CONFIDENCE IN SCIENCE:

INTERPERSONAL AND INSTITUTIONAL INFLUENCES

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Le contenu du présent rapport n'engage que la responsabilité du collège et de ses auteures.

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Résumé

Le but de la présente étude était d'utiliser les entrevues avec des étudiantes collège en sciences afin de voir en quoi les expériences d'apprentissage influaient sur leur confiance, leur persistance et leur engagement à l'égard des sciences comme choix de carrière. Plus particulièrement, nous avons essayé de voir comment le comportement de certains professeurs, des événements survenus en classe, des messages de l'établissement d'enseignement et d'autres expériences peuvent encourager ou décourager les étudiantes.

Trente-huit femmes ont été choisies au hasard parmi une population d'environ trois cents étudiantes admises au programme de sciences du Collège John Abbott à l'automne de 1992. Nos entrevues, approfondies et non structurées, ont été effectuées à intervalles réguliers, chaque étudiante étant interviewée au cours des premier et troisième trimestres et pour certaines, au cours du quatrième trimestre. Celles qui changeaient de programme ou quittaient le Collège subissaient une entrevue dès que nous apprenions la nouvelle de leur changement de programme ou de leur départ. À chaque entrevue, l'étudiante devait remplir le questionnaire intitulé *Coopersmith Self-Esteem Inventory*. Les réponses étaient comparées aux sentiments de confiance qu'avait décrits l'étudiante ainsi qu'à ses résultats scolaires. Des observations en classe permettaient de vérifier sa description de l'ambiance qui règne dans les cours de sciences.

À la fin du quatrième trimestre (soit le délai prévu pour terminer un programme pré-universitaire), douze étudiantes avaient obtenu un DEC en sciences. Après l'été, deux autres étudiantes terminaient avec succès leurs études en sciences. Sept étudiantes ont poursuivi le programme de sciences pour un cinquième trimestre alors que les dix-sept autres avaient soit changé de programme, soit quitté le Collège.

L'analyse des données quantitatives (les résultats de l'étudiante au test de Coopersmith, ses résultats scolaires et sa persistance) n'a pas permis d'établir de lien entre l'estime de soi et la persistance à demeurer dans le programme de sciences. L'examen des relations entre le rendement (établi en fonction des notes obtenues) et l'estime de soi n'a pas permis non plus d'en venir à des résultats concluants.

Les étudiantes ont indiqué que leurs sentiments de confiance fluctuaient au gré d'événements encourageants et décourageants. La confiance n'était pas un élément statique pouvant être perçu comme la cause du succès ou de l'échec. Parmi les événements encourageants, les étudiantes ont fait

état de l'obtention de bons résultats à une épreuve, l'appui donné par un professeur et des expériences à l'extérieur du collège, comme la satisfaction tirée d'un travail rémunéré et une bonne performance dans un sport. Parmi les événements décourageants, elles ont parlé des échecs scolaires, des «questions pièges» aux examens, des cours peu reliés à leur expérience et du manque de respect de la part des professeurs. Pour beaucoup d'entre elles, et c'est là également une cause des changements de programme, le fait de se rendre compte que leur rêve de carrière était impossible à réaliser, en raison souvent de faibles résultats obtenus au premier trimestre, était décourageant.

La confiance et la persistance étaient liées à la perception de la façon dont leurs questions étaient accueillies ainsi qu'à la façon dont elles pouvaient s'identifier à des personnes d'autorité, et surtout à leurs professeurs. Le sentiment qu'elles avaient de ne pas pouvoir poser de questions en classe ou en privé ou de ne pas obtenir de réponses à leurs questions était associé aux échecs ou aux changements de programme.

Les étudiantes ont accordé beaucoup d'importance au fait de poser des questions, ce qui montre que la possibilité de poser des questions et d'obtenir des réponses est une façon d'apprendre. Nous avons analysé cette notion en fonction de la théorie relationnelle élaborée par Carol Gilligan et d'autres personnes travaillant au *Stone Centre* du *Wellesley College,* au Massachusetts.

Abstract

The purpose of this study was to use interviews with female college science students to examine ways that learning experiences affected their confidence, their persistence and commitment to science studies, and to science as a career choice. In particular, we were looking at how some teachers' behaviours, classroom events, institutional messages, and other experiences encouraged or discouraged students.

Thirty-eight female students were chosen randomly from a population of approximately three hundred, who were admitted to the John Abbott College science program in the fall of 1992. Our open-ended, in-depth interviews were conducted at intervals; each student being interviewed during her first, third, and for some, fourth semester. Those who switched programs or left the college were contacted for an interview as soon as we learned of their exit. At each interview, the student was asked to complete the Coopersmith Self-Esteem Inventory. The result was compared to the student's self-reported feelings of confidence and to the academic marks she received. Class observations provided verification of the students' accounts of the milieu in the science classes.

At the end of the fourth semester (the stipulated time for completion of a pre-university program), twelve students graduated with a science college diploma (*DEC*). Following the summer, two more students successfully completed their science studies. Seven students remained in the science program during the fifth semester, while the remaining seventeen had either transferred to other programs or left the college.

Analysis of the quantitative data (a student's score on the Coopersmith Self-Esteem Inventory, her marks, and persistence) showed no relationship between self esteem and persistence in the science program. Examination of any relationship between performance (indicated by marks received) and self esteem was inconclusive.

The students reported that their feelings of confidence fluctuated as the *result* of encouraging or discouraging events. Confidence was not something static that could be seen as the *cause* of success or failure. As encouraging events, students reported receiving good marks on a test, support given by a teacher, and experiences outside the college milieu, such as satisfaction with paid work or performance in a sport. Discouraging events were failing grades, "trick questions"

on exams, teaching that failed to connect to their experience, and disrespectful treatment by teachers. Discouraging to many, and a cause of program switches, was the realization that their dream career was not within reach, often due to low marks received in the first semester.

Most importantly, confidence and persistence were linked to the students' perception of how their questions were, or might be received, and to how they could or could not relate to others in significant positions, primarily their teachers. The perception that they could not ask questions in class or privately, or that they could not get satisfactory answers to their questions, was associated with failing grades and/or program switches.

The students ascribed profound importance to asking questions, which indicates that asking questions and having them answered is a way of learning. We have analyzed this concept using the framework of relational theory as developed by Carol Gilligan and others working at the Stone Centre at Wellesley College, Massachusetts.

Acknowledgements

About This Report

In order to guide the reader through a wealth of data, interpretations and discussions, we offer a few explanatory remarks about the organization of this report. The first four sections, *Introduction, Methods, Results and Discussion, and Recommendations* constitute the main body of the report. Then follow three articles, *Career and Life-Choices, Staying In or Switching Out,* and *In Science There is No Gender?,* written either for conference presentations or as articles for publication. They deal with particular themes or issues, and may be read independently. There is some overlap between sections where, for example, the same quotation is used in different contexts. We believe the inclusion of these free-standing units offer a richer interpretation of the interview data.

About the Researchers

We are two researchers who designed and directed this project. How we see the world around us is coloured by our experiences and our training, and at times it is clear in this report which one of us is speaking. We see this as a strength rather than a weakness. Margaret Waller, sociologist, did most of the class observations and could describe the science program in our college with fresh eyes, something that could not have been achieved by someone who works in science on a daily basis. Anne-Marie Weidler Kubanek, physical scientist, was familiar with the program structures, the demands put on students in the science program, and the problems they might encounter while making career decisions. These different perspectives facilitated the understanding and interpretation of some of the narratives of the students in our sample. We believe that the achievement of absolute objectivity is an impossible task. In our struggle to acknowledge each other's perspective and analysis of the data, our research team became a microcosm for the greater struggle of bridging physical science and social science disciplines.

INTRODUCTION

Women in Science and Technologies

This project began from a concern about the under-representation of women in science and the technologies. Women constituted a majority (54 per cent) of students at Canadian community colleges in 1990-91; a majority (59 per cent) of students graduating in post secondary career programs and were a majority in all but two career-program fields. In the category of engineering and applied sciences, they were sixteen per cent, and in natural sciences and primary industries, they were 31 per cent (Government of Canada, 1990-91). At Quebec colleges young women are well represented in the health science programs, but fewer choose the pure and applied stream that traditionally leads to careers in engineering and other technological fields. At John Abbott College 27 per cent of students registered in the pure and applied science stream in fall 1991 were women.* Of all Canadians enrolled in a post secondary institution in 1989, 27 per cent of males, but only five per cent of females, were in engineering, applied sciences and technological trades (Lowe, 1992).

Between 1975 and 1990 there were substantial shifts in women's university degree choices. The proportion of women graduates in some previously male-dominated fields such as business, management and commerce increased to such an extent that they no longer could be defined as male-dominated at the undergraduate level. Engineering and physics continued to qualify for such a definition by graduating the highest proportion of males. There was no change in the proportion of women obtaining undergraduate degrees in mathematics and the proportion of female graduates in computer science actually dropped because the number of male graduates grew more rapidly (Stout, 1992).

Although the proportion of women in general science programs at university is relatively high, their numbers decline drastically in post graduate studies. In 1990, women earned 47 per cent of master's and 32 per cent of doctoral degrees in Canada, but only thirteen per cent of master's degrees in engineering and six per cent of the doctorates (Stout, 1992).

In Quebec, women represent four per cent of civil and mechanical engineers and just over six per cent of electrical and aerospace engineers (Gouvernement du Québec, 1992). This level of representation in the engineering profession has not changed significantly in recent years although the proportion of Canadian women obtaining bachelor's degrees in engineering rose from less than two per cent in 1975 to almost twelve per cent in 1990 (CCWE, 1992; Stout, 1992).

* Registrar's Statistics , John Abbott College, 1991.

The fact that the participation of women in undergraduate science programs has been increasing might lead us to believe that it is only a matter of time until women are well represented in all fields and at all levels including university faculty and administration. Modest changes have been used by some to deny that there is a continuing problem. Sheila Tobias, a political scientist, has studied the culture of science and is able to describe it as an outsider. She has found that despite discouraging statistics about women in science "it is surprisingly difficult to convince working scientists that there *is* a problem or that it is *their* problem and not the fault of women scientists themselves." (Tobias, 1993, p. 150). We cannot be assured that equity will be obtained automatically once the number of women in science reaches a critical mass (Etzkowitz et al.,1994). Therefore, the question remains: why are women so scarce in sciences?

Why are There so Few Women in Science?

We can sort answers to this question into three categories. The first is based on a deficiency model: females lack some gene, ability, trait or socialization that is essential to doing science. Fuchs Epstein (1991) points out that in North America and elsewhere, there is a widely held belief that "great scientists and artists possess innate traits that generate achievements, that such individuals develop independent of external situations or influences, and that the products of their imagination or skill, if powerful enough, somehow will rise to the surface, that *genius will out*. Those who do not add to knowledge or high culture are believed generally to lack the capacity to do so." (p.239). We suspect that this belief generates much of the gender difference research. Working from this model, the proposed solution is to identify the deficit and remedy it.

The second may be called the recruitment model. In this view women have had a delayed start because of past discrimination, but equity in participation is just a matter of time and effective recruitment. The next generation of women will move into previously male-dominated fields. In this model, there are no longer any barriers to women's successful participation in science studies and careers.

The third category of answers focuses on retention. This *leaky pipeline* model defines the problem as one of supplying adequate human resources for our society. It assumes women have the ability and do undertake science studies and careers, but they drop out at higher rates than do men. To satisfy society's need for trained scientists we have to find means to stem the flow of women leaving their science studies or careers.

For female students entering science programs at CEGEP, the problem should not be academic ability. Overall they have the strongest academic record among high school graduates. At John Abbott College, female science students have an overall higher average than males and their academic performance is stronger as indicated by the results of a recent study which showed that 41 per cent of females but only eighteen per cent of males acquired a science DEC in the requisite two years. Female and male students transferred out of science at about the same rate; however, they gave different reasons for transferring. A higher percentage of female students gave as their reason for changing programs "not doing well" or "failure" (83 per cent female, 69 per cent male).* Of those who transfer out of science, more females (nineteen per cent) than males (five per cent) believed that their ability was not suited to science (Sidorenko et al., 1989). This was part of an overall tendency of females to attribute their failures or lack of success to intrinsic factors (ability) while males tended to attribute failures to extrinsic factors (poor teaching).

Historical Overview

In 1990, lack of confidence was the most salient of the deficiencies attributed to women in order to explain their low participation in fields related to science and technology. This was the latest entry on a long list of such deficiencies used since the emergence of science as an institution to exclude women or discourage them from becoming full partners in the building of modern science. From arguing that females lack ability, debate had progressed to the speculation that they lack confidence in their ability to do science and science-related studies such as mathematics.

