetence (Graham & Barker, 1990; Karabenick & Knapp, 1988). My own awareness of keeping students waiting, as well as Penny's input, have helped me to appreciate that the Pathfinder Lab environment needed to provide a less visible and more immediate personal

response to students in need of instruction in order to keep them involved and learning. Providing an alternative learning environment may be the first step, changing the learning culture is the next.

Cassy

Cassy was a very attractive and vulnerable fifteen year old in Grade 9. Cassy's counselor identified her as "at-risk" due to poor attendance and a drug and alcohol abuse problem she shared with her father. In her comments, she speaks of how her "problems" and "somebody else's problems" impaired her progress; these were her family and substance abuse problems for which she was then receiving counseling. Cassy lived only with her father; her mother had not wanted her to live with her. Despite my best advocacy efforts, Cassy received an administrative transfer to an alternate school in April because she had been caught smoking marijuana across the street from the school and was doing poorly in most of her classes.

Cassy's voice:

January:

> Learning in the Pathfinder Lab is different from learning mathematics before because it's easier. It helps you motivate yourself, really. You don't always have someone on your back telling you what to do all the time. That's important because I feel that I'm independent. It helps me a lot, like when I'm on my own and stuff. I can motivate myself. This helps a lot because you learn off yourself. Doing the work and stuff, there's not really a lot of teachers to go around. So it's really like you learn off of what *you* learn, like you learn yourself, basically. If I need help I go to a teacher. I don't get discouraged. I try to do it by myself. If I can't do it, if I can't get one of my friends to help me, then I will ask. When I have my friends help me, it works, because they explain it more easily. Like they may say, "what don't you understand." You just tell them what you don't understand. They tell you how to do it, like they do it like you guys, like a teacher. I understand why. It's not like she does the question and she gives me the answer. I don't think that helps. And it's not that she's telling me to follow rules. No, I feel that I'm understanding. Sometimes it's like rules but then sometimes it's really not clear, so you ask a teacher.

I know I've been absent quite a bit, but it hasn't got anything to do with what happens in here. Here helps, because when I'm doing my work in here I'm not doing the same thing as everyone else. I'm working at my own pace, so it's like you work at your *own* pace. And my problems outside of school, everything, it all has to do with working at my own pace too. In a way it's like drug and alcohol counseling. It's like my counseling that I'm going through outside high school. You do that at your own pace. And you have to motivate yourself to go, and actually go there. Like actually do it. It's the same thing in this classroom. Yea, you've got to like tell yourself, "You don't have to if you don't want to." It's just like giving yourself a little push or whatever. Because I have to. Because I *want* to; I want to make something of myself. When I tell myself, "I should" or "I have to", it doesn't feel like I'm telling myself what I want to do. Not really, it's like someone else, like a conscious or something. But if I tell myself I *want* to do it; just choosing that different word can make a difference, it feels different. So when I walk in here and I pick up my binder, I usually think, "check your homework", because I do homework. Sometimes I'll take a pretest, or post test and study off them. When I want to correct a test, I usually go to you and we'll look over it.

I've been feeling kind of discouraged about where I am in my path. Like only 9% through; but it's because of my problems. Well, somebody else's problems but they ask for help. It's a big problem, kind of. But it's better for me in here because it used to be like, I'd usually talk lots and I never used to do my work in the classroom. Now it's totally changed. Like I do my work now, stuff like that. I don't know what it is that's changed about me but that's the way I am now. I like the change. Like everything matters now. I failed Mathematics 8 three times. If I was dealing with these problems in a regular classroom, I wouldn't go. I wouldn't go to class. No, 'cause I would be *totally* behind. In a regular mathematics class everyone works at the same thing, and if you were to think about it, I would be totally behind. I would have like absolutely no chance. Yea, like I still have a chance here. I can do it *myself*. Yea, I can do like whatever. I can learn how to work on my own and take that knowledge into other classes. The things that have been interesting are that I never knew I could motivate myself, and I didn't think I could do mathematics but, I guess I can.

Analysis:

Cassy's learning experience in Pathfinder Mathematics had changed her perception of her ability to learn mathematics. Cassy described her typical behavior when she'd come into the Pathfinder Lab. Given the opportunity, through my questions, to blame her slow progress on the learning environment, she claimed that, despite her slow progress and very significant problems, she felt empowered to learn; that the learning environment was facilitating her understanding, her improving work habits and her continued attendance at

school. Cassy appreciated the Pathfinder Lab. She found it easier to learn and she enjoyed her learning autonomy. She did seek help when she required it, which afforded me opportunities to respond to her questions in an appreciably more facilitative and personal manner than I could have, were I at the front of the class with twenty-nine other students listening. Cassy, too, affirmed the positive understanding she constructed through discussing her queries with her tablemates. When understanding did not result she would seek help from a teacher. Cassy was empowered by the learning environment to demonstrate developing self-regulated learning behaviors and constructively used available social resources in her mathematics learning (Corno & Rohrkemper, 1985).

When I questioned Cassy about her frequent absenteeism, she responded by drawing an analogy between the drug counseling she was involved in and learning at her own pace. She expressed an awareness of how her changed self-talk and autonomy influenced her motivation, how previously *having to work* had now become *wanting to learn.* She was demonstrating Ryan et al.'s (1985) third form of self regulation, *identification*, whereby formerly extrinsic regulation is experienced as one's own value or goal, and therefore the relevant action in pursuit of such goals is experienced as self-determined. Cassy was one of many adolescents seeking self-determination, who need learning environments that enable their continued learning, despite the issues in their lives that confound the typical expectations of the public secondary school. It is my belief that adding failure to their list of problems is not in theirs or society's best interests.

Billy

Billy was a Grade 12 student and star player on the school's football team. He was repeating Mathematics 10A. Billy was enrolled in the Pathfinder Lab for both Mathematics10A and Communications 11. I taught him Communications 11; his Mathematics 10A enrollment was with a colleague. Billy's learning experience in the

Pathfinder Lab learning environment was influenced by other issues in his life. The flexibility, responsiveness and scope of the qualitative research model suggest it is appropriate to include information acquired from his Communications 11 class to more fully understand Billy's perceptions. I appreciate the opportunity to share an expanded view of Billy's perspectives with the reader as it vividly attests to the impact of affect on all learning, for the student, as well as the teacher. My perceptions of Billy lead me to believe that he was a shy, sensitive, acquiescent, wise, considerate and cooperative student dealing with depression and a poor-ability self-concept.

Billy's voice:

January:

It's different in Pathfinder because for one thing, I find that I can work well with music. So I just use a Walkman for example. In a regular mathematics class I wouldn't be able to use it because the teacher would be explaining the work, she'd be telling us what to do. While here, you know, I've just got to think to myself. I think I actually don't listen to the music, but when I have it playing I can talk to myself better. Just do this and do that, right, and I don't think it's disturbing the others. It helps me tune in better. It also depends what kind of music it is; it can't be crazy, or hard core. It has to be like soft music or something. So it can't be like any music but it does help me tune in.

Learning here is different. It is because I'm actually getting better marks. I did a Unit 1 test and I got 95%. I never, as far as I remember, did do that in mathematics. I wish I could go faster though. I really don't want to rush it, because the more pretests I fail the longer it takes. So I just try to take my time with the test. I just put the scores in, and try to get as many done as I can, without doing more work. If I get something wrong, I go correct it and I do the work I have to do to move on. I can see what I've done wrong and I can correct it, instead of just not correcting it, moving on and doing the assignments. And I might get them wrong too if I don't correct because I wouldn't know what I did wrong before.

The chairs are more comfortable in here. I think that makes a difference because you don't have to keep moving around. Actually that sort of helps with the movement in the room.

You don't have teachers on your back all the time, like, "do your work", or whatever. Sometimes you do, but you know that if you don't do your work, you sort of slow yourself down. And you want to get through it, so I guess it shows how bad you want to get through it. I can push myself to do work, and I was out there socializing but now I notice I can't really socialize and work at the same time, right?

Mostly I'm doing my work, and sometimes I'll need help. Then that's when I'll go talk to somebody. But not really to socialize.

Right now I'm on finding cubic area and volume. I've done it before but I sort of had to freshen up on it again. I had difficulty with the metric system. I had some trouble with that. I tried to find a teacher that was free, that I could talk to, who wasn't busy. When I couldn't I'd ask another person to help me out in class. Sometimes it's difficult when all the teachers are busy and the student tutor is busy. Most of the time it's easy. If everybody's busy I just wait.

In previous years, like if there was a teacher assigning the work, and it was for marks, we'd have to do it, right? Although we think it's not necessary but we'd have to do it. If I understand it, like the metric system I'm doing now, I just need to freshen my memory again and then I know what I am doing. So here it's a bit more flexible. I'm able to decide how much work I need to do. I usually decide the right amount. I don't do too much but I also know that I shouldn't do too little because I know I need more work than that. But if it's something that I really understand, then I'll do about half. I feel good this way. I prefer it this way. If it's not necessary, you know, then I can just use my time in doing some new work rather that studying the same work over and over. I have more control about what I'm doing. I think it's an advantage here because the way that I figured it, the teachers are there, right, and they help you out, but it's more you're teaching yourself. So I know what I'm learning and I know where I need to put my effort, where my weak spots are. Sometimes in my previous mathematics classes I would have to spend my time doing the work when I already understood it. I could have been doing something else. That bothered me. It's not bad, right, but it did bother me because I knew what I was doing; I just didn't want to do it again. Sometimes I guess I'd just tune out, I'd still listen, but I guess I can sort of wander off in my mind. I'd still be listening but my concentration would be a lot lower because I'd think I don't need to listen to this, I already know it. But if I heard something different, then maybe I'd sort of tune in a little. In here though, when I hit something new, I just try to remember and I ask for help, if I get stuck.

The environment here is also different because there are a lot more people in it, so there's more movement in there. There's too much movement and talking at the same time. There's a lot of distractions. I'm not sure teachers can actually do anything about it, because it's mostly students individually. You could tell them to be quiet, but that creates noise too, and I don't think they'd listen anyways. I think maybe it's because of the tables; there's too many people at the tables. But I think desks would take up too much space. Sometimes we talk about our work. I discuss it with Jaz. When I don't understand something, I'll ask him, if the teachers and tutors are busy. If he doesn't understand something, sometimes he'll ask me. We're friends. We'll say things that we understand and maybe teachers won't understand very well, but we know what we mean. It sort of helps our understanding, because we sort of talk our way.

Some kids have called the Pathfinder Lab the Retard Room but I think it's just a neat word, it's not really an attitude. They're not saying, "Oh you're a retard" or "dumb", or whatever. It's just a name we got for it. Maybe we'd be walking down

the hall and we'd ask, "What class do you have now?" Maybe sometimes you'd say to yourself, "I got Retard Math". I don't think it's Retard Math, but it's just a name. The first time I ever heard it, somebody said, "Well I got to go to Retard Math", "Well what? Where's that?" "There, up in the lab." "Oh I got Retard Math too." And we'd just start laughing. It's not really like, someone's going to go tease you; it's just a name. I wouldn't rather be in a regular mathematics classroom. I couldn't work as fast and I think my marks are actually better. I hope I'm going to finish the coursepath by the end of the year. I'm trying to work faster now, but at a faster level I can handle without messing my work up. I'll be successful as long as you're there when I ask for help.

If someone was deciding whether to enroll in regular mathematics or Pathfinder Mathematics I'd tell them, "As long as you can be responsible to do your work, I think you can do all right in Pathfinder Mathematics, because it's faster and you can actually find out a lot about yourself. You can push yourself to do more work than you thought you actually could. You actually feel better because when you've passed a test you think, 'Well, um, you know I had a little help here and there but I really had no one telling me what to do, right? So you sort of can see what you accomplished. It's actually a good feeling, too. It not just, 'I'm going to pass' or whatever, it's a good feeling."

May:

I'm correcting my assignments. I try to see what I do wrong and try to correct the answers and when I think I've got it right, I keep on going and when it comes to the test, it comes out wrong again. I've tried to get help from the teacher, but maybe I'm just impatient, he's usually helping someone out. I'll just stand there. Like I won't interrupt, I'll just stand there. I get tired of standing there, you can see he'll be awhile so I just go back, sit down and try to do it on my own.

Next year I'm going to work during the day time and I'll go the Night School. I wanted to come back here, but after I spoke with the counselor I sort of agreed that I shouldn't. I'm not really doing as well as I should be. I'd just be wasting my time. But I don't really think so. I just need to put my head into it. I've got attendance problems in some classes; some I go to. You know what I think it is, I need the teacher to keep pushing me. Not just pushing me, like "go do your work", " do this, do that", right? Just like telling me, you know, "you should show up for this", I don't know, it's just, I've got other stuff going on...

Sally's Journal:

Being nineteen years of age, Billy could only return to school in the fall if he was showing more visible progress in the academic elements of his schooling. When the issue of attendance was raised with Billy (absent:17, late:13), and he tried to describe the type of support he needed from his teachers, it became evident the tape recorder was making Billy uncomfortable so I put it away.

I had returned to the room during my preparation period to find Billy out in the hall. I asked him why he was in the hall and he described how one of the teachers in

the lab refused to allow him to sit where he usually does, off by himself by the window. She had sent him out of class when he argued with her about moving to a table. I suggested that now then would be a good time to interview him again since he was missing class anyways. I had also wanted to talk to him about an evaluation he wrote in our Communications 11 class on a picture in the school art show. I asked him about the quest "for peace in his life" that he described in his art work evaluation. He told me he had been "pretty down lately, but not suicidal or anything". When I asked what was troubling him he told me that he had not wanted to move here from Texas a few years ago; but his mother had wanted dual citizenship so they had to remain in Canada awhile longer. He told me that his five best friends in Texas were now dead and that he was troubled because he knew he'd be dead too if he had remained there. They had died in various incidents involving drunk driving, shootings and car highjacking. In addition to this he was having trouble at home. He said he had great respect for his mom but that I wouldn't understand how it is for a woman in an Hispanic family. He explained that despite the fact that his mom had given him permission to go to the after prom party over two weeks ago, his stepfather had not given him permission. In consequence to this his stepfather had said he should leave the home if he would not continue to keep a 10:30 p.m. curfew.

In the two years I've known Billy, he's always worn his coat to class. It gives an aura of transience and coldness to his learning experience. He has an expressionless face that breaks into a broad smile and twinkling eyes with well creased corners when he says hello. Although absenteeism continues to be an issue, I do see him when he attends Communications 11. His writing shows considerable insight. Below are some listening responses that Billy wrote in November in Communications 11 class when the class did oral presentations on the meaning of various quotes and cartoons.

On: "Education is not received, it is achieved."

"You only get to be as educated as you want to be, not as educated as other people want you to be. You get what you work for. Educate - to bring forth from within. You have to put yourself into it, you have to receive it; if it's there and you don't take it, it does no good. I think that the quote was a good one because it had to do with the previous one, about setting goals to achieve and to move on with your life. Education is put out by the teachers and it's up to us to receive it. I think that a higher level of maturity by the listeners and the presenters should be put into action. I think that the idea of the presentation was good and it can help us all, if we want it to."

On: "Mistakes are to learn from."

"If you made a mistake, best into it - right away. Try to fix it yourself, if you can't, ask for help. Then try to see where your thinking took you the wrong way. The positive thing about this quote is that it encourages you to make yourself a better person. You should learn from your mistakes, but you can also learn from the mistakes of others."

On a cartoon of a frog trying to strangle a pelican while it is caught in the pelican's beak:

"Don't just say "don't give up", do something to stop yourself from giving up. You can't always succeed and if you don't you try to find a way to do it. The cartoon is positive because it shows us that we can be at a dead end and you have to, can, find a way out. It's interesting how sometimes we say that there is no way out and you want to give up, but you find a way out and you decide not to quit. This can help your determination a lot."

On a 'Team Work' poster:

" It's good to work in a group or play in a team. You can help each other as you move along. It is so important to have people in your corner....I can relate to this because of my involvement in the senior football team. We all have to work together or nothing works and we lose. The linemen have to block for the backs, the receiver catch the ball, the defense do their job, etc. We have to almost be like a family and mutual respect is necessary."

On a 'Try until you hit the bull's eye (succeed)' cartoon:

"Don't let up at anything, don't give up. If you try and don't succeed, try and try again. Build up your confidence....I like the presentation because it talks and tells us about something I hear a lot of, "don't ever give up." If you can't succeed at something you should try again and as you keep trying your confidence builds up and you can accomplish what you want."

Analysis:

Billy's writing in November would lead one to believe that he was a well motivated and clear thinking student. He was one of many students who faced issues both in and out of school that significantly challenged their learning. Being passive was a means to cope with the challenges his personal and school environment presented. The Pathfinder Lab was Billy's preferred mathematics learning environment but it was not able to provide Billy with a sufficiently accessible means to the instruction he needed. He did not complete his coursepath but was given a Standing Granted for Mathematics 10A.

Being able to concentrate was an issue for Billy. His concentration and self-regulated learning behaviors were enhanced by being able to listen to music while he worked, by being in a comfortable chair, by being able to determine what and how much

of each assignment he needed to complete, and by being able to construct meaning with his friend or a teacher when he needed help. To reduce the distraction of the noisy table groupings he sat off by himself by the window. Sadly, he was so accustomed to failure that he accepted repeated failure on a section of his coursepath when he should have been instructed and advanced by the teacher. Waiting for instructional assistance from the teacher was frustrating for him and a visible statement of his incompetence to his peers.

Billy, like many other students, often avoided doing assignments, choosing to do the next test on the same objectives rather than the assignments indicated by the test scores. Billy's behaviors suggested that his perception of success in the course was to be passing tests *without* doing assignments. Thinking that he would save time by passing at the pre-test level, he would spend inordinate amounts of time trying to master content on a pre-test rather than use the pre-test as a tool to receive appropriate assignments. When students received less than 80% on a test they could advance to a new test again on the same objectives by inputting that they had completed the appropriate intervening assignments when in fact they hadn't. Billy also did this when he felt he understood the objectives of the test. He enjoyed the autonomy of determining what assignments he needed to do. His analysis of what he did and did not need to do indicated an improving affect, increasing cognitive involvement and the development of more self-regulated learning behaviors compared to his previous mathematics learning:

> I know what I'm learning and I know where I need to put my effort, where my weak spots are. Sometimes in my previous mathematics classes I would have to spend my time doing the work when I already understood it. I could have been doing something else. That bothered me. (Billy, January)

Billy's new behavior of correcting his errors on the tests was constructive but did not afford him sufficient scope or practice in using new concepts. Not doing assignments meant a student was not exposed to the instructional opportunities in the learning materials. Billy never came in after school to borrow books to do homework; nor did he

work in the lab after school. I believe that would have been too visibly counter to his and his friends' underachievement culture. Judging from the cruel comments I heard many of our hard working slow students receive from other students, I would suggest that there exists an element of school culture that believes failure due to apathy is an acceptable fact of life; to fail after visibly trying says you're a "real loser" to your peers. It was preferable to Billy and others to blur through minimal effort, one's publicly perceived level of intelligence; visible effort too clearly exposed one's level of incompetence.

Although Billy too acknowledged the "Retard Math" label among his peers, he saw no malice in it and his comments indicated he actually preferred the Pathfinder Lab to a regular mathematics class. I believe this was due to the different affect he experienced in the classroom. He perceived the room as unavoidably noisy but he also acknowledged and appreciated the opportunity to comfortably construct mathematical meaning in discussions with his peers. He expressed a pride and ownership in the learning he accomplished, "It's actually a good feeling, too" (Billy, January).

Being able to access the teacher's help when he needed it proved to be an ongoing problem for Billy and other students. Where in his January interview he claimed he would "just wait" for the teacher, by the second interview in May, despite doing more assignments than he previously had, he had reached an impasse in his coursepath that could long before have been quickly and constructively addressed, if only he had accessed the teacher. Billy did not know to ask his teacher for test answer keys after computer scoring his tests in order to review which of his errors were legitimate errors and which may have been typographical or entry errors. Nor did he know or think to ask for a re-mark on a test when he would score as high as 79%. I saw Billy hanging back by the file cabinets to wait for his teacher on a few occasions. Billy was not as assertive as some students in making his needs or presence known. When Billy's teacher was instructing someone he would not interrupt himself to deal with what were often just quick computer

correction entries that could progress students in their coursepath and preclude them from re-writing unnecessary tests. Where I would often deal with more than one student at a time, I know that some students resented the intrusion of other students on their instructional time with the teacher. This was a professional decision each teacher in the Lab had to address daily. Although the computer-managed instructional system afforded individualized instruction to students, the unpredictable nature of the demands on teacher time for this instruction could be frustrating to both students and teachers trying to effectively optimize the use of their time in the Pathfinder Lab.

Dino

Dino was a Grade 12 student enrolled in Introductory Mathematics 11 in the Pathfinder Lab. He had failed Mathematics 11 the previous year. He had an attendance problem; he missed 55 periods and was late for 13. Dino was very social and was often seen chatting with the attractive female students in class. In the early spring Dino realized that in order to graduate he needed to acquire a Grade 11 mathematics course credit. He asked to be double blocked into the Pathfinder Lab and transferred to the coursepath that would give him Mathematics 11A credit. Neither his attendance nor progress improved. In the last two months of school he completed it with a first class average.

Dino's voice:

January:

> Learning mathematics in the Pathfinder Lab is different from learning mathematics in a regular mathematics class. In the regular mathematics class, it was more like, we go in there, he teaches a lesson on the chalkboard, right? Then he gives you the assignment, you do the assignment, you go home, you do your homework. It's really redundant, you know. You do the same thing over, and over, and over again. It's really routine. You learn new things, you get your little quiz. But in the Pathfinder, you get to go at your own pace. If you're really feeling like doing mathematics that day, you do like two or three exercises or tests. If you're in a bad mood, or a bad day, you don't do that much, you may do one example, or

whatever. You take it easy, you just go at your own pace. So it's a lot better like that.