We say progressed ironically because accounts of women's deficits in the sciences, though continually changing, seemed to progress only in the sense that the causal factor became more narrowly defined. Early Greek philosophers opined that women's entire nature was incompatible with doing science. The Aristotelian view of women as emotional, subjective, weak, illogical, and earthbound, was contrasted to science as objective, logical and resting with the mind; all qualities attributed to the male (Tuana, 1989). This view, expanded upon by Galen, attributed all creative power to the male sex, going so far as to assert that the male plants a complete seed of a human being in the female womb. The only function of the female is to nurture the male seed. Leeuwenhoek, the discoverer of the modern microscope and one of the most respected scientists of

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* A report from Vanier College cited a one and one-half to two times higher rate for drop outs and transfers out of science for women than for men. (Davis, Steiger and Tannenhouse, 1989).

his time, reported seeing completely formed male figures as he examined human sperm under the microscope; a reminder that the objectivity of scientists can not be taken for granted and that even the most reputable scientists might see what they expect to see (Bleier, 1984).

During the nineteenth century the "women-can't-do-it-model" was still prevalent but explanations narrowed from the nature of women, to focus on brain size and differences in ability. George Romanes claimed in 1887 that women's brains were smaller and therefore, they were less intelligent than men. Even an apparent abundance of ability was interpreted as a disadvantage: women's allegedly superior verbal skills disqualified them as scientists because it made them facile liars (Caplan and Caplan, 1994).

As women struggled to gain access to institutions of higher learning at the end of last century, the focus of the debate shifted from "women can't do it" to "you may, but see what happens if you do" and later to "you may, but we won't pay you." An influential study in 1873, claimed that women's health was ruined by intense study. Their delicate and lighter brains could do science, but doing so would drain energy from a limited supply and jeopardize their true role of reproduction and motherhood. This in turn would endanger the whole human species (Rossiter, 1982; Bleier, 1984).

Some women found ways to do science in spite of the obstacles and without apparent harm to their off-spring. During the early part of this century a few gained access to institutions and working fields previously closed to them. However, science was a vocation primarily for economically privileged women because they were seldom paid fairly for their work. When Ellen Gleditsch, a Norwegian nuclear scientist, went to work in Paris at the laboratory of Mme Curie in the beginning of this century, she offered to do so "solely out of love for science, not to gain a degree" and she certainly did not expect to be paid for her efforts (Kubanek and Waller, 1995b, p.128). Lise Meitner, an accomplished Austrian nuclear physicist, had to be satisfied with an unpaid position at the university while her co-worker, Otto Hahn, enjoyed the prestige and research facilities that came with a professor's title and an endowed chair at the Kaiser Wilhelm Institut for Chemistry in Berlin-Dahlem (Sime, 1991).

If women scientists married they were expected to resign outright because their first obligation was to husband and children. Harriet Brooks, a Canadian nuclear physicist, who had studied with J. J. Thomson at the Cavendish laboratory in Cambridge, England, had attained a position at Barnard College, New York City. In 1906, she notified the dean of the college she was planning to get married. The dean promptly told Brooks that the college trustees expected her to resign. In her letter

to Brooks, she wrote: "I know that they expect and wish that a woman should dignify her home-making into a profession, and not assume that she can carry on two full professions at a time. This is more than most able men assume to be possible." (Rayner-Canham and Rayner-Canham, 1992, p. 47).

Recent Developments: Confidence and the Deficiency Model

As the second wave of feminism took hold in the nineteen sixties and seventies, a plethora of studies sought to identify the problems and deficits of female students that inhibited their participation in science and technologies. Concerns that not enough women were pursuing careers in these fields generated numerous investigations of student attitudes and abilities (Benbow and Stanley, 1980; Schafer, 1981; Meece et al., 1982; Science Council of Canada, 1982; Guilbert, 1985; Lafortune, 1986). Attention was also directed at classroom climate, teacher behaviours and professional subcultures (Leinhardt et al., 1979; Hall and Sandler, 1982; Davis, Steiger and Tennenhouse, 1989; Tobias, 1990a; LaFrance, 1991).

Most researchers structured these studies in ways that compared males and females and both looked for and emphasized differences. (see Baxter Magolda, 1992).* Researchers on sex and gender differences put forward a new list of deficiencies in women that purported to explain their low participation in science and their failure (with a few acknowledged exceptions) to produce excellence when they do. One of the most damaging of these studies was Benbow and Stanley's claim of males' innate superiority in mathematics (1980). The deficiency list has, at various times, included poor spatial ability, dependency, lack of aggression, lack of competitive spirit and other assertive behaviours, and preference for people rather than objects.

It should come as no surprise that in this social context some women expressed a lack of confidence in their ability to pursue a scientific career. However, instead of seeing this as a predictable result of messages that undermine confidence, lack of confidence itself was added to the list of deficiencies.

In the United States, the American Association of University Women (AAUW) reported that numerous meta analyses of student achievement in five areas (verbal skills, writing, mathematics, spatial visualization and science) indicate that gender differences are few and those that have been demonstrated are small and declining, except for achievement in science, which is not decreasing

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* We discuss the Baxter Magolda study in detail on page 53.

and may be increasing (AAUW, 1992). The AAUW then called for more study of the gender gap in the sciences and, in particular, issues of confidence.

In Quebec, Louise Lafortune (1986) concluded after extensive studies that "mathophobes" lack confidence rather than ability and that women lose confidence in themselves more easily than men . Chabot (1990) summarized the situation of girls and women in science thus:

> Malgré leurs succès scolaires, les filles abandonnent en plus grand nombre à chaque
> étape, et la situation se répète au niveau universitaire (p.32).

> Alors que les garçons ont davantage tendance à mettre la faute sur l'examen trop
> difficile ou à invoque d'autres raisons indépendents de leur volonté, les filles diront plus
> volontiers qu'elles n'ont pas compris, qu'elles n'ont pas assez étudié. Cette attitude
> suivie de quelques échecs convaincra plus rapidement les filles qu'elles n'ont pas le
> talent nécessaire pour poursuivre dans la voie des sciences. (p.33).

Inspired by a model proposed by Meece et al. (1982), Mura, Kimball and Cloutier (1987) studied eighty-nine Quebec high school students. They asserted that even after young women had chosen a science program, they were more vulnerable than boys. This vulnerability did not lie in their lack of ability, but rather in the perceptions about their own ability, which made the young women less confident of their success. Mura also spoke of the attitude barrier, although she chose not to speak of female deficits: "Je ne dirais pas que les filles manquent de confiance, je dirais plutôt que les garçons en ont trop" (Chabot, 1990, p.33).

Efforts to identify the characteristics of the attitude barrier continued into the 1990s. In a longitudinal study, started in 1993 at Vanier College, St. Laurent, Quebec, Fran Davis and Arlene Steiger (1995, 1993) continue to investigate the differences in attitude to science learning between female and male students, and the vision of science held by their science teachers. At York University, in Toronto, Lorna Erwin and Paula Maurutto (1995) are focusing on an all female sample of undergraduate science students in their study on gender influences in education.

Many of these investigations are based on the assumption that self-perception and self-confidence are fairly stable. Our preliminary interviews with college students suggested a more malleable perception of self.* Listening to students talk in this way inspired us to look at how

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* Meece et al. assume a "fairly stable perception of ones-self" (1982, p.334).

confidence may waver and shift during college, as it did for the student who had transferred from science to commerce after "realizing what you are":

> I kept on hearing about people switching out [of science] and saying, "Ah, that would never be me, that would never be me". . . within a few short months, my - like I was totally - not slapped in the face, but in a sense, because I thought I would work well - I didn't do well, and, sort of thing, and it turned out that I was really bad, worse than average. And it was realizing what you are instead of what you thought you are, so . . . because in high school, I would be considered, you know, a good student, you know, I tutored people even in chemistry and stuff.

The direction of much recent theoretical work has been to question the conceptualization of any personality characteristic as being independent of context. Feminist theorists, in particular, have emphasized interpersonal and relational issues in the development of girls and women. The work of Carol Gilligan (Gilligan, 1982a; Gilligan, Lyons & Hanmer, 1990) and the Stone Center theorists such as Judith Jordan and others (Jordan et al., 1991) have contributed to a concept of a self-in-relation. Kaschak (1992) has proposed a "self-in-context" and argued for a metaphorical *sense of self*, which includes the physical, affective, and cognitive experiences associated with this metaphor. She places as much emphasis on the "demands of a situation as interpreted by the people in it" as earlier theorists placed on early childhood experiences (p.154).

Others have demonstrated that lack of confidence is not an intrinsic trait or quality of students but a state or condition that may be affected by behaviour of teachers and parents. Dweck, Goetz, and Strauss (1980) found that both male and female students who were praised for performance on tasks and criticized for behaviour gained confidence; those who were criticized for performance and praised for behaviour lost confidence. However, girls tended to be praised mainly for good behaviour; boys were praised for good work, criticized for misbehaviour.

Teachers interviewed by Mura, Kimball, and Cloutier "saw their female students as having less potential and as succeeding more because of effort." These researchers also suggest that "girls will interpret positive feedback as meaning that they work hard rather than that they have ability" (1987, p. 143). Such work directs our attention toward the interpretive process by which students make sense of feedback they receive from teachers. Thus it is important to understand how students interpret teacher behaviours and what influence these interpretations have on student self-confidence.

We agree with the authors who summarized a 1992 symposium of young Canadian women, that confidence must be studied in a social context: "Although the psychological (inner) aspects of self-esteem have been studied for centuries, they still defy analytical clarity. It may be more feasible to look at the economic and sociological aspects of self-esteem and to address systemic barriers which prevent many women from appreciating their worthiness." Furthermore, they argued that "the various elements which add to or subtract from self-esteem must be clearly identified and communicated" as one step in dismantling the barriers (CACSW, 1992, p. 19).

In her book *School Girls*, the journalist Peggy Orenstein reports on her study, undertaken in association with AAUW in response to its call for more research on the gender gap in science (see page 5). During many hours spent with girls in two high schools in California she found that in spite of fewer barriers to equity these girls "had learned to see boys as freer, with fewer concerns, ultimately more powerful." She noted that with a diminished sense of self, the girls, often unconsciously, had taken on an accommodating, second-class status. "Few of the girls I spoke to had ever been told that girls 'can't' do what boys 'can' - most were overtly encouraged to fulfil their potential. Yet all, on some level, had learned this lesson anyway" (Orenstein, 1994, p. xxviii).

Baker and Leary (1995), also in the United States, studied what influences girls to choose science. In semi-structured interviews each girl was asked to respond to questions as if she was a boy. In grades two, five, eight and eleven, the girls were highly self-confident; they held a strong equity position and felt that women can and should do science. This finding that younger girls describe themselves as being confident suggests that a lack of confidence is not innate.

Defining Confidence

In our study, we have conceptualized confidence as a process or state of mind that is socially constructed in interaction with others, as distinguished from other conceptions of confidence as a more or less stable trait of individual personality.

The Oxford Dictionary of Current English (1984) defines confidence as drawing our attention to a *feeling* component linked with trust, assurance, self-reliance, and certainty. The AAUW (1991) survey which used "happy the way I am" as an indicator of self-esteem and self-confidence, also emphasized a feeling component. The Canadian Advisory Council on the Status of Women survey used three statements as indicators of how young women see themselves: "I feel good about myself; I have a number of good qualities; and I am self-confident" (Holmes and Silverman, 1992).

Reviewing theories of self-esteem for a study of its antecedents, Stanley Coopersmith (1981a), distinguished four major contributors (p.37):

> The amount of respectful, accepting and concerned treatment that an individual receives from significant others. . . .
> The individual's history of successes and the status position that individual holds.
> The individual's values and aspirations. . . .
> The individual's manner of responding to devaluation.

Although Coopersmith assumed adult self-esteem was the relatively stable consequence of childhood experience, we see that the actions of significant others are a major component. One can as easily recognize these four factors as part of an on-going dynamic process: one's accumulation of respectful, accepting and concerned treatment, and one's history of successes and current status position, constitute a bank of resources that one brings to any situation. Values, aspirations and one's manner of responding may be viewed as the more interpretive or active parts of self-esteem. One interprets and ascribes meaning to current experiences in the context of one's values and aspirations and perhaps with a more or less habitual manner of responding to devaluation. Each of these elements is subject to change. One's accumulation of respectful treatment can increase or diminish like a bank account.

There is an interesting bias to Coopersmith's (1981a) schema in that only devaluation is included and self-esteem is conceptualized as in need of defence. In order to accumulate a history of successes, one must defend self-esteem by defining "an event filled with negative implications and consequences in such a way that it does not detract from his [sic] sense of worthiness, ability or power" (p. 38).

In addition to the four components of self-esteem, Coopersmith asserts that individuals use four criteria to define successes: power, significance, virtue and competence.

> Power is the ability to influence and control others.
> Significance is the acceptance, attention, and affection of others.
> Virtue is adherence to moral and ethical standards.
> Competence is successful performance in meeting demands for achievement.

Coopersmith's (1981a) goal was to answer the question "What are the conditions that lead an individual to value himself and to regard himself as an object of worth?" His answer was warmth, clearly defined limits, and respectful treatment (p. 37).

It is evident that teachers may function as significant others to students, and thus have the potential to dispense or withhold respectful, accepting and concerned treatment. In teacher-student interactions, power is unequal, and because teachers have more power they are in position to accord significance, to establish standards of performance, and to define virtue and competence. Teachers use judgments about virtue and competence to allocate attention and acceptance. Students use judgments about their virtue (worked hard, did the homework) and competence (smart student) to justify claims to teacher attention and acceptance. We shall return to these criteria throughout this report; therefore, it is useful to elaborate on them here.

Power: In the classroom and in the larger institution the power of teachers and students is unequal. For example both teachers and students evaluate the performance of the others, but the consequences of these evaluations are markedly different. Teachers' evaluations of students have material consequence for a student's future. The academic record, to a large extent, stands for and represents the student to other educational institutions. Students evaluate a teacher's performance but, in our institution, these evaluations have no material consequences for the teacher. In practical terms, evaluations of teachers have no institutional existence in that they are confidential to the teacher only, or sometimes to a department head.

Significance: Part of the individual's sense of significance is the acceptance, that is the "warmth, responsiveness, interest and liking" exhibited by significant others. Teachers are significant others for students because they are in positions of authority. For those students who placed a high value on a positive interpersonal relationships with teachers (the majority of our sample), teachers' behaviours toward them were especially important. (see p. 57)

Virtue and Competence: An individual attains virtue by conforming to standards and expectations. In this setting standards include being smart, competitive, and working hard. Through conforming to standards and meeting demands for achievement, the individual comes to be seen, and to see herself, as competent. Both teachers and students use such standards and judgments of competence to allocate or claim attention and acceptance.

These four components described by Coopersmith are a useful scheme for looking at events in college that add to or subtract from a student's self-esteem. Framing our discussion of confidence

around these four criteria can contribute to our understanding of our interview data. One way to think about many of the students' narratives is that they are interpretive accounts of experiences that have had implications and consequences for their self-esteem.

Our approach to the problem of confidence is derived from the theories of Charles Horton Cooley's "looking-glass self" and more recent work on the social formation of mind:

> An individual emerges through the processes of social interaction, not as a relatively fixed end product but as one who is constituted and reconstituted through the various discursive practices [talk] in which they participate. Accordingly, who one is, is always an open question with a shifting answer depending upon the positions made available within one's own and other's discursive practices and within those practices, the stories through which we make sense of our own and others' lives" (Davies and Harré, 1990, p.46).

Talking and composing narratives are key actions in the construction of self. Along with a growing number of philosophers and social theorists, Somers (1994) directs analytical attention to the stories one tells (and hears told) about one's self. In this she is much like Bruner (1986), but her perspective is more sociological in that she conceptualizes the individual as acting in a specific historical and relational setting which includes institutions, structures of power, cultural networks, and those others who are central or significant to that individual.

The Study

We began this study with three assumptions. First, that the confidence argument was another deficiency argument that placed the responsibility for the under-representation of women in sciences and technologies on individual women, while ignoring the contexts in which the females developed and attempted to realize their aspirations for a place in science. Second, that the concept of confidence generally used in such arguments (a relatively stable individual characteristic determined by early life experiences) did not adequately represent women's real life experience. Third, we intentionally moved *confidence* outside the individual by pairing women's confidence in themselves with their confidence that science could be an interesting activity, a feasible program of studies, and a desirable career direction.

We wanted to look for interpersonal and institutional influences on the ways women saw themselves as they moved through a college science program. This study addressed the following questions:

How do students construct and sustain confidence in the context of a college science program?

What teacher behaviours, classroom events, and institutional messages affect student confidence (e.g. encourage and discourage students)?

How does the student construct or construe "doing well" and "not doing well?"

What is a good enough grade and what is the relationship between marks and the feeling of doing or not doing well?

What factors account for college women's decisions to persist or change programs and career directions?

Avoiding Gender Comparison

We sought to avoid a gender difference or gender comparison approach because, inevitably, such comparisons are invidious for females. The best way to avoid the deficit model described above, is to avoid comparisons in which male behaviour will be taken as the norm. By focusing on differences, one easily fails to see the complexity of the data and may resort to a more simplistic, dualistic interpretation.

We have not been altogether successful in achieving this goal. In every discussion about this project, we have been subjected to, and sometimes drawn into, speculations about whether, or in what ways the experiences of males would be similar or different. Daily we have confronted what Kaschak (1992) asserts is the most notable aspect of current gender arrangements, namely the reality "that the masculine always defines the feminine by naming, containing, engulfing, invading, and evaluating it. The feminine is never permitted to stand alone or to subsume the masculine" (p.5). We have sought to allow these female students to stand alone and speak for themselves. As Catherine Bateson once asked, "after all these ages in which 'man' has meant human, perhaps readers will be able to generalize 'woman' to the same degree." (Bateson and Bateson, 1987, p. 197)

Caplan and Caplan (1994) demonstrated how studies on sex and gender differences are fraught with poorly designed methodology, research questions based on false assumptions, and unsubstantiated conclusions. The fact that most scientists have been members of the privileged categories of class, race, and gender has profoundly affected what questions have been asked, and

what direction their research has taken. This is not to say that gender differences do not exist, but when one is recorded, it tends to be too small to be of any practical importance, as the differences within a gender group are much greater than those between the genders. For example, researchers who compare females and males and then assert that "depressed self-confidence is normative for females" (Clark and Zehr, 1993) obscure the range of confidence among females and label the entire category as impaired. Unfortunately, the refutation of such results is seldom well publicized and these beliefs take on a life of their own in the minds of the public.

Byrne (1993) calls this phenomenon *the Snark Syndrome*, a term she has borrowed from Lewis Carroll, who in *The Hunting for the Snark*, says "What I tell you three times is true." In a more academic way, Byrne defines the Snark Syndrome as "the assertion of an alleged truth or belief or principle as the basis for policy making or for educational practice, although this proves to have no previous credible base in sound empirical research" (p. 3).

METHODS

This is a longitudinal and descriptive case study. We followed one cohort of students who entered a post-secondary, pre-university science program in August 1992. We gathered descriptive data by conducting open-ended, in-depth interviews and by observing in classrooms. In addition, we analyzed the relationship between a standard measure of confidence, the Coopersmith Self-Esteem Inventory (SEI) and institutional measures of performance (marks), together with the students' persistence as reflected in program changes and their success in obtaining a diploma.

Sample

Using computer-generated random numbers we chose fifty names from the list of female students enrolling in the science program at John Abbott College in August 1992 (N = 308); then invited them by letter to attend an information session about our research project. Next we telephoned them to confirm that they had received the letter and to remind them of the date and time of the information session; however, we made no request that they agree to participate at that time. At the information session we discussed the project, showed students sample reports of similar research, and distributed consent forms (including parental consent forms for students under eighteen). Students who chose to participate in the study scheduled appointments for interviews with us. Twelve students chose not to participate or failed to keep two scheduled appointments, resulting in a total sample of 38 women.

The participants were a diverse group. They had attended public and private schools, which were either all girls or coeducational. Unlike most Quebec colleges, John Abbott College has a residence, and some students originated from farms and small towns throughout Quebec as well as from the metropolitan region of Montreal. Their cultural roots included East and West Europe, China, East Asia, and North Africa, as well as Anglophone and Francophone Canada. Many were bilingual and multilingual. Unfortunately, neither Native peoples of Canada nor African Canadians were represented in our sample.

Most women were between 16 and 18 years old at the beginning of the study. Our sample did include one older student who was retraining in sciences and who, typically for her gender, class and generation, had been directed away from science in high school.

Data Collection and Analysis Procedures

interviews

We interviewed the students in their first, third and, for some, their fourth semesters. Those who changed programs or left the college were re-interviewed as soon as we learned of their decisions. The interviews averaged over one hour in length. The interview guides (see Appendix) were derived from the work of Meece et al. (1982); Gerson (1985); and Mura et al. (1986).

In the first semester we asked students to recall how they came to choose a science program and to describe early experiences related to sciences, their college experiences and their aspirations about the future. The interviews focused on school experiences, but inevitably, life being one rich tapestry, relationships with family, friends and employers were sometimes interwoven. The sequence of topics in each interview was determined by the student, as the interviewer worked to maintain an open, conversational style. The second and third interviews began by asking students about their immediate experiences. In addition, we often asked about issues from the previous interview. The later interviews tended to conclude with an explicit invitation for the student to talk about her sense of confidence and how it may have changed over the time spent in college.

We used intermittent classroom observations to verify and elaborate our understanding of the experiences that students described, as well as to generate questions and hypotheses to be explored in later interviews.

analysis of interview data

The complete transcripts of interviews were verified by the interviewers listening to the tapes. The transcripts were then copied to a microcomputer text data base called *Note Bene*. After the coding, *Note Bene* allowed us to index, search and retrieve segments of interviews. In the first phase of analysis, we derived a set of comprehensive categories from the data. Ultimately, we analyzed each student's interviews as a chronological case, observing changes in key categories and preparing individual profiles. We used a reduced number of the initial coding categories to order and compare the profiles. Our goal was to find organizing themes without oversimplifying or over-generalizing.

In the analysis of the interview data we wanted to understand the elements that influenced students' confidence. We sought to understand by listening to what they had to say about it. We looked behind the words for their assumptions about confidence and the role it played in their successes and failures. By listening to their stories we gained insights into how they constructed

confidence and how the actions of significant others (teachers, peers, parents, and employers) challenged and enhanced their sense of confidence in themselves and in science as a career direction.

To assure validity in the interpretation of the interview data we sought feedback from colleagues as described by Wolcott (1990), and the student participants, as advocated by Roman and Apple (1990). We met with our students in an informal setting each year to discuss our work in progress, and provided them with copies of papers and other communications. Their reactions constituted another check on the validity of our analysis and interpretation. Furthermore, we consulted at different times with independent researchers skilled in qualitative data analysis. We provided each consultant with sample interviews and compared themes and interpretations they identified to our own. These checks enabled us to identify and correct omissions or biases in our analysis.

After the second and third interviews, categorical analysis fit the data less well, and we worked with longer narrative segments. The longitudinal nature of the data allowed, indeed demanded, different ways of understanding, or making sense of each student's story. Thus, one aspect of our analysis became focused on the work of Margaret Somers.

Somers (1994) has synthesized work in narrative studies. She proposed a theory that focuses on the stories people tell and use as guides in the construction of identity: "people construct identities (however multiple and changing) by locating themselves or being located within a repertoire of emplotted stories. . . . " Somers argues "that *experience* is constituted through narratives; that people make sense of what has happened and is happening to them by attempting to assemble or in some way to integrate these happenings within one or more narratives; and that people are guided to act in certain ways, and not others, on the basis of the projections, expectations, and memories derived from . . . available social, public, and cultural narratives" (p.616).

This is strikingly similar to the "transactional self" described by another constructivist, Jerome Bruner (1986) , for whom the images and stories of a culture provide "a map of possible roles and possible worlds in which action, thought and self-definition are permissible" and, indeed, comprehensible (p. 66). Chanfrault-Duchet (1990) labels such images and stories collective myths. Somer emphasizes the sociological perspective in that she explicitly situates the individual in a specific historical and relational setting which includes institutions, structures of power, cultural networks, and those others who are central or significant to that individual.

In this study, the students defined who they were and how they saw themselves through the stories they told about their experiences in college. In our analytical work, we came to see that certain themes were shared by many students. Initially we identified these as normative statements and our coding labels reflected their imperative tone, for example, "women should". . . "a good student should. . . ." These shared themes may also be called public narratives, which are part of cultural, institutional and interpersonal networks larger than the single individual (Somer, 1994). In other words, they may be understood as part of a repertoire of narratives available to individuals trying to make sense of their particular experience. The list of such collective myths or narratives include:

- speaking out in class takes confidence
- a good student should be able to learn from any teacher
- girls and women should do science
- a science diploma keeps all career doors open and opens doors to the best jobs
- a woman should raise her own kids and not "push them off on strangers"

We will discuss these narratives in the sections *Results and Discussions* and *Three Perspectives on Confidence in Science*.

bias, balance, and frequency counts

In a qualitative study like this one, we do not count the frequency of events, rather, we report the events as recalled. These accounts were not balanced. For example, we asked students to tell us about encouraging and discouraging experiences. Although discouraging events came readily to mind, encouraging events were harder to recall. Interestingly, the encouraging experiences they recalled tended to be associated with jobs and activities outside of college .

Rather than discounting such anecdotal evidence as isolated or unique incidents, we emphasize that each life is composed of such events woven into individual history and social context. The quality of experiences may outweigh or overshadow their frequency. Many of the classroom events were public and even one incident of rudeness or harsh treatment could affect all those who witnessed and participated. Our goals were to identify patterns rather than make generalizations, and to open up possibilities rather than draw conclusions.

We believe that the value in this approach is principally to illustrate, from the students' perspective, the kinds of experiences that diminish and enhance their subjective sense of confidence.