In a regular class when the teacher was explaining something, I was able to follow, to a point. But they don't really explain it very well, you know? Like I was in Mathematics 11 last year and he just went like really fast, and he'd go "OK, and this" and then he'd go to the next thing, and he'd go "OK" (*inflection and manner indicating the explanation is finished*). And when you'd ask questions, he'd say "it's like this" but he wouldn't go into more detail. I couldn't follow it.

So far in Pathfinder Mathematics, it's mostly review because they're all topics that I've already done before. I look at a book and I go, like, "Oh, I remember this." I just have to read it a little bit, skim through it to remember how to do it. I haven't finished Unit 2 yet. I haven't found problems, but it's just like, I look at some of them, I remember how to do this, but then I remember last year. It bothered me. Like I was looking at it and I didn't know what to do and the teacher went too fast. I just go like "OK, forget it!" I just gave up. This way, like for a day I don't really do it, a second day, I'll say, "OK, I'll try." I can usually figure it out on my own, with time. When I get an answer and then I ask one of the monitors, like Vicky, and they get a different answer; then I'll feel that I'm right so I'll want to see how the teacher does it to see if they do it differently. That's about the only reason I ask for review with a teacher. I know that if I were in a regular Introductory Mathematics 11 class I'd be further through the course by now, but I wouldn't understand. Like even though I've done less in the Pathfinder than I'd do in a regular class, I understand, I understand it all. What I've done now I totally understand. If you were to give me a test right now I'd probably get 90%. But in a regular class you must skim through it. In regular they're going too fast, everybody's doing their own work, you get discouraged. You know? Like they're all going really fast, they understand what's going on, you don't. When I get discouraged I give up. I give up right away, I just think like, "Ah, I won't do it."

I like not being hassled to do my work. It's very easy to get help in the class; there's no pressure. I like going at my own pace; I have no excuses for my actions. If I fail, I can't blame the teacher, for anything that she did, right? You guys aren't doing anything wrong. You give us what we have to do at the beginning of the year; you have to do this to pass, that's it. And we take it upon ourselves to do the work, to understand the work; there's help if we need it. But in a regular class they just go like "zip"! They don't like going backwards, you know? Like I feel like I can blame them more, for going too fast, for not helping me out enough.

So how come I don't come to class? Well, I've been sick a lot, I've been sick a whole lot lately. I had bronchitis for awhile. I skipped a few times.

I find the usage of computers for every individual student interesting. Also the trust teachers have in you to do your own work. I find the computers interesting because they're something I haven't done before. Entering my work on the computer makes it give you different assignments, depending on if you did good, fair or not so good on it. But it's not a pressure; you guys are, "we're here if you need us." You're not saying, "OK, you *have* to have this done by tomorrow! You *have* to have that done by tomorrow! We're checking it!" When it's no pressure like this, it's more

of a relaxed environment. And it gets to the point where if you see one of your friends doing work, you want to do your work. You see them doing work and you say, " OK I 'll do the work too." Then we'll help each other out. But in a regular mathematics classroom, it's so strict. You can't even look at them, you can't talk to them, you can't ask them for help. Better than asking teachers is asking other people how they do it. The student beside you will help you more.

What's negative in here is that with no pressure I tend to slack off or just start talking sometimes. You could put us in assigned groups. If we had, not a daily thing, but by the end of the week, we had to have one chapter test or pretest taken, we'd have something to look forward to for the week. Otherwise you can go like two months without even completing one exercise or unit test. I don't think goal sheets each week would help because they're not for marks. If it's not for marks, it's like big deal, we're just writing our comments, it wouldn't help us at all. You could offer like two marks or something, to get if you reach your goals. Then if you told them right out, most students would notice, if they can get two attitude points every week or so. That'd really add up. Obviously it's not going to be 10% for your letter grade every time you hand this in, right? Just say like, "if you complete your goal every week, it'll add up to 10%," and 10% could bring you up an entire letter grade. I mean, everybody will understand that. With the goal sheet, you've got to make sure they know what it is though, or else they'll just throw it in their book and won't do it for two weeks. Like when you gave me the PING. I didn't even look at it for the first two weeks. I thought it was just like the first, that we'd hand it in with our binders. So I didn't really take much interest in it. It's in my binder.

I find the noise very distracting from those people beside us. They always walk up and they talk in class and I don't appreciate that. Our table does a more constructive kind of talking. You could take the students that are obviously not working, those ones distracting the class, and put them in pairs or threes and assign a student monitor to help them. Don't be as lenient towards people who want to talk, give more punishments. You give them the option: if they talk constructively then they can be free to learn at their own pace, but if they don't, then they have to have this assignment done by next week. Then they'll get tired of it and they'll just do their assignments. I've noticed in class that some of the more disruptive students might argue but I'd be fine with that policy. Most of the students, would be OK with that; but half the students would be like, "Oh ya, I don' t talk to her any more, she's mad." We need to have that cooperative mathematics talk, but to a limit. When they get disruptive, if you've given them two warnings, then they're out of here.

I don't get the purpose of the drawers. I don't use mine to store my binder; I always take my binder home. I was going to say, you should have made the binders out of more, even if you're not going to count them. I know our binders are actually worth 30% of our total mark, but people don't realize that. They think like, 10 marks per unit, no big deal. You'd get a better response if you make it out of more marks.

Also not having the textbook any time I want is a con. Sometimes if I have nothing to do and I know that I'm behind in my mathematics, I haven't got a book at home to work on; it's an inconvenience. If I could borrow a book to take home, that

I didn't have to bring back to class every morning, that would speed up my progress. I can get all my assignments; I just enter that I did well on an assignment and get the next assignment. But it's a hassle to have to borrow a textbook after school.

April:

Basically I missed some classes because this class gives you your own responsibility to do the work when you want to. So when I don't feel like doing any work that day, I won't bother coming to class. Then I take it for granted, and I go, "I can miss one more day, I can miss one more day, I can miss one more day, and it gets carried away. I can't really think of anything that you could do to encourage me to attend. Honestly, it would have to be like a sense of punishment. Like saying, " If you miss one more class without a note, then we can't pass you." Then I'll be forced, then I'll think, I have to come to class. Even giving me the two blocks didn't really help. It's not a matter of you giving me one, two, or like five extra blocks. It's a matter of me *wanting* to do it. Like if I don't want to do it, then it wouldn't matter if I came the whole day; I wouldn't do it. I skip this class the most of all my classes. I'm mostly having troubles with this class and social studies. For first term, you shouldn't have said, "I just need one unit test to mark you on,". You should have said, " If you don't get three done, I give you an Incomplete for the term." Instead, I did one and I did nothing and I got a B. So if you just said "You have to get 3 unit tests done," then maybe I wouldn't have gotten a B but I would have got the work done. If at the end of first term I got a fail because I hadn't completed the first three chapters, it would only be my fault. Basically, we know you're leaving us alone to do it; and if we need any help, we come to you. If I don't get to it, it's not as if it's too much work, so it's my fault. I think it needs to be a little more strict in here, but that's it. Not as lenient, like when you know someone hasn't done anything one week, stuff like that. Toughen up.

June:

What I do on a typical day in here? Honestly? OK, really honestly. I'd come in, get my assignments, and then I'd probably, if I didn't feel like doing anything, I wouldn't do anything. I'd just talk to whoever was in the class, whoever I sat around. Then if I'd have to do an assignment I'd just enter that I'd done it into the computer, because I found all the assignments easy and then I'd just get the test and do the test. I didn't do many assignments. I've seen most of it before because I took Mathematics 11 last year. I'd just have to quickly refresh my memory.

I like working at my own pace; you don't feel pressured and you don't feel like you have to commit to deadlines and stuff. There should be some deadlines but you know you shouldn't have to feel pressured, like, "I have to get this done, I have to get this done!" You can do it at your own pace; you can do a lot one day and not much the next day. I like the flexibility but I think you should have to complete at least a certain number of order numbers each week. I think if you don't, then you should penalize their grade, not like a whole letter grade but a certain percentage, or something like that. I don't think people would come in after school for help though. You could tell people to come but I don't think they'd come. You can just say that

it's open and if they come, they come. I know you had that policy this year, but that's their own fault if they don't come.

If I had a new topic to learn, I didn't find that the monitors really helped that much, because they had their own mathematics, right? So they were like, really trying to remember; they didn't really explain it well. If I didn't understand something I'd just come to you. I didn't do many corrections. I just figured I'd done enough of an assignment when it started becoming repetitive. I'd do the first three and then on the next one, I'd just quickly do the answer, and then I'd go get the test.

I didn't much like the environment in here because there were all different grades; there were three Grade 12's, a bunch of Grade 11's, some 9's and Grade 8's. So I didn't really like that because the younger kids were really being idiots most of the time.

I'd say that I finished my coursepath because *I decided* I had to get it done. *I decided personally* to get it done. You helped out a lot. Learning this way put the pressure on me; not like the pressure on me from *you* guys, but like I put lots of pressure on myself, you know? Everybody's signing annuals right now, doing this grad class stuff, and I come here and do the mathematics; so you know, you decide to do what you have to do.

(Dino signed my annual)
"Thank you for all your help in math this year. I couldn't have done it without your patience and understanding. Dino."

Analysis:

Dino appreciated the learning autonomy the Lab provided and the lack of "pressure" from the teachers. He had a low tolerance for repetition evidenced in his description of his "redundant" regular mathematics class experiences and the fact that he would only do a few questions, if any, from his assignments in the Pathfinder Lab and few corrections. The affect he brought to doing mathematics in the Lab evidenced a significant negative impact from his previous mathematics learning experiences.

I haven't found problems, but it's just like, I look at some of them, I remember how to do this, but then I remember last year. It bothered me. Like I was looking at it and I didn't know what to do and the teacher went too fast. I'd just go like "OK, forget it!" I just gave up. This way, like for a day I don't really do it, a second day, I'll say, "OK, I'll try." I can usually figure it out on my own, with time. (Dino, January)

Dino also evidenced the lack of persistence that impedes the progress of many "at-risk" students (Hadfield, Marten & Wooden, 1992). "When I get discouraged I give up. I give up right away, I just think like, "Ah, I won't do it" (Dino, January). But the "relaxed environment" encouraged him to cooperate, to construct mathematical meaning and to self-regulate his learning when he would see his friends work:

> OK, I'll do the work too. Then we'll help each other out. ... Better than asking teachers is asking other people how they do it. The student beside you will help you more." (Dino, January).

Like Allison, whose table he sat at, he attributed a much improved understanding of the mathematics he studied to the interactions afforded by the Pathfinder Lab learning environment. As Dino had a relatively forthright and confident nature, he never indicated any difficulty in getting help from teachers *if* he sought it. By June however, he faced a deadline and imminent failure. He became somewhat impatient with the credibility of the peer tutor's assistance and was then motivated to seek teacher assistance as frequently as necessary to speed the completion of his coursepath.

His interviews throughout the year indicated that despite difficulties in motivating himself to attend, he preferred having the responsibility for his learning and did not attribute failure to his teachers as he previously would:

> I like not being hassled to do my work. It's very easy to get help in the class; there's no pressure. I like going at my own pace; I have no excuses for my actions. If I fail, I can't blame the teacher, for anything that she did, right? You guys aren't doing anything wrong. You give us what we have to do at the beginning of the year; you have to do this to pass, that's it. And we take it upon ourselves to do the work, to understand the work; there's help if we need it. But in a regular class they just go like "zip"! They don't like going backwards, you know? Like I feel like I can blame them more, for going too fast, for not helping me out enough.(Dino, January)

Dino's absenteeism may be attributable to an insufficient accountability demanded by the learning environment but it may also be attributed to a well established negative affect for learning mathematics and tolerating teachers' instruction and demands. When he

did attend Pathfinder Mathematics, he at least knew he didn't need to cope with "too fast" or "redundant" teacher instruction and demands. He felt sufficiently comfortable to seek help from teachers when he needed it and sufficiently independent to ultimately take responsibility for his learning and complete his coursepath.

Strong evidence exists in Dino's comments confirming that what staff perceived they were presenting to students, particularly about progress and marks, and what students perceived they heard, in many instances, were not the same. Report marks were based on *achievement-to-date* to counteract an entrenched negative affect many students brought from their previous mathematics learning experiences; an affect created from students receiving poor marks for learning what for them may have been very difficult. When learning-challenged students achieved mastery of content, it was our philosophy to recognize their level of accomplishment, not the time-frame in which it was completed. Students term marks had represented their mathematical competence achievement, not their attendance, not their homework completion, nor their speed or degree of progress through the coursepath. Dino, and a few others who completed their coursepaths, were very happy and satisfied learners when they received their B or better marks at the end of that year. Unfortunately, despite having included additional term reports to parents that indicated the percent of the coursepath completed, satisfactory first and second term marks contributed to students' complacency throughout the year and many found themselves facing summer school or the completion of an In Progress in the fall . Thus, the Pathfinder Lab policy of basing students' marks on their achievement-to-date, *without a time-frame*, was ultimately misleading to students because a final letter grade for a specific mathematics course had to be given by the end of first term the following school year for students with In Progress marks in June.

> For first term, you shouldn't have said, "I just need one unit test to mark you on,". You should have said, " If you don't get three done, I give you an Incomplete for the term." Instead, I did one and I did nothing and I got a B. So if you just said

> "You have to get 3 unit tests done," then maybe I wouldn't have gotten a B but I would have got the work done. If at the end of first term I got a fail because I hadn't completed the first three chapters, it would only be my fault. Basically, we know you're leaving us alone to do it; and if we need any help, we come to you. If I don't get to it, it's not as if it's too much work, so it's my fault.

Dino's perception that I had said, "I just need one unit test to mark you on," was similar to what Steve had taken from my explanation of how marks would be determined. The students took what they *wanted* to hear from the information and were unable to address or ignored the clearly presented expectation that they were responsible for setting and meeting goals organizing their time to complete their coursepath, preferably within the year. To respond to the complacency, and foster communication and goal setting, I gave students "goal sheets" to complete the first and last period of each week. They were encouraged to comment about their learning and communicate any concerns they had to me. I reviewed these each Friday, and as Dino stated, because they weren't "for marks", few students handed them in each week. Again, I was confronted with the fact that although I could provide an alternative learning environment to foster cooperative and self-regulated mathematics learning, to change the extrinsic motivation orientation of the school learning culture was another issue. Were we to have followed Dino's suggestion stipulating the completion of three units by first term, we would have had to give failing marks to many students, contribute to their ongoing negative mathematics affect, and damage whatever improved affect their PING comments indicated the Lab environment had afforded them. Whereas failing marks may stimulate some students to greater self-discipline, commitment and work-output, many of our students were defeated by failure in school. Heaped onto the many personal issues in their lives, failure could be the stepping stone to involvement in ethnic gangs, illegal behavior, abuse of drugs and alcohol, themselves and society in general. Student failure is self-defeating for both students and teachers. What Dino had perceived as leniency, I had perceived as an offer of understanding, tolerance and support.

Nan and Daleen

The following two students, Nan and Daleen, were successful in completing their coursepaths in the Pathfinder Lab. There is only a June interview for each because they were interviewed to provide perceptions of the learning environment from students who were able to successfully self-regulate their learning in the Pathfinder Lab.

Nan was an ESL student who had spent her year previous to Pathfinder Mathematics in an ESL Mathematics class. She had difficulty with spoken and written English but was a motivated, industrious student. When she wrote the final exam for Introductory Mathematics 11 she received a score of 96%.

Nan's voice:

June:

I started Introductory Mathematics 11 in September. Pathfinder Mathematics is very different. I have to go to the computer and get my homework by myself, not from the teacher. In my other class last year, the teacher had to give me the homework and told students what to do. But here I have to do it by myself and I can do whatever I like to pass the course. I can do more work than other students. Some other students, they don't like to do it and they slow down. But if I want to finish the Introductory Mathematics 11, I have to work hard and get more assignments. Last year, in the other class, I had to wait for other students and so I couldn't pass ahead of the other students. I like this way, being taught self-paced, because I can move faster. It's a freedom.

When I start a new topic, I just get an assignment and finish it and have a test, like that. Dividing by a radical was a new topic, like dividing and multiplying, I hadn't done that before. I just learned it. I just looked in the text book, at the example in the book. I figured it out. I learn on my own. It's not hard to learn on my own; it's easy. If I understand all the words, the English, then it's easy for me. I was able to understand the book. I even got 100% on the Chapter Seven test.

There were just some of the new things I couldn't do on my own. Like Chapter Five. I hadn't done problems before and I didn't know anything about it so I asked the teacher. No problem asking for help. Some of the assignments, I didn't know how to do so I'd look in the text book and if I couldn't find out, I'd ask my teacher. I did all of my assignments, all the work that was assigned, I did it. I did my

corrections too. When I would check a test and I didn't know how to correct a mistake, I would ask the teacher to explain it to me and then I'd understand it.

The learning environment was so noisy. Because we can learn on our own, some people don't, won't, work and they just start talking. They interrupt the people working hard. I don't like this. I would like everyone in separate desks. Some people sit together and then start talking and they don't do anything. They weren't talking mathematics, they were talking social things. Sometimes I worked with other people on my mathematics. That was good, then we can share and understand the problem. It helped me to understand. So did working hard. I would review before a test, like one hour in school and then when I went home, two hours at home after school. I did homework I think every day, just except Saturday and Sunday. Every day after school in the Lab and then I'd go home and do it. When it's noisy I just try to concentrate on the book. I have to push others away; I just try and concentrate, to do it without letting anything interrupt. I'm better at that now. They helped me too. Before I didn't usually like to go to school because it was so boring. Now mathematics is my most favorite subject. Before I didn't like mathematics because I knew everything the teacher taught already. But now I know more, then I try to work more. I want to catch up with regular people my age; like they're finished Mathematics 10, 11 already, so I want to. I want to study more. I want to study more mathematics. I think I want to finish Mathematics 12 next year. I am going to go to summer school this summer to do Mathematics 11. Last year I did ESL Mathematics, like Mathematics 8 or 9, I think. I don't know how the school passed me up here into Introductory Mathematics11. I would tell other kids if they were thinking of doing Pathfinder Mathematics, to try to do more homework, review before a test, and get more assignments from the Search the Library menu. Do more assignments I think, even more that the system gives you. Go ahead with your future assignments by choosing Search the Library, don't wait for your teacher to mark your unit test before you start on the next unit's assignments. And one more thing. Something you know already, you don't have to do it. Just do the assignments you don't understand already, because doing assignments you already understand wastes time you could use learning stuff you don't know yet. I liked learning here.

(Nan wrote in my annual)
"Dear Mrs. Warner! First, I wish you all the best in this summer, I hope to see you next year. You are really a person who was so helpful to me, thanks for everything you did, I will miss you. Forget me not! Love, Nan."

Analysis:

Nan preferred her Pathfinder Lab learning experience to her previous mathematics class because she found it less boring and had more autonomy in her learning. She

developed and practiced effective self-regulated learning behaviors. Nan expressed no difficulty in getting teacher assistance when she wanted it and also cited the benefits of working cooperatively with her peers. Although she found the noise of the room distracting, she evidently improved her ability to concentrate and was able to learn at a pace that changed her attitude to mathematics.

> I just try and concentrate, to do it without letting anything interrupt. I'm better at that now. They helped me too. Before I didn't usually like to go to school because it was so boring. Now mathematics is my most favorite subject. Before I didn't like mathematics because I knew everything the teacher taught already. But now I know more, then I try to work more. I want to catch up with regular people my age, like they're finished Mathematics 10, 11 already, so I want to. I want to study more. I want to study more mathematics. I think I want to finish Mathematics 12 next year. I am going to go to summer school this summer to do Mathematics 11.

Nan's learning experience in the Pathfinder Lab resulted in her choosing to take Mathematics 11 in summer school in order to be able to enroll in Mathematics 12 in the fall. She had acquired a confidence level and satisfaction in doing mathematics that empowered her to voluntarily enroll and master Mathematics 11 as a summer course; a course that would ordinarily take most students the school year to complete.

Daleen was a Grade 11 student who had recently moved to Canada. She joined the class in January, started the Introductory Mathematics 11 coursepath, and finished by June. Daleen was a motivated student; she often spent time in the Lab after school or at lunch doing assignments and getting instruction on new topics or corrections. She re-enrolled in the Pathfinder Lab in the fall of 1996 to take Mathematics 11 and continues to make good progress.

Daleen's voice:

June :

> On a typical day in the Pathfinder class I would come to class, get my book and then start to work, do the exercises, or tests I suppose. Working at my own pace is

easier. If I feel like working more one day I like to be able to come in and do it. I can decide what I want to do, like what goals I have. I like to set my own goals. It isn't really hard to motivate myself; it depends on the unit. Like geometry was hard. I didn't do it then for a couple of days. Geometry wasn't new but it's hard, so if it was something new and I didn't know how to do it, I'd go to the teacher and ask him. Sometimes it was all right, sometimes it was confusing. It helped to have the teacher explaining it individually to me because he could spend more time with me. There's more teachers around because you've got three teachers in the classroom. So if one teacher's busy you can ask somebody else. It's no problem to ask. Like if you're in one classroom, like a regular mathematics classroom, there's one teacher and if she's busy, then you're out of luck; but here the teachers are always walking around the classroom so you can keep busy.

Sometimes when I do assignments, I skip the things I really already know. I look at the assignments I'm supposed to do, then I'll read the book, then go read through the examples and see which questions I don't understand, then I'll do it myself. If what I've done is wrong, then I just go up to the teacher and ask him if it's right or wrong. When I was studying for a test or pretest, I'd write notes, brief notes. It helps me to organize my thinking, I'll go over it more. I know if I've done enough of an assignment when I understand it. If I understand the hard questions I move on. I do an easy question, a hard one, another one, and then if I can do all three, then I move on. I choose the hard ones because if I do those then I can keep doing it, and doing it right. Learning mathematics this way is easier, it's more fun. I don't know why, maybe because I can move at my own pace. Sometimes I don't have enough time to do my homework for other classes because of other things that night, so I'd come in here after school and I'd finish it off. I have some flexibility this way. It's less pressure, I think it's better here and I like it better.