Rather than revealing *the truth* we see our role as similar to the one described by Jane Gaskell (1992) as offering *alternative* ways of seeing the world.

This kind of reporting may be of value to science students who can recognize their own stories in those of other students. As they realize their experiences are not unique, their sense of isolation may be broken. Such insight might be of particular value for female students who have a greater tendency than males to accept blame for failures and other negative experiences (Sidorenko et al., 1989).

We hope that science educators will use these specific and concrete illustrations to reflect on their own practices. We see two obstacles to reaching this audience. First, some teachers may not be aware or may not recognize how their own practices are similar to these accounts in effects or consequences. Second, this kind of reporting may be particularly foreign or inaccessible to teachers in the sciences who customarily value generalizations based on statistical evidence from quantitative studies.

Quantitative Measures of Confidence

A quantitative analysis was done on the relationship between confidence and academic performance and persistence. We chose as an objective indicator of confidence the short form of the Coopersmith Self-Esteem Inventory (SEI). Academic performance was measured by course grades and number of failures. Persistence was defined as perserverence in the science program.

Coopersmith Self-Esteem Inventory (SEI)

The Coopersmith SEI was developed and used for academic settings. It is a twenty-five item, self-administered questionnaire. Scores were ranked (low, medium, and high) by using the individual's quartile rank in the group (scores in the lower quartile were designated low self-esteem while those between the lower and upper quartiles were classified as medium).

Self-esteem, assessed by the Coopersmith SEI (1981b), is defined as "the evaluation a person makes and customarily maintains with regard to him-or herself." The instrument "centers on the relatively enduring estimate of general self-esteem rather than on specific and transitory changes in evaluation" (p.5). We used the Adult Form adapted from the original School Form of the Inventory. The Adult Form is designed for persons 16 years of age and over. The total score correlation of the School Form with the Adult Form exceeds 0.80 (p.6).

Like the majority of objective measures, the SEI was standardized on all male samples. Initially Coopersmith used mixed samples of school children to validate the SEI. However, he excluded female subjects from the research on which the more theoretical work, *Antecedents of Self-Esteem*, was based, but used the mothers (and the mothers' time) to provide information on the behaviour of the sons and their fathers.

RESULTS AND DISCUSSION

The Setting: a Science Program at CEGEP

The purpose of the science program is to give students a general science education equivalent to the first year of a Canadian university outside Quebec, and to prepare them to enter undergraduate programs in science, engineering, or health-related fields. The program comprises two streams: Pure and Applied Science and Health Science (fig.1). The normal work load is seven courses per semester: three *concentration* courses chosen from mathematics, physics, chemistry or biology, three *core* courses English, humanities, and physical education, plus one student elective. Some students may opt for a course in geology or computer science to supplement their interests.* The science program is designed to be completed in four semesters (two years), however, the majority of students take at least one additional semester to graduate.

figure 1. Program Distribution of Persisters

The chart shows the distribution in the Pure and Applied (P & A) and the Health Science streams of those students who stayed in science during the course of the study.
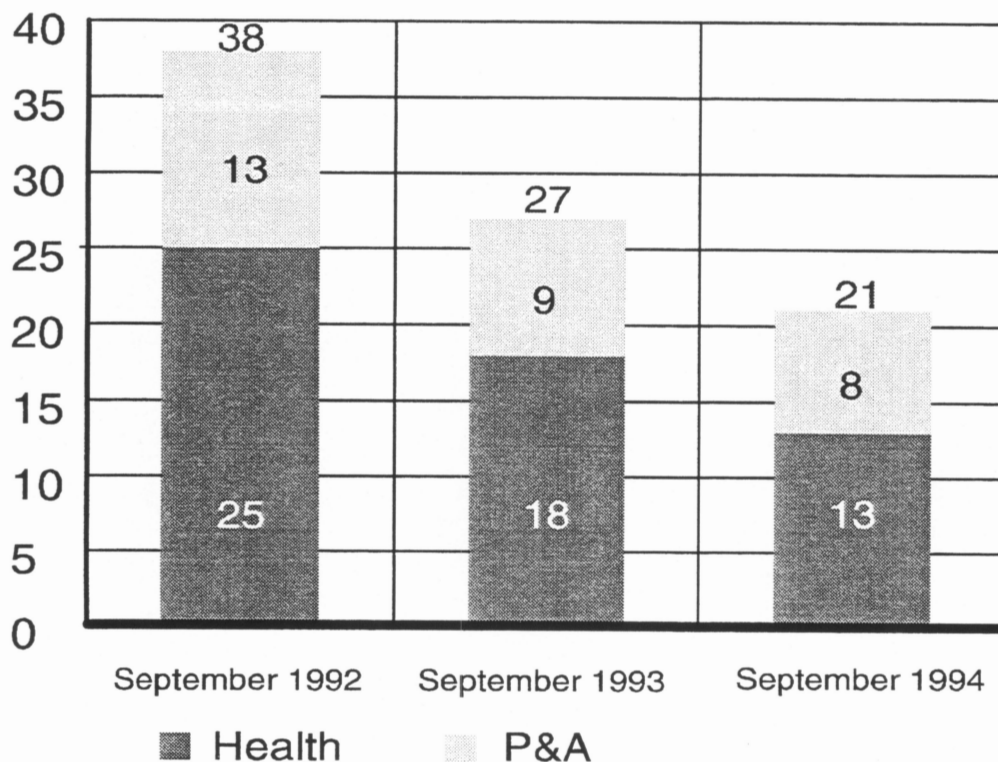
* A revision to the program was implemented in 1993; thus courses and workload are now different. Our cohort of students followed the old system..

institutional characteristics

The average class size in a science course is between 35 and 45. Biology, chemistry and physics courses meet five hours per week. Three hours are designated as lecture and two hours are for laboratory instruction.

Classroom observations were limited to lecture sessions. Chalk boards and overhead projectors were the only tools used during the class visits. All lecture sessions, except for biology classes, included some problem-solving time in which students worked on mathematical or computational problems, usually at their desks, while the teacher walked about the room. During one lecture, students competed four-at-a-time to solve designated problems at the chalkboards. Science concepts were presented first through mathematical demonstration or proofs, rather than through discovery or intuition.* A teacher in either chemistry or physics might begin a class with "What we are going to do today is take a look at [concept]. As practical "number-crunching" starts, these [problems I will display on the overhead projector] are the same as you will find on pages. . . [in your textbook]." After twenty to thirty minutes of "number-crunching" a teacher might give another twenty minutes of *theory* or explanation of why the concept is important; "Now, without doing it quantitatively, let's see how. . . [it works] on the basis of modelling." And later, "Okay, now we can discuss what we can do with this [in every day life]."

Student participation consisted of responding to teacher-initiated questions, and sometimes offering their own. The proportions of such teacher-student exchanges within lecture presentations varied considerably. In most of the lecture classes, students appeared passive. However, closer observation revealed that they were working in complex ways. In addition to listening and taking notes, students engaged in private exchanges in which they asked each other for explanations of the lecture. These exchanges, although problematic in that they created a certain amount of ambient noise, did help some students to stay on track. Such talk may be productive rather than dysfunctional, and may be particularly necessary where opportunities to ask questions are limited (see p. 45-57). Many students worked on assignments while the teacher lectured. Frequently these assignments were for other courses. Thus, the level of attention directed towards the lecture varied widely.

Teachers asked rhetorical and closed questions more often than open ones. "How do I get the magnitude of a vector from the components. . . ? Do you agree that. . . ? Do you want the exam Monday or Wednesday?" There were few discussions.

* Students described physics, in particular, as being counter-intuitive.

Observations in a selection of math and science courses suggested that they were based on a conception of college-level science as a body of facts and prerequisites to be communicated by teachers and mastered by students. As a good study strategy, teachers regularly recommended that students study old exams on file in the library.

The above description sets the dominant institutional climate. There are teachers who use different strategies, hold different values, and occasionally pursue different goals, but common final examinations for multi-section courses, in practice, limit the degrees of freedom for teachers.

teacher culture

At the post-secondary level, science teachers are predominantly males. All of our students' science teachers were over the age of forty, and thus approximated a fatherly or parental status. The combination of maleness, age, and academic certification constitutes an extreme status and power differential between teachers and seventeen year old female students.

Most science teachers at our college would say that gender does not matter in the science program. Nonetheless, there is a gendered hierarchy of student achievement in the sciences that seems unique. Teachers and academic advisers use the terms *top female* and *top male*, not simply *top student*. When an academic advisor told a student she was *the top female* in her program, the student said, "No, don't tell me that! [laughter] Because then I have to keep it up. And, then I'm like, Okay, so who's the top male?"

The achievements of top students, particularly in external competitive examinations and in admissions to medical school, are significant sources of teacher satisfaction. However, in conversations with our peers, we most often heard teachers discuss students' abilities in terms of their weaknesses, and what they do not know, rather than in terms of their accomplishments. Teachers attributed students' failures to inadequate preparation, poor study habits, and lax admissions criteria.* It was acknowledged, however, that today's students do have a broader preparation and wider interests.

Among students, particularly those in other programs, the sciences have the reputation of being killer courses. The main goal appears to be to prepare students for university science or engineering programs, rather than to give them a general or basic science preparation aiming to make a student scientifically literate. Departments offer general interest courses, such as *Chemistry of Winemaking*, and *Biology of Sexuality*, which students refer to as *not real science*.

Quantitative Data Analysis

confidence

The mean self-esteem score in Year One for all 38 students was 67.316 with a standard deviation of 17.099 and a median of 69.00. The mean self-esteem score in Year Two (calculated on 33 students) was equal to 71.758 with a standard deviation of 19.357 and a median of 76.00. For Year One, students whose scores fell below 64 inclusive were rated as low self-esteem. Those whose scores were between 65 and 75 inclusive were medium self-esteem, and those whose scores were 76 or greater were high self-esteem. For Year Two, low self-esteem was 65 or lower, medium was 66-83 inclusive, and high corresponded to 84 or greater.

Change in self-esteem from Year One to Year Two was calculated in several ways. Subtracting raw score self-esteem at Year One from the raw score at Year Two resulted in a mean difference score of 2.303 with a standard deviation of 12.924 and a median of 4.00. This difference score was converted into a dichotomous self-esteem difference score. Students whose self-esteem decreased or stayed the same from Year One to Year Two were labelled *Decrease/Same,* while students whose score increased were labelled *Increase.* Twelve students' self-esteem decreased or stayed the same, while 21 students' self-esteem improved.

Another difference score was calculated from the tertiary splits on self-esteem described above. Participants' rank on self-esteem at Year Two (low, medium, high) was subtracted from their rank at Year One. Students whose self-esteem decreased to a lower rank were coded as *Decrease.* Those whose self-esteem remained relatively constant were coded as *Same,* and those whose self-esteem increased to a higher rank were coded *Increase.* Six students' self-esteem decreased by this measure, 21 stayed the same, and six showed an increase over the two year period.

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* This is not unique to our institution. See for example *Science*, 266 (4) Nov. 1994, a feature issue on university programs, where professors describe students as "poorly prepared in math and sciences. . . fearfully underprepared," and varying "widly" in their level of preparation. All of the examples of poor preparation are factual: "Even at top science schools such as MIT and Caltech, faculty members can easily point to undergrads lacking such basic knowledges as the fact that white light is composed of different colors" (Gibbons, 1994, p.845).

academic performance

Students' academic performance was measured for each year by the grades they achieved in science, math, and other classes at Year One and Year Two. These marks were transformed into deviation scores from the class mean. Performance was also assessed by the overall average mark and by the total number of failures from each year (see Table 1). One participant's grades were considerably worse than the others, resulting in skewed distributions on several of the performance measures. As this participant did not complete either semester, her data was omitted from the following analyses.