My attitude's better. Mathematics is better here because before it was confusing, I didn't like it. It's less confusing because there's more help from the teachers. And coming here during lunchtimes and after school, the room's open more and teachers are available more. The learning environment here is positive. You can ask people next to you about your mathematics, and some people will come up to you and ask you how to do things and that's good. If I say something wrong, they don't criticize you or anything, it's positive. If you don't know how to do a question, you can just say, "I don't know, ask somebody else." I don't mind helping other people. And I don't think it's too noisy in here, I think it helps my mathematics if I help other people. I think I was able to do the whole course in just a half a year because I worked hard; like I spent most of the time doing it, in here. It just seemed like easier to come in. It's not like scary work or anything. It's not scary work, like "read pages and pages of this book and then...." Like some things I knew already so it was like revising what I knew before. My attitude to mathematics is more positive now. But before, mathematics was hard; working in here, it's quite easy. At first working in here was hard; then I got used to it and now I find it easier. It's just better. I'll probably work in here for Mathematics 11.

Analysis:

In Daleen's opinion, the learning environment was "positive" and without "scary work". She described her attitude as "better", and mathematics as "less confusing", "more fun", "easier" and "better". Accessing teacher assistance was "no problem" and she felt the individualization of this assistance afforded her more time to construct understanding in her learning. Clearly, her mathematics anxiety had been reduced and she had effectively constructed mathematical meaning through her interactions with teachers, students and her learning materials. The autonomy she experienced in her learning encouraged her initiative and provided a flexibility that allowed her to interact, experiment, evaluate and develop personal learning strategies that were both satisfying and effective. The initiative she demonstrated in her learning strategies was reinforced through the positive experiences she described. It can be anticipated that these learning strategies will positively influence her future mathematics learning (Johnson & Johnson, 1985). Her *perception* of the learning environment, as Nan's, positively influenced her mathematics affect, achievement and motivation.

CHAPTER FIVE

Conclusions and Implications

These secondary level students' perceptions of their learning of mathematics have provided information about both traditional mathematics learning environments and a computer-managed mathematics learning environment. The respective parameters of each environment generate both positive and negative perceptions among individual students; neither environment can realistically be expected to provide a panacea to the challenge of enabling *mathematics for all* (Damerow & Westbury, 1984). The elements of both the human and physical environments are influenced by many variables. The characteristics of "at-risk" learners are too widespread to apply a remedial template that will predict success for them (Berenson, Carter & Norwood, 1992). These students' perceptions can, however, provide teachers with a greater awareness of attributes of mathematics learning environments that generally appeal to, enable and empower adolescent students to acquire a positive mathematical attitude and achieve mathematically. Certain attributes of learning experiences and learning environments may strongly influence the affect that "at-risk" learners derive from their schooling and apply to their future learning.

Positive attributes of the computer-managed learning environment

Table 5.1 contains a summary of the third term PING anonymous responses that students made to the student comments from previous interviews and PINGs, indicating agreement, undecided, or disagreement (see Appendix B for individual responses). The 43 statements are *students' perceptions*, constructed from the *students' actual language*. The tally of their results offers *qualitative* information in keeping with the member check criteria for naturalistic inquiry (Guba & Lincoln, 1989). It should not to be construed to be

a research questionnaire from which quantitative statistical conclusions are drawn. "Undecided" was not a choice but was included in the tally to show where some students indicated their indecision by choosing both "agree" and "disagree" or by marking the space between the choices. The majority of students at the time they completed this last PING were facing the likelihood that they would *not* finish their coursepath by the end of June. This meant that many were facing an In Progress for a year end mark or possibly, a Fail. An In Progress mark would indicate that the student had not yet finished the curriculum requirements of the coursepath for course credit; this ultimately meant the student had a choice to return to the Pathfinder Lab in the fall to complete the coursepath within the first term, accept a Fail in the course or attend summer school.

Table 5.1 PING3 Summary of Responses

POSITIVE			
1. I like working at my own pace.	52A	1U	22D
2. I *understand* mathematics better learning this way than I did before	40A	1U	34D
3. I'm *usually* able to get help when I need it from a teacher or tutor.	57A		18D
4. I like that we help each other and learn from other students.	54A		21D
5. I have learned more mathematics working at my own pace.	38A		37D
6. I like being able to learn from more than one teacher.	48A	1U	26D
7. Learning this way helps me to focus more on my learning.	37A	2U	36D
8. I try harder working at my own pace.	47A	2U	26D
9. I'm in competition with only *myself* now so I try harder.	47A	1U	27D
10. I'm feeling more confident about learning mathematics.	43A	1U	31D
11. We start on our own; I didn't like the way, in previous mathematics classes, each mathematics class started with a lesson by the teacher.	44A	1U	30D
12. I like that the computer marks my work, not a teacher.	43A		32D
13. Even though it's sometimes hard, I enjoy learning this way.	50A	3U	22D

(continued)

14. When I do corrections, I find the tests are easier.	52A		23D
15. I'm moving faster through my path now because I do corrections.	33A		42D
16. I like the way it's up to myself to learn, I'm independent.	48A	1U	26D
17. I'm proud of my improved scores on my mathematics tests.	54A		21D
18. I like not having teachers bugging you when fail a test.	52A	3U	20D
19. Things I never understood before are sinking in; I get them now.	58A	1U	16D
20. Mathematics is getting easier.	33A	4U	38D
21. My attitude to mathematics has changed; it's better.	45A	1U	29D
22. I don't just give up, I ask for help now when I need it.	65A	3 U	7D
23. I *learn from my mistakes* now, before I didn't.	55A	1U	19D
24. I've learned how to work on my own; I apply this in other classes.	52A	2U	21D
25. I don't feel pressured learning this way.	55A	1U	19D
26. I'm better organized in my learning now.	40A	3U	32D
INTERESTING **It's interesting how...**			
27. I learn from other students.	47A	1U	27D
28. that once I understand something in mathematics, it's easy after that.	61A	2U	12D
29. that no one has to bug you to work, you just do.	61A		14D
30. that we work on computers.	66A		9D
31. that I pay more attention to learn from mistakes now.	50A		25D
32. I'm more aware of how I learn now.	55A		20D
33. even though I get less than 80% on a pre-test, I can pass the post test without doing assignments; I just correct my pre-test and move on	62A	1U	12D
NEGATIVES			
34. Having to borrow books after school to do homework.	45A	2U	28D
35. Nothing is negative.	20A	1U	54D
36. I think I'm moving too slowly through my path	53A		22D
37. Too often I don't do enough assignments to pass my post test.	32A	2U	41D
38. It's too easy for me to get distracted and not work.	41A	3U	31D
39. The room is too noisy.	38A	3U	34D
40. I repeat too many post tests.	35A	2U	38D
41. I socialize (talk) too much.	23A	1U	51D
42. I find it harder to get myself to work in the Pathfinder Mathematics.	33A	2U	40D
43. Working out of more than one textbook.	49A		26D

The computer-managed instructional environment enabled a *gentler* learning environment (Dill & Haberman, 1995) in that students experienced cooperative interactions with one another in their learning and teachers modeled a *less authoritarian* and *more learning facilitating* role in the classroom. Positive perceptions of the students' interactions affirmed that many students experienced a *cooperative* learning environment (statements 4, 22, 27, 29). The self-paced and computer-managed attributes of the learning environment ameliorated the impact of absenteeism and provided a degree of privacy that reduced the competitive aspects (statement 9) and visibility of students' achievement to their peers (statements 12, 18). Jean's second term PING states:

> The new system makes me feel that I can do the material. It gives me many opportunities to learn the material. It gives me privacy, to work without anyone telling me I'm stupid or that I'm not able to do my work. (Jean, PING2)

The degree of student autonomy within the learning environment allowed teachers to positively and personally mediate both instruction and interaction with students. One student remarked, "The interesting thing about this Pathfinder class is that the teachers are more nicer than the teachers in the real classes" (Student #13, PING3). Mountview teachers are very caring, genuine, "nice" people and professional colleagues. Whereas I don't underestimate the "nice" qualities of any of my colleagues, I believe that the learning environment in the Pathfinder Lab predisposed teachers to more opportunities for positive interactions with students. Pathfinder Lab teachers were more able to:

> avoid patterns that are characteristic of violent environments: an authoritarian and directive approach in which the teacher overpowers the student. Thoughtlessly authoritarian responses do not relieve the fear, distrust, verbal threats, and physical pain many children bring to school, conditions that interfere with learning. (Dill & Haberman, 1995, p.70)

The interviewed students each made comments affirming the facilitative role teachers played in the Pathfinder Lab.

This research helped me to appreciate that students with absenteeism problems generally have sundry other problems in their lives. In each of my previous year's mathematics classes, I witnessed a few individual students who would miss a few classes, return for a few, fall further behind, give up on the current topic, struggle hopelessly with future topics and then attend only enough classes to avoid expulsion from the school. At that point, they were no longer learning mathematics; they were developing a negative affect and reinforcing the self-handicapping behaviors aimed at protecting their self-worth (Covington, 1984; Nicholls, 1984). For many, the issue was not their cognitive ability to do mathematics as much as their affective and metacognitive inability to successfully *manage* both the personal experiences their lives delivered them and the various cognitive, metacognitive and affective demands from their other courses and schooling experience. Cassy, Penny and Billy exemplified this issue. As Zimiles (1981) concludes:

> Psychologists encounter so much difficulty in simply identifying and measuring the basic parameters of affect and cognition that it seems impossible for them to explore productively the interrelation between two such largely unknown quantities. And yet it may be that the *interactionistic properties* of these entities are among their basic defining traits and that *a thorough understanding of each cannot be achieved without dealing with their interrelation*[italics added].(p.62)

Mathematics educators need to respect these "interactionistic properties" and approach students' mathematics learning challenges from a flexible and holistic perspective in order to offer *mathematics for all* (Damerow & Westbury, 1984, De Corte, 1995). Indeed, we need to even search beyond the social-contextual variables, such as task features, setting conditions, metacognitive knowledge and skill that affect SRL (self-regulated learning) behaviors. We need means to address students' underlying sense of self-efficacy and personal agency (Zimmerman, 1995).

The computer-managed learning technology offered a degree of flexibility to aspects of the learning experience and environment that may not be as available in the

typical mathematics classroom. The ability to create customized coursepaths meant students could be acquiring the same course credit but completing elements of different coursepaths that addressed their specific learning needs. The flexibility of the system was also evident in enabling course designation changes throughout the year. This year, with a mix of both academic and modified mathematics course students enrolled in the Lab, students such as Adam evidenced the acceleration potential offered by this type of learning environment. After completing Mathematics 10 in four months with 93%, Adam intends to finish Mathematics 11 by year-end. Adam received the top mark in the school on the recent Mathematics 11 cross-grade examination. Other examples of the benefits of the course designation flexibility include, changing Kelly's Mathematics 10 course enrollment mid-year to Introductory Mathematics 11, which enabled her to receive a graduation level mathematics course credit; and when by the end of term two it became evident some other Grade 12 students were unlikely to complete Introductory Mathematics 11, coursepath revisions enabled them to acquire Mathematics 11A credit. This degree of flexibility meant students needn't waste a year by failing a course; they could still receive a mathematics course credit for the year, which for some students made the difference in graduating and not graduating from Grade 12.

The self-paced parameter of the computer-managed learning environment offered students autonomy and flexibility in managing their own learning, and encouraged them to develop effective SRL behaviors (statements 1, 13, 16). To progress through their coursepath it was necessary for them to make decisions about which assignments they would do, how much of an assignment they would do, when and from whom they would seek assistance, whether assignments or another test would be the most appropriate next task, and what they would do for homework. Students may make these same choices in typical mathematics classrooms, but in the Pathfinder Lab these decisions were acknowledged to be the student's responsibility, not the teacher's. Whereas statements 14,

22, 23, 24, 31 and 32 and students' PINGs generally evidenced students' increased awareness of effective SRL behaviors, this awareness did not necessarily ensure sufficient motivation or control of these behaviors to manage their learning effectively (Zimmerman, 1995). Although almost 71% of students felt they were moving too slowly through their coursepath (statement 36), over 82% agreed with statement 33, "It's interesting how even though I get less than 80% on a pre-test, I can pass the post test without doing assignments; I just correct my pre-test and move on." Their concern regarding their slow pace of progress evidently did not empower sufficient motivation to overcome their aversion to doing assignments. Having reviewed many low-achieving students' binders showing only tests and few if any assignments completed, it is evident that I need to create coursepaths for this work-avoiding type of student (statements 37, 42) that specify *obligatory* introductory assignments to be completed before pre-tests. Although this would reduce the autonomy in the learning environment for these particular students, it would enable them to experience more productive learning behaviors while maintaining a self-paced element in their learning.

Absenteeism was an ongoing problem in the Pathfinder Lab, and continues to be. Absenteeism slows a student's pace of coursepath progress. The ramifications of absenteeism in the computer-managed learning environment, however, may be less personally destructive to students' self-esteem and achievement potential, in as much as whenever students do attend class they carry on learning from the point at which they left it. The issue of feeling everyone in the class has left you hopelessly behind after a period of absence is somewhat diminished. Ironically, this fact may also have *contributed* to absenteeism as some students who were prone to "skipping" classes evidently perceived the Pathfinder Lab to be the class they could skip with the least negative consequences.

Each of the interviewed students elaborated on how the *quality* of mathematics learning derived from the self-paced system and interactions with their peers had

significantly improved their mathematical understanding. Two-thirds, or more, of the students agreed with statements 1, 3, 4, 13, 17, 19, 22, 25, 28, and 30 which suggests that this learning environment positively influenced not only their understanding but also their attitude to learning mathematics.

1. I like working at my own pace.	52A	1U	22D
3. I'm *usually* able to get help when I need it from a teacher or tutor.	57A		18D
4. I like that we help each other and learn from other students.	54A		21D
13. Even though it's sometimes hard, I enjoy learning this way.	50A	3U	22D
17. I'm proud of my improved scores on my mathematics tests.	54A		21D
19. Things I never understood before are sinking in; I get them now.	58A	1U	16D
22. I don't just give up, I ask for help now when I need it.	65A	3 U	7D
25. I don't feel pressured learning this way.	55A	1U	19D
It's interesting how...			
28. that once I understand something in mathematics, it's easy after that.	61A	2U	12D
30. that we work on computers.	66A		9D

Of the 40 students that agreed with statement 2, "I understand mathematics better learning this way than I did before," 37 of these students also agreed with statement 19, "Things I never understood before are sinking in; I get them now." At the end of first term, Sara wrote:

> I understand way more than I did last year. It's interesting the way I started to understand things much more quickly because I never did before. Nothing has been negative. (Sara, PING1)

My teaching experiences at Mountview Secondary have led me to believe that the greatest impediment to learning success among "at-risk" students derives from their personal environment and a self-esteem protecting veneer of apathy and belief that they "can't do mathematics". A few appear to have no desire or interest in learning mathematics. Their discouragement is evident in their inability to initiate a constructive means to address the confusion, frustration and failure they have experienced learning

mathematics. Jenna, who had failed in my Mathematics 9 class the previous year, wrote in her first PING:

> What is interesting is how much I concentrate on my work, unlike before. Now I make an effort to finish my assignments. My attitude towards doing my work has changed as well, I don't just leave it or give up. I ask for help if I don't understand. (Jenna, PING1)

Regardless of the type of mathematics learning environment we offer students, a continuing challenge for teachers is to *maintain* a student's positive attitude when it does improve. Despite Jenna's awareness of an improved attitude and interest in her work in mathematics, other interests and issues in Jenna's life disabled her improved attitude over several months and she transferred out of the school the following year. Neither teachers, nor learning environments, can successfully mediate *all* the issues that come to bear on students' learning.

Perhaps the most significant outcome in this study, was that over 86% agreed with statement 22, "I don't just give up, I ask for help now when I need it." To provide a learning environment that offered these "at-risk" students even some experience of the initiative and metacognitive skills that enable both learning satisfaction and mathematics achievement (statements 3, 7, 8, 9, 10, 13, 14, 16, 17, 19, 20, 21, 22, 23, 24, 26, 27, 28, 29, 31, 32) offered me great professional satisfaction. These thinking skills and attitudes are life skills that they can constructively apply in all their future learning (statement 24). That over 26% of the responses were positive to statement 35, "Nothing is negative", suggests this environment offered such a different affect for learning mathematics, that these students' learning satisfaction enabled them to overlook many negative elements that were a part of the learning environment.

Negative perceptions of the computer-managed learning environment

Seventy-two percent indicated they *disagreed* with "Nothing is negative". Indeed, a few students felt "everything" was negative and their goal was to get out of the class (Students #15, #31, #49, #71, PING3). Remarks by these students indicated they wanted a single grade classroom with one teacher providing instruction from one textbook; the more typical mathematics classroom. Negative perceptions in the environment focused on the noise level, multi-age groupings, slow coursepath progress and the availability of instruction and text books.

The noise level in the Pathfinder Lab perhaps was an inevitable outcome of the combination of:

- the large number of students enrolled, forty per block,
- the seating of six students at each table,
- the movement of students to and from computers, the monitor's desk by the Pathfinder Library and the teachers' desk and testing area, and
- the constant necessity for instructional interactions among students and teachers.

Although both students' PINGs and interviews attributed improved mathematical understanding to these peer interactions, the social interactions were too easily masked under the veil of mathematical meaning-constructing interaction with peers; this enabled too many students to waste too much learning time (statements 38, 39, 41). Ria stated in the Negatives section of PING2: "I tend to be late sometimes so I have to work on that. I also waste time during class sometimes and talk too much." Although I appreciate the value of Ria recognizing her behaviors that impaired her progress, my perception of Ria's learning experience would change her "sometimes" to chronically. Angela was another of several students who also expressed an awareness of their inappropriate behaviors in the room: "I should start doing more work instead of horsing around" (Angela, PING2). Out of 53 students who agreed with the negative statement, 36, "I think I'm moving too slowly

through my path", 47 agreed to, or were undecided, about one or more of the following statements:

38. It's too easy for me to get distracted and not work.	41A	3U	31D
39. The room is too noisy.	38A	3U	34D
41. I socialize (talk) too much.	23A	1U	51D

A total of twelve agreed with all three (see Appendix B). This year, a reduced enrollment in the room (33), a lower pupil teacher ratio and fewer students per table have enabled the provision of both quiet study areas and instructional interaction areas. The learning environment now includes tables, individual desks and study carrels. The choice of seating offers areas for both interaction and individual study and enables staff to more effectively monitor the needs of easily distracted students.

Throughout the year a number of students remarked that the multi-age groupings and disruptive students were the negative elements in their learning experience. The complainants, however, were also often seen to be the perpetrators. Being able to attribute negative attributes to others or the learning environment, provided poorly motivated or disruptive students with sufficient means to justify their poor progress to themselves and thus avoid personal accountability for their learning. Just as Dino had said that in his previous mathematics classes he would blame the teacher for his poor progress, poorly progressing or disruptive students in the Pathfinder Lab could blame their poor progress on the noisy and crowded room, not enough teachers and the mixed age groupings. Obviously both perceptions contain elements of truth, but an element of personal accountability is lacking in each. It is noteworthy that Dino's comments about his Pathfinder Lab learning experience indicated he had become aware of his teacher-blaming attribution pattern that negated personal accountability in his previous mathematics classes. The positive and cooperative affect afforded the learning environment by the peer interactions, whether mathematical, social, or a blend of both, however, should not be

underestimated; 72% (54) agreed with statement 4, "I like that we help each other and learn from other students."

Textbooks and other learning materials were available only from the Pathfinder Library located within the room. As materials had to be returned at the end of each block, or each morning if borrowed overnight, this prevented the learning materials from being adequately available to students to complete sufficient homework to enable reasonable coursepath progress. Students resented and wasted time lining up for textbooks and answer books. Negative statements 34 (60% agree) and 43 (65% agree), and comments such as, "I really hate having to come all the way up to third floor to borrow books to do homework" (Student #45, PING3), and "I hate having to carry heavy books home for homework" (Student #33, PING3) indicate these were common perceptions. The textbook policy was inappropriate. This year, I have been able to secure more copies of frequently used textbooks and signed them out to students on long term loan. To encourage more homework completion, students now also take their binders home between classes instead of storing them in the drawers in the room to prevent loss. Both these changes have reduced the amount of movement of students within the room and the consequent noise. Occasionally students have "lost" their binders. Some have lost them in transit, others have had school bags stolen or their lockers broken into. Denying a student 30% of his term mark for his "lost" or "stolen" binder seemed somewhat unjust; thus a subjectively based alternative mark was assigned in these cases. It was neither feasible nor possible to distinguish and address the differences between actually lost or stolen, and conveniently disposed of, binders.