Table 1   Relative and Overall Performance, and Number of Failures

Year One	Mean	S.D.
Relative Grades*		
Math	4.10	17.78
Other Science	3.23	17.65
Non-science Courses	7.35	7.92
Overall Performance		
Overall Mean	75.97	10.05
Number of Failures	1.35	1.57
Year Two		
Relative Grades		
Math	-1.56	19.89
Other Science-	1.50	14.87
Non-science Courses	6.47	7.88
Overall Performance		
Overall Mean	75.30	11.79
Number of Failures	1.37	1.80

* Measured as deviation from class mean.

persistence

Persistence was measured by continuation in the science program. Of the original 38 participants, thirty continued in science throughout Year One, while eight changed to other programs. At the end of Year Two, twelve graduated in science, eleven remained in science at John Abbott, three more had

Figure 2.   Program Changes of Students in Sample

Beginning of third semester

Science
27
3 — Left the college
8
Other programs

End of fourth semester

DEC in Science   Science
12   11
4 — Left the college
11
Other Programs
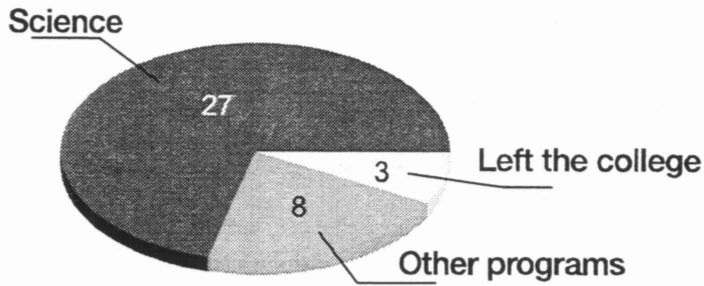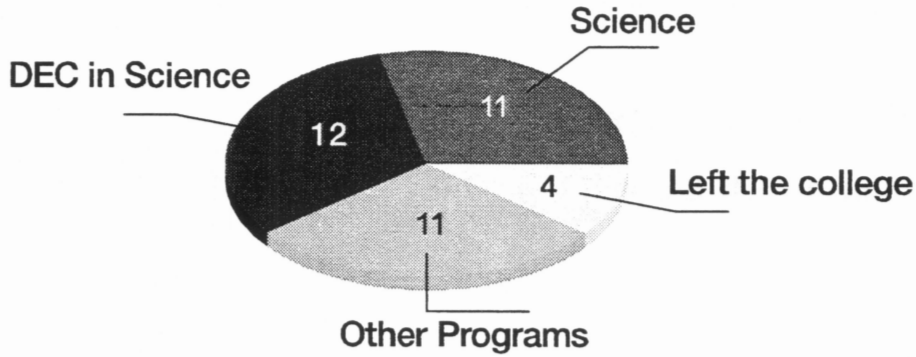
Beginning of fifth semester

DEC in Science
4   Science
6
1 — Dec in other program
7   10
Other programs   Left the college
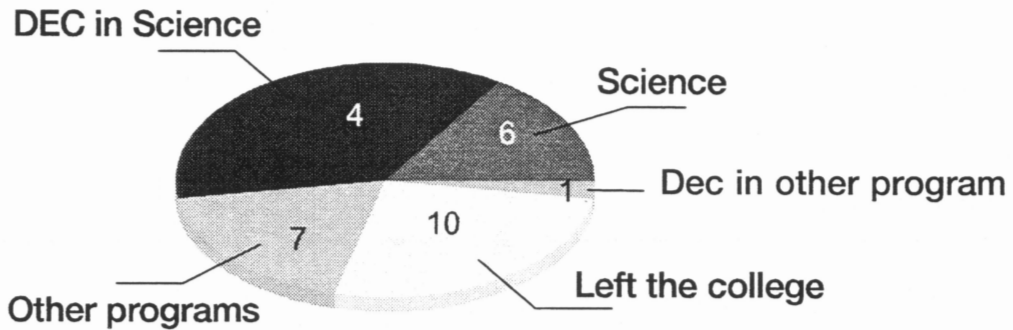
THE CHARTS SHOW HOW STUDENTS, ALL ORIGINALLY ENROLLED IN THE SCIENCE PROGRAM, TRANSFERRED TO OTHER PROGRAMS OR LEFT THE COLLEGE DURING THE COURSE OF THE STUDY, SEPTEMBER 1992 - DECEMBER 1994.

switched out, and four had either dropped out of college or transferred to other institutions. (Participants who graduated after Year Two, and were listed as having continued in the program in Year One, were included among those persisting in the program at Year Two for all further analyses.) Thus, a total of 23 subjects were considered to have persisted in the science program through Year Two. (Fig. 2)

performance and self-esteem

Five one-way analyses of variance (ANOVAs) were calculated to predict relative grades and overall performance at Year One from the three-group (low, medium, high) self-esteem scores at Year One. None of these analyses were significant (see Table 2). Similarly, five one-way ANOVAs were used to assess the impact of self-esteem at Year One on performance in Year Two. As shown in Table Two, none of these anaylses approached significance. Thus, self-esteem at Year One does not appear to have predicted academic performance in science or non-science classes, nor did it predict overall performance.

Table 2   Performance by Self-Esteem at Year One

Performance, Year One by Self-Esteem, Year One	d.f.	F	p
Math Courses	2.34	1.95	n.s.
Other Science Courses	2.24	<1	n.s.
Non-science Courses	2.34	1.25	n.s.
Overall Mean	2.35	<1	n.s.
Number of Failures	2.35	1.51	n.s.
Performance, Year Two by Self-Esteem, Year One			
Math Courses	2.25	<1	n.s.
Other Science Courses	2.34	1.22	n.s.
Non-science Courses	2.31	<1	n.s.
Overall Mean	2.32	<1	n.s.
Number of Failures	2.32	<1	n.s.

One way ANOVAs were then used to assess the relationship between self-esteem at Year Two and performance scores at Year One and Year Two. Of the ten analyses performed, none were significant (see Table 3). Thus, self-esteem at Year Two did not predict academic performance at Year Two. Self-esteem itself does not appear to have been influenced by academic performance at Year One.

Table 3   **Performance by Self-Esteem at Year Two**

Performance, Year One by Self-Esteem, Year One	d.f.	F	p
Math Courses	2.30	1.45	n.s.
Other Science Courses	2.30	2.12	n.s.
Non-science Courses	2.30	<1	n.s.
Overall Mean	2.30	<1	n.s.
Number of Failures	2.30	<1	n.s.
Performance, Year Two by Self Esteem, Year One			
Math Courses	2.24	<1	n.s.
Other Science Courses	2.24	<1	n.s.
Non-science Courses	2.28	<1	n.s.
Overall Mean	2.29	<1	n.s.
Number of Failures	2.29	<1	n.s.

persistence and self-esteem

Chi-square analyses were performed to test whether persistence in science was related to self-esteem. Persistence at Year One and at Year Two were both unrelated to self-esteem at Year One, $\underline{X}^2 (2) = 3.12$, n.s.; $\underline{X}^2 (2) = 3.07$, n.s., respectively. Likewise, persistence in the science program at Year One and Year Two, was unrelated to self-esteem at Year Two, $\underline{X}^2 (2) = 1.72$, n.s.; $\underline{X}^2 (2) = 2.76$, n.s. respectively. Therefore, there does not appear to be a relationship between self-esteem scores and persistence in the science program.

performance and change in self-esteem

One way AVOVAs were performed to examine the relationship between academic performance at Year One and at Year Two and change in self-esteem from Year One to Year Two. Five analyses were done on academic performance in each year (see Table 4). Only one analysis was significant. Change in self-esteem was significantly related to performance in math courses Year One $\underline{F} (2.30) = 3.98$, $\underline{p} < 0.05$. Post hoc Newman-Keuls tests revealed that subjects whose self-esteem improved from Year One to Year Two performed more poorly relative to the class average in math courses at Year One ($\underline{M} = -9.25$) than did the subjects whose self-esteem either remained the same ($\underline{M} = 6.31$) or decreased ($\underline{M} = 14.50$.) Thus, subjects' self-esteem seemed to improve from Year One to Year Two if they did relatively poorly in math in Year One. Given the number of tests performed, however, this result should be viewed with caution, since performance of a large number of tests increases the likelihood of obtaining a significant result just by chance.

Table 4   **Performance by Change in Self-Esteem**

Performance, Year One by Change in Self-Esteem	d.f.	F	p
Math Courses	2.30	3.98	<.05
Other Science Courses	2.30	<1	n.s.
Non-science Courses	2.29	<1	n.s.
Overall Mean	2.30	<1	n.s.
Number of Failures	2.30	1.05	n.s.
Performance, Year Two by Change in Self-Esteem			
Math Courses	2.24	<1	n.s.
Other Science Courses	2.24	<1	n.s.
Non-science Courses	2.28	<1	n.s.
Overall Mean	2.29	<1	n.s.
Number of Failures	2.29	<1	n.s.

Performance and change in self-esteem was also assessed using the dichotomous split described in the self-esteem section of the results. These analyses did not differ from the results obtained with the three-group split of self-esteem, and so will not be further discussed.

persistence and change in self-esteem

The relationship between persistence and change in self-esteem was examined using a Chi-square analysis for persistence at both Year One and Year Two. Neither of these analyses was significant ($\underline{X}^2(2) = 2.27$, n.s. for Year One; $\underline{X}^2(2) = 3.24$, n.s. for Year Two). There does not, therefore, appear to be a relationship between persistence in science and change in self-esteem.

Qualitative Data Analysis

One advantage of an in-depth rather than a comparative study of confidence is that it highlights the differences between young women and reminds us that generalizations such as *women lack confidence* misrepresent many of them. The feelings and experiences of confidence that these women described were as diverse as their backgrounds. Yet, all these women had done well enough in sciences in high school to be admitted to a college-level program and the beginning of their first semester was a time of high hopes and aspirations. For most of them, college was a new beginning following the successes of high school.

too much confidence

Some women thought that an excess of confidence had been problematic, or at least unrealistic. Others said that they either lacked confidence or didn't have enough. They all claimed that the confidence they described was an *outcome* rather than a *cause* of their successes or failures in courses.

One women was in an advanced or accelerated program in high school. She began talking about confidence in negative terms: "Confidence? I think that if you don't think you will do well, you won't." Her narrative identifies a series of real events associated with workload, the level of understanding, and evaluations from teachers, that lead to discouragement.

> Like, at the beginning of the year I was like really, oh yeah, this is going to be good, I'm going to do good in this class. . . then you get more work and things get more confusing and the teacher gets more picky. Your marks start going down and then you start to get discouraged. So then it's just like, why bother, I'm not doing good any more. That's why I find lots of people just let go of a course.

Although this narrative starts with "if you don't think you'll do well, you won't," it appears those thoughts come to her later when the workload, her lack of understanding, and the teacher's evaluation got her discouraged. The positive thoughts in the beginning, "this is going to be good," did not assure success.

Another student said she had "too much confidence" and had to narrow her expectations about what she could do in the future. This is a picture of confidence adapting to a new awareness of "things that get in your way".

I had too much confidence when I came here. [You did?] Yeah, coming from a small school. . . being the best there. Not ego, but you thought, I can do this, I can do that. Get here and it was a lot different. . . . Yeah, it definitely changes. It has a lot. Like I still have confidence and - not so much the level changes, but how you - a different way of looking at it I guess? . . . I still know I can do something, like I still have confidence and everything, but I know that you have to work at it and it's not as easy, it's not just, okay, go out, [and] do this and you'll do it, and you'll get this, sort of thing? There's little hooks and loopholes and things along the way that get in your way. . . just unexpected things that come up that you never thought about, like not liking something you thought you would or just things getting in the way.

Not every student got caught on the "little hooks and loopholes." Nearing graduation this student still believed anything was possible.

I think I could do anything that I want. I could do anything, even if I don't want to do it. . . . I could even become a psychologist. I don't think I'd be happy in it, so I won't become a psychologist. If you work hard you can do what you want.

Still, this student experienced doubts she could get into the career of her choice (medicine) after receiving disappointing grades the first semester. Like the previous student, she says her confidence in herself doesn't change, despite doubts about what opportunities lay ahead.

Like, last year I was really confident that I would get into medicine and now I got my grades and it's like, oh, my god, what happens if? What if, what if? And then I guess I put more pressure on myself to keep studying. Like, I don't have tests this week. But, I will study. I will study just like I would have tests, I guess. [What about confidence in your own ability somehow, does that change?] No. No. Cause, I know I can do it. I know I can get good grades. I got good grades before. I don't know why I wouldn't be able to get good grades now.

In both students' narratives we see the shared belief that "if you work hard you can do what you want." However, the first student has scaled down from *anything* you want to *something*. Obviously, the competitive grading scheme, as well as stringent acceptance requirements at higher institutions assure that not every student can get good grades, or that those who do, can be anything and everything, as this student suggests.

[Can you think of times where your confidence has changed - lows and highs and that kind of thing?] When I went into [college] I was all confident that, you know, I could do it and everything. And then it just kind of like soared to an all time low, when I found out that I couldn't. . . .

The contrast between these last two students illustrates the link between changes in confidence and *competence*, or successfully meeting the demands for achievement. The maxim, "if you work hard you can do or be anything" was widely shared. Those who encountered "things that got in the way" modified that belief. A student who was successful might attribute this to hard work. A student who worked hard and still did not succeed offered other explanations that included a lack or loss of ability. Nevertheless, no students said that a lack of confidence in themselves caused such problems.

doing well

Those who had worked hard for marks in high school were most vulnerable to doubts about their ability. One student who had been a hard-working honours student in high school, was tearful and depressed before the end of the first semester. "I'm having so many problems with school I feel like I don't have brains any more." Her "problems" at college were not failures, but rather, grades in the 65-75 per cent range. She was passing, but not doing well enough to qualify for admission to university programs in medicine, dentistry or physiotherapy (the three most frequent preferences). Students with a similar profile (passing, but with unaccustomed low grades), felt they were not doing well.