A lack of homework and assignment completion contributed to students' slow coursepath progress. It had been hoped that self-paced computer-managed instruction would ameliorate the consequences of the absenteeism and non-completion of homework that were characteristic of some of our Mountview Secondary students. Billy, Dino,

Allison, Penny, and Steve did little or no homework each week. They each demonstrated this common attribute that impaired student achievement in regular mathematics classrooms and slowed student progress through their coursepath in the Pathfinder Lab. They and others would avoid doing assignments, inputting to the computer system that assignments had been completed when they had not, in order to get the next test on the previously failed objective. Almost 83% responded positively to statement, "Even though I get less than 80% on a pre-test, I can pass the post test without doing assignments; I just correct my pre-test and move on. (statement 33)"

Completing corrections and analyzing errors on a failed test was a productive and encouraged learning behavior. Students were frequently reminded that analyzing their errors would develop their thinking skills and their mathematics skills. They also knew that another test on the same objective would follow a failed test, and the same question could possibly occur on a subsequent test. The practice of *only* completing corrections and few if any assignments (statement 33) however, prevented students from accessing the meaning-constructing instructional opportunities in the assignments. Sully wrote, "It is interesting to use computers in mathematics. It is so enjoyable for lazy students" (Sully, PING2). In marking students' binders I would check for completed assignments between failed tests. Some students would dispose of their failed tests and only keep their passed tests to avoid having to account for not completing assignments. Having only passed tests in their binder would be the justifiable reason that no assignments would have been completed between tests. These students appeared to be more interested in "beating the system" than learning mathematics. Whether this "work-avoidance" was a personal predisposition, an affective response to the computer-managed system or an entrenched affective response to learning mathematics was unclear. Because students who demonstrated these behaviors were all chronic low-achievers, I would suggest that an affect of habitually attributing their low achievement elsewhere than themselves was a self-

esteem protective mechanism derived from their previous cultural and learning experiences.

The qualitative nature of this study provided evidence that instructional quality was significantly influenced by the attributes of the different coursepaths and the individual students. The coursepaths differed in their method of content presentation and students differed significantly in their motivation and ability to initiate instructional interactions. The Introductory Mathematics 11 coursepath, which had been developed by the Belmont Learning Centre, gave thorough introductory assignments *prior* to the pre-tests in a unit. *Different* assignments then followed for any failed outcomes on the pre-test. The introductory assignments, the teacher-administered unit tests, and the fact that most assignments came from only one textbook and consumable learning resources, were significant differences between the Introductory Mathematics 11 coursepath and the Pathfinder Learning Systems Mentor Mathematics 8, 9, and 10 coursepaths.

The Pathfinder Learning Systems Mentor Mathematics 8, 9 and 10 coursepaths introduced students to a new mathematics topic via a pre-test. A pedagogical justification for this is that it offers students a sequential review of prerequisite content knowledge and precludes students wasting learning time on completing assignments they already understand. If, however, after completing the assignments designated by failed outcomes on the pre-test, students then failed the post-test, they could be then given the *same* assignments they had completed after the failed pre-test. This could be very discouraging for students: "I'm not really learning anything because the computer keeps on giving me the same work over and over again" (Mina, PING1). The Introductory Mathematics 11 coursepath's method of giving students an introductory assignment before a pre-test, and different assignments thereafter was possibly less discouraging to students.

As the computer system cannot distinguish a careless or typographical error from a knowledge error, students needed to ask teachers for answer keys to compare them with

their score report responses and determine the character of their errors. Although most students now practice this analysis of their errors with answer keys, it was the case last year that few students bothered to request answer keys or were aware that they could request them. Staff and students gradually became aware of the need to request answer keys because alternative answers, that the system had marked wrong, would be brought to staff's attention during students' corrections of their tests. A spacing error such as "8 / x" instead of "8/x" should not obligate a student to a series of assignments. That some students would repeatedly get the same assignments from the system without seeking help from a teacher is a testimony to the validity of Graham and Barker's (1990) and Karabenick and Knapp's (1988) findings that help-seeking behaviors imply low ability to peers and are practiced least by those who most need them.

Test results from Pathfinder pre-tests and post-tests, and the coursepath unit tests, acquired a powerful influence on the students' experiences and behavior in the Lab. There was a considerable incentive for students to score more than 79% on the pre-tests because they knew that the system would then move them ahead through the whole section of outcomes under the test objective, and they would then not need to write a subsequent post-test on the objective. Because of this potential to be directed to fewer assignments if the pre-test was passed, the Introductory Mathematics 11 coursepath's method of content presentation, with introductory assignments prior to pre-tests, gave students more incentive to thoroughly understand and complete their introductory assignments before writing the pre-test. Students on the Mathematics 8, 9 or 10 coursepaths are now encouraged to get the outcome assignments from the Search the Library menu on the computer system and see me for instruction or direction to software tutorials or videos when they receive a pre-test on a topic entirely new to them. This requires them to evaluate choices in directing their own learning and enables them to have more understanding of a new topic before completing the pre-test. As they are now also

encouraged to get answer keys, by showing me their test's score report, I can see from the scoring what outcomes are not yet mastered and either provide immediate instruction or direct the student to alternate learning resources.

Students' responses to failed tests differed. It required strong self-regulated learning behaviors and a relatively mature attitude to learning to accept that a *failed* test was an expedient or motivating means to direct the course of one's learning. Two different approaches to the computer system by students became evident as the first year progressed. Some students clearly evidenced a positive affect and significant progress in their self-regulated learning behaviors in relation to their learning experiences in the Pathfinder Lab (statements 1-10, 13-17, 19-32). They would reflect on their learning strategies, undertake and analyze corrections, review or do assignments, and seek instruction from teachers, monitors or peers. Others, although they generally liked the self-paced qualities of the program and lack of pressure (statements1, 25), perceived it negative that "you have to teach yourself and constantly ask for help; there's no teacher to teach you the lesson" (Delia, PING2). Many students were evidently accustomed to a more passive involvement in the typical mathematics classroom: a passive involvement that exposed their inabilities less visibly than they perceived the help seeking behaviors inherent to successful learning in the Pathfinder Lab would.

Whereas the attributes of the Pathfinder Lab learning experience demanded initiative and self-regulated learning from students, the direction this took varied. I would estimate that the majority of students would, to some degree, attempt to *manipulate the system* by asking friends for answers and assistance: the line between mathematical meaning-constructing interactions and cheating was blurred. After repeatedly failing tests on the same objective, a student could have accessed all the objective's test items from the test bank. I am aware of at least two students who would intentionally fail their tests and then set about getting the correct answers to all the objective's test items. Evidently their

goal was just to "pass tests". It was as if they had accepted that they couldn't or wouldn't learn mathematics; and they generally were not motivated, comfortable or confident enough to seek instruction from teachers (Graham & Barker, 1990; Karabenick & Knapp, 1988). Being able to maneuver their way through the Pathfinder tests, their perceived challenge then was to somehow pass the teachers' unit tests.

Failing grades on the unit tests helped to expose students manipulating the system. When I had been ill and consequently absent from school, there were thefts from the lockable file drawers where the unit tests were kept. Student informants and minor changes in the tests helped to expose three students who were in possession of stolen tests and had cheated. Despite a concerted effort by Mountview Secondary staff and abundant locks to the rooms, cabinets, teachers' desks and file drawers, I have come to accept that nothing is secure in the room. For an indeterminate number of students, cheating was perceived to be a plausible route to success.

Differentiating elements of the computer-managed learning environment

The In Progress mark was used on June report cards to give students additional time to complete their coursepath. Whereas the proposed introduction of this letter grade has been a source of concern among my colleagues and is considered somewhat unmanageable in the context of the typical September through June mathematics course, it was a necessity in the Pathfinder Lab to allow its self-paced format credibility. An In Progress, had to be changed to a final mark by the first term reporting period (mid-November) of the following school year. Of the 107 students enrolled in my four blocks at the end of June, 48 passed, 24 failed, and 35 received an In Progress. Of those receiving an In Progress, 22 passed, 4 failed, 7 did not return to the school and 2 passed in summer school. One advantage for the students whose In Progress marks became a Fail in November was that they would not start their mathematics course over again; they

continued on their coursepath from where they were at term end and receive credit as soon as their coursepath credit requirements are completed. They may thus start a new mathematics course mid-year in the Lab. This year, a few well motivated and capable students have completed the entire academic Mathematics 10 coursepath in approximately 4 months and appear likely to complete Mathematics 11 before the end of June. The self-paced course delivery is well appreciated by students needing time blocks for other courses before graduation, and by ESL students who may be held back or experience difficulty managing the language in regular mathematics classes. Having a reduced enrollment cap of 33 students per block in the Lab this year, 20 of whom are enrolled in mathematics courses, and a mix of students on both academic mathematics courses and modified mathematics courses has significantly changed the culture of the room and reduced the noise level. Although there are students with behavior problems, serious learning difficulties, and mental handicaps enrolled in the Lab, positive learning behaviors are being modeled by students in both academic and modified course streams.

Computer-managed instruction is still in its infancy. *What* curriculum is managed, *how* it is managed, and the *availability of technical support*, make significant differences in student outcomes and perceptions. Eighty-eight percent of students found using computers interesting (statement 30). Technology break-downs, however, have a strong negative effect on learning:

> I don't really like the fact that we barely get help from the teachers because they're too busy fixing things. (Octavia, PING1)

> The first month was kind of wasteful, because we didn't do much that pertains to our course right now. Now it's straightened out. The computer system always breaks down! (Allison, PING1)

Although I appreciated the opportunities to be able to modify the coursepaths in the system we used, I had difficulty finding the time to do it despite very long days on the job. The totally text-oriented learning in many of the coursepath assignments became

boring for some students (Students #20, #49, PING3). I see a need and look forward to creating shorter coursepaths, that use fewer textbooks, with more *prior to pre-test* introductory assignments based on computer-aided instruction, video, interactive and instructor provided elements. A computer-managed instructional system must include this element of *instructor control of the curriculum and technology* to provide instruction responsive to individual learner's needs.

Implications for mathematics learning environments

The student perceived attributes of the learning experiences and learning environment exposed in this study suggest that satisfying and effective mathematics learning environments should provide:

1. a student-perceived degree of student autonomy,
2. ample opportunities for cooperative, meaning-constructing peer interactions,
3. facilitative rather than authoritative instructor roles,
4. a pupil-teacher ratio, physical space, and furnishings that facilitate *both* interaction and quiet study,
5. curriculum and student self-evaluation tools that encourage growth in self-regulated learning behaviors,
6. a systematic, feasible and reliable means to monitor and address student progress, and
7. well-supported, functional and flexible computer technology.

A computer-managed instructional environment within a regular secondary school setting can provide an effective *alternative* learning environment for some students to learn mathematics. Many "at-risk" students may bring into the mathematics classroom their own negative affect from previous mathematics learning experiences, family and cultural values; educators must seek to provide mathematics learning experiences and environments to counteract this. Although this particular computer-managed instructional

environment did not ensure success or appeal for all "at-risk" learners in its inaugural year, it did provide a *gentler,* more cooperative environment that enabled many students to take the time to construct an understanding of mathematical concepts that had previously been beyond them, change the affect they brought to their mathematics learning and become more aware of their own effective and ineffective learning behaviors.

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APPENDIX A

PING 1: Term 1

PING 2: Term 2

PING 3: Term 3

PING :

POSITIVE, INTERESTING, NEGATIVE GOALS

Successful learning is a product of many factors. Reflecting on your learning through self-evaluation is one of these factors. A successful means to self-evaluate your learning is through a process called **PIN Thinking.** This is an acronym for **positive, interesting, negative.** It can be used to evaluate anything but in the Pathfinder Lab it will be particularly useful to help you communicate about **your** learning situation and progress.