Students' beliefs about the admission criteria that universities use influenced their interpretations of how well they were doing. Expectations about grades, and definitions of *doing well* were derived through a complex weighing of their own past history, current prospects and future aspirations for schooling and careers. For most, 75 per cent was the lowest "okay" acceptable, tolerable or good-enough grade. These young women were already aware that once at university or in the workforce, women in scientific fields would be more visible than men. Therefore, they felt they needed proof of their competence, such as obtaining high marks.

Students who were not doing well revised the picture of themselves. They talked in terms of their abilities, particular mind-set, "knack," and gifts.

I just had this different idea that, you know, sure I can do it, I did it in grade eleven. Then when I figured out that I couldn't, it kind of shocks you. . . Sometimes I'll go to bed and

just like think about it, you know. I end up not being able to sleep, cause I just start think-
ing so much. You know, like why can't I get it? And then I just found myself like, "Oh
well, I can't get that," just making excuses, you know. Just because I don't have the proper
mind or something.

Not "getting it" led another student who had done consistently well in high school to speculate
that "maybe I just don't have it" and even to wonder if she had only imagined she "had it" earlier.
She was thinking seriously of switching to the commerce program at the end of the first year, but
stayed in science because she was stubborn and remembered, or thought she remembered, things had
been different in high school.

Like, when I remembered high school. . . I said, "Well, no. . . it was easy in high
school." That's why I didn't know what had happened. My marks were so good in high
school. I enjoyed it so much. And I liked science so much. And then when I got here,
like nothing was clicking in any of my courses. And I couldn't understand. And I said [to
myself], you don't just turn stupid, or you don't just lose your study skills, or whatever I
had, they wouldn't just leave. And, yeah, so that was it. Right away over the summer, I
was just switching to commerce. Cause I said, well, maybe I just don't have it. Maybe, I
was just imagining high school.

To some students, a *different abilities* explanation was suggested. This woman who also
experienced a decline in grades, was wondering,

. . . whether you're still as smart as you thought you were, or whether you were just
smarter then. . . And, then another thing, like, I liked my [discipline] teacher, but he said
"My wife" - that's him saying it. He goes "My wife couldn't do [this course] to save her
life. She couldn't get past, like grade 9 math" he said "but she's still a very intelligent
woman, just in different areas." So that's maybe what I think it is. Maybe I'm not intelli-
gent in math, physics and chemistry, but I have - I know there's other areas [where] I am.

Redefining themselves as members of that group who can't do science has negative consequences
for their dreams about careers and for their self-image because they have been taught that "the best
students do science," and science programs are the open doors to all of the well-paying, high status
jobs. "Everything would be closed to me if I don't do well."

Students who were not doing well in their science courses re-evaluated their career aspirations, sometimes trying unsuccessfully to rearrange the heirarchy of careers into a series of equivalent choices.

> I had a chart, like if I wanted to put it into this sense, I had a chart. At the top is zoology, we'll call it the animals - zoology - and then next might have been, you know, I haven't really thought out the rest because the top was so clear, but the rest would be like, you know, what is it, what's the other one? - anthropology - there we go! - archaeology and then it would go lower and lower past the different jobs that I like. I think what you have to do is just move the top to the bottom and put them all on the side, equal with one another and just choose. . . . But, that's hard to do because what I'd really like to do is zoology. . . . I don't think you can [make them equal] because if that's what you want to do how can you put everything else on equal footing? So, there's nothing I really want to do as much as that one. So there is no chart basically. When I was younger, you know, you had everything. . . . [pause]

A student might begin revising her career dreams on the first day of classes, before any of her work had even been evaluated. This happened to one woman after her teacher announced that they'd have to have 90-95 per cent to get admitted to the most sought after university programs. Teachers may intend such statements to motivate students to work hard and do their best, but they may have the opposite effect on students who know how few are able to achieve a 90-95 per cent. Thus the emphasis placed on being a *top-student* can be a source of discouragement.

> One of the teachers came in, one of the first things he said was, "If you don't get 95, ninety to 95, McGill [University] doesn't accept you. . . . The lowest they'll accept is eighty, and if you have any marks in the seventies, science courses in the sixties, they won't accept you. Won't even look at your circumstances." So right there I felt, you know, like in shock. . . I couldn't breathe, I said, "Oh my god, forget it." That's exactly what I said when I went home. I figured I'd have to look for something else besides health. . . . Like I'm - I can't. There's no way I can compete with these people, what happens if I don't get up over 85 or whatever? I just got discouraged.

Another student persisted past this early discouragement into her second year. Although she still dreamed of being a dentist, she did not take the required tests for admission because she believed her seventy average wouldn't "open the door."

I know that you were supposed to take a test. I didn't take it cause I knew I can't get in. I feel like I'm not even gonna open the door. I can't even go to the door. Like the mat of the door I can't even go. They're not gonna accept me.

Declining expectations, combined with messages from teachers and guidance councillors that only the highest grades will qualify students for university, was a significant discouragement for many women, including some students with an honour roll background. "I've never been as discouraged as since I've started [college]. Now I'm looking [at other university programs because] I can't aim as high."

Conflicting information from different sources sustains uncertainty about the feasibility of career aspirations. These periods of discouragement and doubt, which often diminish a student's motivation, are costly because the fast pace and sequential nature of required courses need continuous, steady work. The uncertainty raises the question, *is it worth it*?

When I came to CEGEP, I was pretty confident I would finish with high marks and I would go on straight for a veterinary. And, then after - It's like, well, my marks started to go down. It's like I didn't have as much confidence that I would be able to do it. And, then last fall, [another woman said that] her son with the 92 average was refused - I was like - Then it's like - I figured I'll never get into veterinary. So, I wasn't sure what I would do, or if it was even worth - I was, like, unsure if I'd get accepted or not. So, then - Well, it was like - I think it was two weeks' ago - And, the guy who was telling my Mum [that] someone with a 72 average was accepted, well that helped a little bit. . . . You don't know if you'll be able to achieve it or not . . . . Especially, when - Like, I wasn't sure when I - When I found it hard and that, but then when I found a 92 average was re-fused, it was like. . . [Did you give up your dreams at that time? What did you think?] Not really. Well, I thought, well, I don't know if I'll be able to do - Go in and study for a veterinary. I don't. . . But, after a couple of weeks I figured, well, if I can't get accepted for a veterinary, there's always lots of other things I could do. But, it was like - I'd like to be a veterinary, but like, well. . . I figured I'd apply anyway and if I was refused, I was refused.

evaluation, marks, and confidence

Teachers' methods of evaluating students could encourage or discourage students early in the term. Most students approached college with high hopes. This student worried about failing the summer before even beginning college. Her mother reassured her; "It isn't set up for you to fail,

people don't want you to fail." However, she was among the eighty per cent of students who failed the first test in one of her science courses. Her first thought was "OK, wrong program" because she had studied, worked hard, and thought she understood basically everything in class. She staked her hopes on doing better on the next test, "now that [she] saw how the tests are. . . [and] know how it is."

Many students encountered testing based on a *weed-them-out* philosophy. This approach may have gone out of fashion in the best American universities, as journalist Ann Gibbons (1994) claimed in a special feature in *Science,* on science education. There are still teachers who believe that a difficult first exam will motivate students to work harder. A failure rate of 80 per cent on a test might, as Mary Frances Richardson (1993) said, be compared more accurately to clear cutting rather than *weeding out*.

One student did well in high school and expected marks in the 90's. During her first interview, she was discouraged because she had failed her first math test. The class average was 60 per cent. She "guessed" she "didn't study the right things" but the results of the test made her feel like she didn't want to study any more.

"Something in the seventies" would have been "okay" with another woman, who was "not expecting nineties." But she, too, was shocked and discouraged by the results of the first test. "At first I felt like I didn't want to stay any more."

Exacting examinations with high failure rates discouraged many students early in the first semester and caused some to question whether they were in the right program. In our interviews, we clearly saw a range of reactions that pointed to confidence being sustained or undermined by teachers' methods of evaluating student learning. One student who had studied abroad had considerable insight into the discouraging effects of "super hard" tests.

> Like I know some teachers, they make their tests like super hard, which I find is very discouraging. Because, even if I studied. . . [if] you put, like, a really really super hard problem on the test, I wouldn't be able to do it. And I would be really discouraged and I would have no confidence.

trick questions

Frequently, teachers use increasingly complex problems to sort students by means of *objective* tests. Students call this category of problems *trick* questions. Past performance and regular study are no insurance of success.

> All his tests are trick questions. Like they're all the hard, the hardest examples, of every, every single question. You have to do some sort of manipulation to it, if you're going to get it.

The next quotation contains the elements that teachers might use to describe *trick* questions, although they would be unlikely to use that term. Most teachers agree that it is acceptable, even desirable, to include in a test a few questions, that require students to "put different things in different situations. Thus, a student cannot "memorize" but has to "understand" in order to "put it into the equations." The pedagogical justification for asking students to apply known concepts in an unfamiliar context is to encourage them to think more deeply about the concept and not simply memorize and use an algorithm to solve a problem. Undoubtedly, teachers also use *trick* questions to determine who is worthy of top marks in a class. Teachers believe such questions separate the weaker students from the stronger ones.

> I like teachers who will teach you the material and then in class give you examples. . . . Then you can go home and you'll know the type of question that'll be asked. You'll know what to expect. And this teacher, he'll give material and then on a test he'll give you the questions. And you don't really know all the terms and you don't. . . Well, you think you know the material and then, I guess, when it comes to asking it, you have to put different things in different situations. They'll trick you, so you have to know really - I don't know how to explain this? You can think you know something and then when some-one asks you to do something with it, it's like a whole different thing. You think you know it. You can memorize it. You can do anything. But, to understand it you really have to know how to put it into the equations.

When "all [a teacher's] tests are trick questions," students feel frustrated by the evaluation process. This student came in liking math and had taken calculus in an advanced high school program.

> My first quiz I did very well, but I was like just starting to like - oh my goodness these are so hard. . . but I did get them. And then my second quiz, now my marks are starting to go

way down. Like just, I don't know what to do now with all these trick questions. Even if I get it, I'm so sure that it's not the right answer that I cross it out, and then I don't do it. And I don't [know] about this last test. I'm now doubting if I even passed.

Knowing is demonstrated predominantly in one way: "knowing how to put it into the equations". "Trick questions" make it difficult to know what one knows and to judge one's own performance. Confidence can be brought down, even erased, by such questions because they dissolve trust; trust in what one can do, trust in what one knows, trust in the teacher, and trust that "you'll know what to expect". One student even lost confidence in her textbook because there were errors in the solutions to problems.

> And it's not just me, it's my other friends [who] used to do well in math. . . and it's the whole crap, all these trick questions. [laugh] They're, they're like. . . I now don't trust that I can do a question any more. . . And, and having confidence really affects your marks. Like, like my math, like you know, I had no more confidence in my ability of solving problems so he [the teacher] just erased my confidence.

Students are aware that not only their understanding, but also the level of difficulty of the problems, and the teacher's way of marking have an influence on their marks. The institutional legitimacy of marks, and the power of those who determine them, are less open to questions than are the student's behaviour and abilities. This creates doubts and uncertainties.

The student quoted earlier, who had attended schools outside of Canada, made the clearest connection between how difficult or *tricky* the exam was and how well she could do. She was discouraged by low marks even when she was certain she understood the material.

> Well, I thought that I understood everything and in fact I did. . . it's just that the questions, the exam, it was set in a very difficult - a very high standard. And sometimes it's difficult to understand the questions and sometimes they were tricky, so I was sad about it. Like I understood, I understood, it's just that . . . . I liked [the subject]. It's just that the course itself was very difficult for everyone. . . except for some of those particularly brilliant [students]. So the course was difficult and it discouraged me to a certain extent, but now, cause I found out that in Canada the science course is less difficult, then I regained my confidence.

One student, whose favourite subject at the end of high school was math, failed calculus the first year. Reflecting on this surprising outcome, she questioned her capability and her study habits. "I thought I was capable of getting eighties and up." Although she wondered if she should have studied more, she also believed she understood more than her marks indicated because the teacher's marking system placed too much emphasis on right or wrong answers, which made it easy to miss a question and lose marks. She obtained a ninety per cent when she took the course a second time. It is interesting to contrast her account of the failure ("I didn't try hard enough.") with her account of the 90, ("I guess I just liked the teacher better").

The connection between *liking the teacher* and *doing well* is an important theme that will be discussed in detail in the section on relational learning (see p.58-66).

Perhaps the student who was outraged rather than discouraged by a low score on the first test conforms most closely to the common image of someone who has confidence.

> The tests are awful. The first test I got sixty per cent. I was really mad and I went to see [the teacher] and I complained a lot! [laugh] I was like, this is impossible! I'm not used to this. I studied a lot and - The average must be - I dunno, like fifty or something. I think four people in his two classes, or three classes, got 75 or more. So I went to him and [said] like, this is impossible! and I was almost screaming. But he has a good sense of humour so, I guess it didn't really matter. . . . I went like, "Next test, will it be easier?" and he goes "It should be." [The student retorts.] "Well you better make it!". [laugh] You know, I was really mad - "You better make it!"

This savvy student knew that out of nearly one-hundred students, four scores above 75 was *impossible* and acted on this knowledge. Her powerful narrative contrasts strikingly with the student who was expecting an eighty in a course, but did not ask the teacher about it when her final grade was seventy. The interviewer asked if she talked to anybody about that disappointing grade.

> I don't really talk to anyone about it. I just think about it. It goes over and over in my mind and - like what could I have done more to understand. I should have studied more, you know. That's all in my mind. [And do you talk to the teachers about that?] I don't really talk to the teachers. [laugh] I - When I don't understand something, sometimes I will go to them and see them. . . ask them about the questions and stuff. But, other than that, I usually keep to myself.

These two extreme examples vividly illustrate the conflation of confidence, voice and power. The most vocal, "I take a lot of space in the labs. . . I go like, scream it 'Sir' come here," contrasted with one of the most silent, "I just keep my mouth shut. I dunno, I just move aside I guess."

marks and persistence in science: a good enough mark

The tension around marks is an element essential to our understanding of students' choices to persist in programs and careers. It has become conventional wisdom that a male with a grade average of seventy may still aspire to engineering while a female might consider an eighty not good enough. This difference has been another of the so-called indications that women lack confidence. We are reminded, however, that theirs is a concrete concern based on realistic perceptions. They know that the performance of any outsider, deviant, or new kid on the block, is subjected to greater scrutiny than the performance of insiders.

As one student said, in a male-dominated field, women have to deal with such obstacles as "arrogant men," being called "bitchy." Anticipating that they will be *going against the current* they want the comfort of knowing that the work itself comes easily or, as the following student said, "naturally":

[Have you felt any time that you have sort of an advantage, or disadvantage, being a woman doing science?] If I was going into engineering, which I really wish I was good at, because I would definitely pursue it. But, I'm - I could probably get by and become a decent engineer, but I don't think I would really enjoy it. [Why not?] Because - I don't know. Cause I really like biology. So I guess - I dunno. If I ever decided to be an engineer, I might actually enjoy it. But, I guess I don't really know enough about the field to begin with. I've not really considered it. But, I just wish - I guess, I think, cause physics. . . I can pull off an eighty, maybe eighty-five-ish. But, I'd wanna to be able to pull off a ninety, no problem. You know. I guess cause I just think that I should be really good in it, in addition to enjoying it. Not something that I have to really, really work at to do well in. I like it to come naturally. But, then I know people that have seventies in physics and they struggle with it every day and they're going into engineering, so. . .

Physics was this student's "better subject" but she thought she was "maybe not smart enough" to pursue her dream career in aeronautics or space as an engineer.

I'm not scared of hard work cause I've been used to - I've been trained to, you know,
spend lots of hours on homework, but I guess its just the material that I'm, like, sort of
hesitant because I think maybe, I'm not smart enough to do it or I'm like - at least to be in
that higher part of the - you know, like the category, like the top twenty per cent or what-
ever it is that would, you know, give you an edge on the other people - the competitive
part of it. Like maybe I'm not smart enough to achieve that goal.

Examples like this contribute to our understanding of why grades in the nineties are important to
these students, and why their own standards are so high. In addition to believing that they need
nineties to get into university programs, they also feel that they have to be better than average to
make it in male-dominated fields. Believing that they have to be better (nineties, not eighty to
eighty-fives) is being realistic. It is not being *overly concerned with marks*. Those who compare men
and women with seventies, and note that the men have the confidence to go into engineering but the
women don't, ignore the reality that a woman in a man's field is exceptional, hypervisible, and
required to prove her competence.

My dad is an engineer at. . . he says that girls are usually better than the men. I don't
know if it's because they know that they're in the minority so they're working harder.

Half-way through the second year, these two students were finding it difficult to choose a career.
One of them, who had aspired to be an engineer, was now considering teaching. The other was
undecided.

I realize that even though people say "Oh, you're good. It was smart. Good idea," [that]
there are a million other people that are smarter. And I find that now, in the world of
science, when like these big discoveries are all over and it's progressing so fast, I find
that you have to be exceptional to make it. Like good is not enough anymore, I don't
find.

I find it difficult now, because whatever you consider now, you really, really have to look
at the future. You can't just say, "This really interests me," because if you want to be an
engineer, you have to look ahead and see that there are a million and one people in it.
And it will be really hard to get a job, unless you're exceptional.

importance of friends

All through the first year, students questioned themselves: will I do well, am I in the right program? In earlier work we identified transition issues such as larger institution and class sizes, loss of status, and interrupted relationships with peers and high school teachers (Cornell et al., 1990). In this study we observed a more complex network of influences. However, relationships with friends and peers continued to be important to success, especially when students had problems understanding teachers and course material.

> The first semester was, like, shaky. . . I think it was lack of other friends in my class. I didn't have - I didn't know anybody in any of my classes. Like, I'd made some friends in the class, but I wasn't - It was more independent learning. I felt abandoned. Like, I couldn't go to anyone for help. Like, I had two really bad teachers. . . and, usually, if I have trouble, you know, I can go to friends. Like, in high school I would have friends to go to and say like "Okay, how do you do this?" But, I didn't have that because none of my friends were in my classes."

There is a practical purpose to knowing other students in a class. They can help and advise on how to do the work in addition to providing social and affective support. A student who reluctantly switched out of sciences suffered from a lack of friends. She told this story when asked to recall an incident that was particularly discouraging. It highlights the element of confidence that Coopersmith labelled *significance*, which included the responsiveness and interest that others accord, (see p. 10). The student's story may imply a judgment about her own *virtue* as well. She may have begun to feel that she was not good enough to deserve help, as we see from her conclusion that "this person felt too good to help me."

> Probably, just when I would ask other students for help, that I didn't know, that I felt were doing well on the course. And they were just not interested in helping me. Cause if I'm understanding something, I'm willing to help anyone. And it's just not like me. And it hurt me that they weren't willing to help me. And it just, you know, brought down my confidence at the same time; that this person felt too good to help me or something.

Another student, who found classmates approachable and willing to help, linked the practical help of peers, to asking questions and growth in confidence. She said that her confidence grew when friends asked her questions because "You feel they trust you." She continued by saying, "I don't lose confidence in myself easily, I don't give up. If my friends are confident, then I feel confident."

> In science, you get to know everyone. So, I find I talk to people all the time and it's so much easier, you can go up and ask anyone a question. You know, if you can't find a teacher, like "Oh, did you get this physics thing?" And they're like "Who are you? Oh, yeah, yeah you're in my physics. Okay, yeah. Here, this is how you do it."

Having friends was important during class, as well as outside class. Friends and acquaintances sitting nearby, might supplement or clarify something from the teacher's presentation that a student found puzzling. Alternatively, sharing *not understanding* could be equally reassuring:

> There's two other girls that I usually sit with in my physics class, and they both feel the same way that I do. Like, usually, like we'll be sitting in class and I'm starting to be like overwhelmed by what he's saying, because I don't - It doesn't fit anywhere for me. Then I'll like - I'll mention something. Then I'll be like "I don't understand" and she'll say "I don't understand too," and then that kinda makes me feel better. Like, I'm not the only person. And then I'll try, and if I'm having a lot of trouble, then I'll go home and try and figure it out, or look it up or something to do a little better. But, sometimes I'll just say "Oh, well, other people don't understand. I don't either. We'll all be alright in the end." And I don't do anything for it.

> [My friend] can say, "Look, don't worry, I'm in the same boat, I don't understand either" - at least I'm not, like on my own, like the only one that doesn't understand.

Friends both clarify and reassure. Hearing so many students say that they used this classroom resource made us aware that student-to-student talk during lectures could contribute to student understanding. We saw frequent instances of this during classroom observation.

confidence from doing

In the second (and for some students third interviews) we asked students to describe their feelings of confidence during the college years. Stories of gains in confidence most often featured jobs, sports and interpersonal relationships. These accounts of action, engagement and accomplishment contrasted sharply, and for us disturbingly, with the slumps and declines they described in the academic context.

> [We look at confidence and how it might vary over time and events that affect it. Maybe, if you can reflect a little bit on that. Have you seen times when your confidence would go down or up? Do you see fluctuations like that?] Yeah. I find it varies within a

semester; quite a bit. On the whole, I think my personal self-esteem, like, has risen. Like, I know more who I am. Just, like, I'm more aware of what I want. . . and what I like. Like, I'm just more aware as a person. Academically, it's definitely gone down. Like, I doubt how intelligent I am [laugh] a lot of the time. Not a lot, half the time perhaps. [pause] But, it hasn't been completely shattered by my CEGEP experience.

[Can you recall particular leaps or bounds or rebounds in confidence? Times when you felt you were really aware of a surge, or alternatively aware of a plummet?] Well, a surge, like, at work usually. Cause when you have to deal with people, whenever there's actually a problem and people complain, you're able to handle it. So that makes me feel confident. Or, whenever I have to tell someone to do it and they give me problems, I still have to get them to do what they have to do. So, I think that boosts my confidence a little, when I actually get them to do something.

Confidence seemed to come from doing things that had tangible consequences.

I swam [competitively]. . . and like I was disciplined and I always did well during school when I was doing it and. . . as I stopped. . . I think sort of, I didn't care as much and there was less motivation. It's funny, because I would think that my marks would go up since I had a lot more free time. . . but I was more motivated then than when I stopped. So it was hard for me to get back in [to swimming] but I got a lot of confidence from that because when I worked hard, even though I was busy and I did a lot of things, I still did well. So I think I got a lot of confidence from that I mean.

I think if you're used to like succeeding or at least doing well on something it will be a lot easier to try something else because, "Hey maybe if I've done okay in that field, maybe I can try something over here," you know?

But I guess, like for me the more things that I do or the more things I accomplish in, I find it boosts my confidence or makes me, you know, like a more rounded person I guess you could say. Cause I like to keep busy, I don't like to - you know, now I'm working. I have two jobs but I don't get very many hours in either one. . . but yeah, because I find when I - I'm sort of testing myself now. . . I'm curious - like I'm trying to figure out maybe if I'm more occupied, if I have something that will keep me busy and stuff maybe I'll manage my time better.

The boost in confidence from outside work carried over to their studies. Sunter (1994) found that the academic performance of female students improved as they worked more hours outside their studies. While male students' academic performance seems to suffer when the number of hours of paid work increases, female students thrive on a mixture of paid work and studies, regardless of the number of hours they spend on outside work. Our students' narratives confirm this finding.

confidence, voice, and power

Belenky et al. (1986) observed that the women they interviewed used the metaphor of voice when talking about their intellectual development. This led the researchers to conclude that the development of a sense of voice was intrinsically linked to cognitive development and the sense of self. Gilligan et al. (1988, 1990) have demonstrated that young women create and define themselves through achieving a voice, and this voice is achieved, in part, through engagement or connection with others. Speaking out publicly was the context or situation in which students consistently described *lack of confidence* as a problem.

The following quotes show how students defined this connection in the process of talking about how their feelings of confidence might have stayed the same or changed over time.

> [What happens to the feelings of confidence during the CEGEP years?] I think my confidence has increased a hell of a lot. When I was in high school I was more drawn back. I was just sitting letting everything happen. Just, you know, taking it's toll. Now I'm a little more involved and I have more courage, like to ask questions in class and things like that.

> I dunno - like, I have a problem with doing orals. I can't. . . like, I can do them, but it really bothers me and it worries me and I. . . To have confidence in myself; to speak out publicly. . . since elementary school it's been a problem. I've done it all before, you know, gotten up in front of the class and whatever, but I don't enjoy it. [laugh]

Doing *orals* (presentations before the class), and asking questions in class were consistently part of students' operational definitions of confidence. They defined their reluctance or inability to ask questions in class as a lack of confidence and thereby personalized the problem. Nevertheless, student narratives and classroom observations clearly revealed that the classroom environment could facilitate or inhibit speaking. As the central power in the classroom, the teacher was the most important of these factors.

Well, it really depends on the teacher I find. Some teachers really don't mind even if it's like the most elementary question or simple or whatever, they don't mind answering it. But others they might say "Well, you should know that by now! You don't have to ask this! What are you doing in this course, if you don't know this already?" And those teachers are really no good. They just discourage you beyond belief. So, it's not really what you're in, but who's teaching it.