Ask yourself:

- "What has been **positive** (good, satisfying, better, productive...) about my learning?" Try to elaborate on your ideas in order to develop and fully appreciate the "good stuff". Congratulate yourself on your successes. We want to know what's going well for you. Consider what new concepts you've learned or are learning, study skills or techniques you may be using or working on, changes in your organization, learning environment or work habits, aspects of your learning that you particularly enjoyed, ... Always think of the positive first in order to create a positive mindset and help you to clarify your goals and what you value in your learning environment.

(Need more room to write?.. Use the back of this paper.)

- "What has been **neither** particularly **positive nor negative** but **interesting**?" This might include **insights** you've had about how you learn, your attitudes about learning, comparisons with previous learning, or an interesting insight or understanding about a concept you previously had difficulty understanding. Again, **elaborate on why it is interesting** to you. The more you generate new thought in your human computer, the more capacity you give your hard drive.

- "What has been **negative** about my work, learning, or progress this term?" The secret to making this part of PIN Thinking effective is to **honestly recognize the negative aspects of your learning in order to turn them into positives. Consider what is holding back your progress so you can set goals to address these concerns.**

PING !

Turn your PIN into a PING. Create your GOALS.

What is positive about your negatives? For example, if you've noticed that you're not getting your work completed, or progressing as quickly as you wish, you may, with some reflection, also be learning that you...

-want to develop better time management skills..., (tell how you'll do this)
-have certain skills that are weak and need review,...(which ones?)
-want to improve your concentration in class in order to progress more quickly,..(how?)
-want to organize a regular homework time and study place to facilitate your learning,... (where? when? how?)
-want to arrange to study with a friend or tutor,...
-want to use some after school Pathfinder Lab time to progress more rapidly,...
-want to develop your perseverance, positive mindset, learning skills and thinking strategies,...
-want to succeed because it builds confidence and empowers your achievement in other subject areas,...

When you think about your learning in the Pathfinder Lab, what do you want to change? What do you need to change in order for you to succeed in achieving your goals?

SET YOUR GOALS, DESCRIBE HOW YOU WILL REACH THEM.

PING 2: Positive, Interesting, Negative,... Goals!

Name_____ Block____ Course Path_____

Some things that we have noticed about your learning are:

1. Students who **correct all** their assignments and their tests before going on to a new test tend to **score between 75 % - 100% on Teacher given Unit Tests**.
2. Students who **correct all** their assignments and their tests before going on to a new test **move faster through their path** because they don't repeat tests on the same objectives.
3. Students who avoid assignments, "borrow friend's answers", and don't correct their work repeat Pathfinder tests and fail the Teacher given Unit Tests.
4. Students understand the work better, score well on tests, and become more confident in doing mathematics when they analyze their mistakes and get help on corrections or new material when necessary.
5. **There are many routes to success but none of them really work unless you do.**

REFLECT ON YOUR LEARNING. Write about what has been positive, interesting and negative respecting your mathematics learning in the Pathfinder lab. Try to write at least 4 ideas for each. When you use these ideas to formulate your goals, think of both short term goals (daily? weekly?) and long term goals (term? year end? next year? post secondary...?).

Thorough and honest reflection on your learning helps you

- **to become a better, more skilled learner and**
- **to find enjoyment, satisfaction and direction in your learning.**

(This assignment is worth 10 marks)

Positive:_____

Interesting:

Negative:

Goals:

Immediate:

Short term:

Long Term:

PING 3: WHAT DO YOU THINK?

Do not write your name on this paper. We want to know your opinion so we can make learning in the Pathfinder Lab the best it can be.

The following ideas are taken from students' PINGs. Please think about whether you agree or disagree with each statement. Circle (A) if you agree, (D) if you disagree.

At the end of each section are lines where you can ADD YOUR OWN COMMENTS.

POSITIVE

1. I like working at my own pace.	A	D
2. I *understand* mathematics better learning this way than I did before.	A	D
3. I'm *usually* able to get help when I need it from a teacher or tutor.	A	D
4. I like that we help each other and learn from other students.	A	D
5. I have learned more mathematics working at my own pace.	A	D
6. I like being able to learn from more than one teacher.	A	D
7. Learning this way helps me to focus more on my learning.	A	D
8. I try harder working at my own pace.	A	D
9. I'm in competition with only *myself* now so I try harder.	A	D
10. I'm feeling more confident about learning mathematics.	A	D
11. We start on our own; I didn't like the way, in previous mathematics classes, each mathematics class started with a lesson by the teacher.	A	D
12. I like that the computer marks my work, not a teacher.	A	D
13. Even though it's sometimes hard, I enjoy learning this way.	A	D
14. When I do corrections, I find the tests are easier.	A	D

15. I'm moving faster through my path now because I do corrections. A D

16. I like the way it's up to myself to learn, I'm independent. A D

17. I'm proud of my improved scores on my mathematics tests. A D

18. I like not having teachers bugging you when fail a test. A D

19. Things I never understood before are sinking in; I get them now. A D

20. Mathematics is getting easier. A D

21. My attitude to mathematics has changed; it's better. A D

22. I don't just give up, I ask for help now when I need it. A D

23. I *learn from my mistakes* now, before I didn't. A D

24. I've learned how to work on my own; I apply this in other classes. A D

25. I don't feel pressured learning this way. A D

26. I'm better organized in my learning now. A D

Other Positives for you...

_____

_____

_____

_____

INTERESTING **It's interesting how...**

27. I learn from other students. A D

28. that once I understand a something in mathematics, it's easy after that. A D

29. that no one has to bug you to work, you just do. A D

30. that we work on computers. A D

31. that I pay more attention to learn from mistakes now. A D

32. I'm more aware of how I learn now. A D

33. even though I get less than 80% on a pre-test, I can pass the post test without doing assignments; I just correct my pre-test and move on A D

This also is interesting for me....

_____

_____

_____

NEGATIVES

34. Having to borrow books after school to do homework. A D

35. Nothing is negative. A D

36. I think I'm moving too slowly through my path A D

37. Too often I don't do enough assignments to pass my post test. A D

38. It's too easy for me to get distracted and not work. A D

39. The room is too noisy. A D

40. I repeat too many post tests. A D

41. I socialize (talk) too much. A D

42. I find it harder to get myself to work in the Pathfinder Mathematics. A D

43. Working out of more than one textbook. A D

The following is also negative for me....

How would you change the Pathfinder Lab room to help you learn better?

What rules or guidelines do we need to help students learn better in Pathfinder Mathematics?

What do you think would help you to learn better in Pathfinder Mathematics?

APPENDIX B: Term 3 PING Responses

Q #	P1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
S #	a=0	d=1	u=9							P	O	S	I	T	I	V	E												I	N	T				N	E	G	A	T	I	V	E	
1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
2	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	0	1
3	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	1	0	0
4	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	1	0	0
5	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0
6	0	0	1	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	9	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	9	0
7	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	1	0	1	0	0	0	0	1	1	1	1	0
8	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0
9	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0
10	0	1	0	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0	0	1	1	0	1	0	0	1	1	0	1	0	1	1	0	1	1	0	0	0	1	1	1	0	0
11	1	0	0	0	0	0	0	1	1	0	1	1	9	0	1	1	0	9	0	0	9	9	1	1	1	1	0	1	1	1	1	0	0	1	1	0	1	9	9	1	9	0	1
12	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1	0	0	1	1	1	0
13	1	1	0	0	1	1	0	0	0	1	0	1	1	0	1	1	1	0	1	1	1	0	0	0	0	1	1	0	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0
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22	1	1	0	0	1	1	1	1	1	1	1	0	1	0	0	1	1	0	1	1	1	0	0	1	1	1	0	0	0	0	1	1	0	9	1	0	0	1	1	0	1	0	0
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Ping 3 Responses - Continued

46	0	1	0	0	1	1	1	0	0	1	0	0	0	1	1	1	1	0	0	9	0	0	0	0	0	9	0	0	0	0	0	0	0	1	1	0	9	0	9	0	1	1	0
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Undecided	1	1	0	0	0	1	2	2	1	1	1	0	3	0	0	1	0	3	1	4	1	3	1	2	1	3	1	2	0	0	0	0	1	2	1	0	2	3	3	2	1	2	0
Disagrees	**22**	**34**	**17**	**21**	**37**	**25**	**36**	**25**	**27**	**31**	**30**	**32**	**21**	**23**	**41**	**26**	**20**	**20**	**16**	**37**	**28**	**6**	**19**	**21**	**19**	**32**	**26**	**12**	**14**	**9**	**25**	**20**	**12**	**28**	**54**	**22**	**41**	**31**	**33**	**38**	**51**	**39**	**26**
Agrees	**52**	**40**	**58**	**54**	**38**	**49**	**37**	**48**	**47**	**43**	**44**	**43**	**51**	**52**	**34**	**48**	**55**	**52**	**58**	**34**	**46**	**66**	**55**	**52**	**55**	**40**	**48**	**61**	**61**	**66**	**50**	**55**	**62**	**45**	**20**	**53**	**32**	**41**	**39**	**35**	**23**	**34**	**49**
Column Su	31	43	17	21	37	34	54	43	36	40	39	32	48	23	41	35	20	47	25	73	37	33	28	39	28	59	35	30	14	9	25	20	21	46	63	22	59	58	60	56	60	57	26
Question #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**

APPENDIX C

Attributes of Computer Generated Test Questions

The computer generated test questions are of four types. Questions may be

1. Multiple choice
2. True or False
3. Fill in the Blank
4. Essay

The computer system marks a student's responses to any of the first three types of questions. "Essay" questions are questions that generally require a more subjective or graphic response than is feasible for the computer system to be programmed to mark. The teacher marks the student's "essay" response, then enters a score for the question into the computer system. The student is then able to request a Score Report on the entire test. Therefore *any* type of question, project or activity can be created by the teacher to be given on a test by designating it an "essay" question. The contact between teacher and student during the marking of "essay" questions affords valuable interaction opportunities to mediate a student's thinking and learning.

As the computer system has limited ability to reproduce graphics, test questions may refer students to coded "graphic" elements in the accompanying library of print learning materials.

Examples of each type of question follow.

1. Multiple choice:

   A bag contains 3 yellow and 2 green tennis balls. What is the probability of drawing 2 yellow balls in succession if the first ball is not replaced?
   a) 3/10
   b) 3/5
   c) 1/2
   d) 11/10

   System accepted answers:
   1) a
      A

2. True or False:

   You will need a copy of the graphic MA-050043.
   True or False?
   From the data listed in the table it is clear that the two variables are independent.

   System accepted answers:
   1) F
      f
      False
      false

3. Fill in the Blank:

   Given the two points (100, 0), (0, 100), calculate the slope of the line joining them.

   _____

   System accepted answers:
   1) -1

4. Essay:

Plot the values of the variables on a scatterplot and label your graph clearly.

M	N
19	83
14	88
2	100
8	94
10	92
6	96

System indicated answer:
1) See MM:AK-7239
(Teacher's answer key reference for marking "essay" questions)