Asking Questions

When we invited students to talk about how things were going, and when we asked them to describe specific encouraging and discouraging events, asking questions occupied a central place in their narratives. Listening to students talk about asking questions reminded us that, from the student's perspective, asking questions includes a complex, and sometimes difficult, interaction with the teacher and the rest of the class (Kubanek and Waller, 1994).

having the right to ask questions

How to Ask Questions in Class is one of many learning and life skills workshops offered by counsellors at our college. Its continuing demand is one indicator this activity is problematic for both students and teachers. The workshop description states that "frequently, students refrain from asking questions in the classroom because of a variety of *irrational* fears" [emphasis added]. The councillors urge students not to be afraid, and tell them, "you have the right to ask questions." It is clear from our students that some of their fears are justified by their experiences rather than based on irrational preconceptions. Not all teachers seemed to be aware of students' right to ask questions, or responded to questions with respect. Although most teachers would willingly respond to students' questions outside of class, many students encountered teachers who prohibited, restricted, or inadvertently discouraged questions during lectures.

having the power to ask questions

Student-initiated questions are relatively rare classroom events. Dillon (1988) summarized an extensive review of writings about student questions in elementary and secondary school classrooms (1938-1980). Observing 721 high school students nearing graduation in 27 classrooms, Dillon heard less than one per cent ask information-seeking questions. Thus, it is unlikely that students will arrive at college with a lot of experience in asking questions or confidence in their ability to do so.

One classroom dynamic that makes asking questions problematic, is the power differential between teachers and students. Asking a question is exercising the power to direct the attention and response of the person questioned; if a person in a less powerful position wants to ask a question, the more powerful one must *allow* it.

Even when teachers do allow it, asking questions in class sometimes goes wrong. Students described questions going unanswered or being answered inadequately. This could happen if the teacher misunderstood the question, hurried through an explanation, or was unable to answer to the student's satisfaction and simply repeated the explanation that eluded the student the first time.

> We put up our hands, occasionally he'll answer the question. . . He just goes whoosh! This is how it's done. . . And he'll repeat it, what he said ten minutes ago. . . The same way. And maybe the girl'll look a little less confused, and she'll say "okay." But if you ask me I don't think she understands.

Another problem is whether the teacher could actually hear the question being asked. We noticed during our observations that it is frequently difficult to hear women's voices in the classroom. The pitch and volume of their voices were less audible than those of the men. The ambient noise of students and the ventilation system compounded the difficulty. Teachers who could not hear a question responded either by asking the student to repeat the question and/or by moving closer to the student. Being asked to repeat one's question was a mild embarrassment because of two subtle possibilities: either the questioner did not speak clearly, or something was *wrong* with the question.

Female students were more likely to sit toward the front of the classroom, nearer the teacher. Consequently, and perhaps in order to hear better, teachers tended to move closer to them during an exchange. The result was that the reply was more likely to be at a conversational level rather than directed towards the whole class. This made women's questions more private, and gave them the appearance of personal concerns rather than ideas or issues that affected everyone. The residual impression for many female students was that asking questions takes the teachers' and other students' time, and does not benefit the whole class.

Sometimes asking questions went painfully wrong when the teacher was condescending, patronizing, or humiliating towards the questioner. Almost one third of interviews in the first year included accounts of students being yelled at, or called *stupid* when they asked questions. Many students recalled that in elementary and high schools "people would laugh at you." An unfavourable

reaction from peers, such as snickering, laughing or even a *look* might silence a sensitive student for the rest of the semester.

A teacher's actions, and the reactions of peers in the first few classes of the term, were particularly influential. One step towards assuming the *power to ask questions* was to ask a question early in the semester and gage the outcome. If the student's question was accepted, *she* felt accepted, having established her place in the class and her belief in the permission to ask again. If the question went wrong, the questioner, as well as others who observed the incident, might be silenced.

> I guess it depends on the first time you speak in a class, how people look at you. If they look at you like. . . hey, yeah, that's a good idea, then you can feel you can talk any time and they wouldn't think of anything. But some people are kind of, like. . . well, that's a weird thing to say. . . and then you don't want to talk any more because you're kind of embarrassed.

Because teachers vary in their receptivity to questions, students tried early each semester to discover if the teacher was the *type* who welcomes questions. Many student stories contained what appear to be stereotypes; "He was the type that just kind of made lightly of comments," or "She was another of those, if you don't understand, you must be stupid." These descriptions reminded us that students had a wide experience of teachers and shared a subculture of shorthand labels or stereotypes. They required relatively few cues in order to categorize a teacher as one who accepts or rejects questions.

> We can go to him any time. Well, most of the other teachers are like that too. It's just that some you don't really want to by the way they talk to you. . . They're the kind that pick on students. . . They will say things like, "well if you guys don't know how to do this yet, then we've got kind of a problem."

having time to ask questions

Teachers assume that students will ask a question if they don't understand, but many do not have time to know whether or not they understand. The pace at which the teacher conducts classes may, itself, limit questioning. When asked why no one was asking questions in a class where many students were having difficulties, one student speculated that it was because the teacher "kind of rushes over things. . . and he's already on the next thing when you think to ask a question." She would like "a little more time to take it in and. . . think about it and say, okay, do I understand this? And if not, then you ask a question."

Sometimes students could successfully moderate the pace at which the teacher gave information; "He does it very fast. . . you gotta ask him to slow down, but he will." However, students' attempts to negotiate a more satisfactory pace could also fail. This student told of one such experiences, as she explained her decision to leave the science program altogether.

> Like one time we were in a class and [the teacher] did something again really fast on the board. He goes, "Does anybody not understand?" So I was sitting there. . . I'll ask, you know. . . question marks everywhere, and I put up my hand and I said, "Can you just give us two minutes, to just look at it and soak it in?" So maybe I will understand something, you know, because he just did it fast; "Does anybody not understand?" He goes, "Okay, fine." So he stood there, waits about two seconds, looks at me and he goes, "You done soaking yet, you finished soaking yet?" Like totally sarcastic, you know. He thinks he's really funny. What a jerk! And the whole class is looking, the whole class.

Maintaining a mutually satisfactory pace can be problematic for teachers and students. Between secondary school and college, the rates of presentation, and the quantity of course material increases significantly (Cornell et al., 1990). Science teachers, in particular, struggle with course content that seems to be continuously expanding. Part of the image of the science program is that it requires more effort than other programs. This collective myth is shared by students and teachers. Sequential courses that build on prerequisites, as well as common final examinations, pressure teachers to keep in step with colleagues in a defined curriculum. "It's almost exam time and we're not finished the program. So now we're going at warp speed!"

> [The teacher] said he's going to do the whole course really really fast so at the end we're going to have five weeks or something just to get it clear in our minds. But I've gotta get one concept clear in my mind, then another, instead of like all at once at the end.

To manage the time problem, some teachers confine question asking to designated periods at the end or beginning of a class. The most acceptable time for asking questions proved to be outside of class time.

> [The teacher] did not like people asking, during lecture, anything like; "I [don't] understand what you're doing." And he did not want to explain it to you while he was teaching. . . But if I had a question that I didn't understand, I would wait until he was finished his lecture, and I'd call him to come over and help me. And then it was fine.

going to see the teacher

Teachers schedule office hours when they are available to give students help. Although comparative data for arts and social sciences is not available, we have a strong impression that in maths and sciences, going to the teacher for help with course work is more expected by teachers and more practised by students than in other disciplines. This is consistent with the belief that learning sciences is different from other types of learning because science requires more explanation.

Because time for questions and discussion in class is so limited, and explanations are essential, interactions with teachers outside of class time, and the quality of those interactions, are particularly crucial to students in math and sciences. Going to see the teacher was a major theme in our interviews.

> In the sciences it takes a lot more explanation to understand something. [In other courses] if you read something and you don't understand it, you go to the dictionary, you look up the word. You deduct. You just follow through on logic. "Well, he's talking about this and going to that." You read it over. You try and like. . . get into it. Whereas in science, if you don't understand the math problems, you don't understand. It's not even so much that you have to understand it in the beginning, as you have to know it. You have to know that from this step, you go to this step - you go to this step, to that step. And someone has to explain it every single step of the way. The way we are taught here, it eliminates the use of logic.

stupid questions

When a student does not conform to the teacher's expectations about what kind of questions are appropriate, and when is the appropriate time to ask, either the student or the question may be labelled *stupid*. The math and science curriculum is based on a building-block concept of knowledge. There is an assumption that students will have mastered the prerequisites of each topic. To have missed a block, or have forgotten one, could be treated as a fault.

If a teacher treats some questions as stupid, students must intuit the criteria the teacher uses to define such questions. As the following exchange between a student and an interviewer demonstrates, it is not always easy to anticipate which questions will be so labelled.

> Like my. . . teacher, just for example, if you ask a stupid question, he like gets mad at you. . . So in that class I definitely don't ask questions. [What kind of thing can you think of has

happened?] Someone asked him a question and he said; "Well, I'm the teacher, let me finish my lecture and if everybody were asking stupid questions like this, then it would be a free for all. Let me just do my lecture and then we'll see."[Does anybody ask questions in that class?] No, not really. Not any more. Not after what he said. [So he doesn't want questions. . . stupid questions.] So how are you supposed to know if it's a stupid question or not?

The teacher has the ultimate power to determine if a particular question is a stupid question. One student explained that it might be something the teacher has "already explained in class and it just went over me, or I didn't pick it up the first time and I should have remembered or something." This student assumed she was expected to know all material the teacher had explained in class, and be able to immediately recall everything she had previously learned. "If you didn't read, and in the five minutes you [didn't] understand, well, your fault then, right?"

At college, as well as in earlier schooling, students have experiences where teachers and other students evaluate their questions and, by association, the student's knowledge, effort and ability. Through these experiences, they learn that stupid questions are not worth answering, and the people who ask them are unworthy (Good et al., 1987). Thus, asking always entails a risk, as a stupid question reveals a fault in the student and makes her vulnerable to criticism.

What appears to be operating here are different perspectives on questions which may be influenced by gender, age, and ways of knowing. These different perspectives may create competing definitions of the situation. Following publication of *In a Different Voice* (Gilligan, 1982a) more than a decade of research has documented the existence of two frameworks for reasoning about problems or resolving conflicts. Gilligan first identified these as the *justice perspective* and the *care perspective*. Individuals using one of these frameworks organize the basic elements of moral conflicts (self, others, and the relationship between them) in different ways.

Briefly explained, individuals using a justice framework tend to emphasize the *self* component, whereas individuals using the *care* framework place the emphasis on the relationship between self and others. Neither males nor females use exclusively one perspective, however, males tend to focus on justice concerns while women emphasize concerns of care. Gilligan points out that if girls and women had been eliminated from her study of moral reasoning, the care focus would have virtually disappeared.

We see these conflicting perspectives in the following narrative as a student described events that occurred when she and a friend were working together during an in-class problem session. The students were solving problems and the teacher was available for individual help. Her friend asked the teacher several questions.

> And she kept on going up, every time - if she didn't understand something, and I didn't understand, she would go and ask him. . . And she went [again] to ask him and then I could tell something was going on because she got really upset. And she came and sat beside me. She was like. . . "I hate him! Nah, nah, nah, nah nah." Started like swearing. "What a jerk, I can't believe it!". . . And she said, "Well, I went up and I said I don't understand this." He said, "You don't understand anything, do you? Are you stupid?" I said, "He called you stupid?" She said, "Yeah, he said you don't understand this, you don't understand this, now you're coming again, so I can tell you're not doing any work." And then, she said, "it's not true." I mean, she didn't tell him that, but she said, of course it's not true, I'm doing the work and I don't understand it. And he just really like shot her down. There were other people, like mostly those were guys there, I don't think he said anything to them. But when she went up to him, he said "You're stupid, you're asking me all these things, you don't even know the material! What are you doing? Why are you even asking me this? You don't do any work, it's obvious. Look at all the questions you're asking me." So he could tell that she was upset. I was even upset! Then she got discouraged. I got discouraged! And it didn't even happen to me.

The teacher, observing that the these two students were upset, apologized to them just before they left the classroom. In his apology he said, "You have a right to ask questions," which indicated that he was aware of this right and of transgressing it.

A student who is operating out of the care perspective and who experiences her need for explanation as central, may define a teacher's refusal to help as a violation of trust. Teachers who are academically trained rely almost exclusively on the justice perspective as an organizing framework. They define a given situation in terms of fairness/unfairness, reciprocity, and equal respect. From this point of view, a student's right to ask questions is contingent on having the requisite basic information ("you don't understand anything, do you?") and having expended enough effort ("I can tell you're not doing any work.") A teacher who judges that these criteria have not been met (the student apparently has not done her share) may also judge that the student does not deserve an answer to her question.

Sometimes teachers are ambivalent about student-initiated questions. This ambivalence may be revealed in surprising ways. One teacher, who arranged a workshop to encourage students to ask questions, introduced the animator as someone who "is going to show you how to make my life difficult." Teachers may say questions are welcome, but when they feel compelled to cover a certain amount of material within a certain period, questions may become problematic. Although some teachers philosophically claim that "there are no stupid questions" they probably agree that questions which regress to previously-covered material, or slow the pace of presentation, are not always welcome. *Good* questions are those that move the topic ahead and originate from students who have understood and can anticipate where things are going.

In telling her story about the in-class problem session the student remarked that the teacher had not criticized other students, who were mostly guys. "There were other people, like mostly those were guys there, I don't think he said anything to them." In making this connection, she suggested that questions from male students were more welcome.

Certain ways of speaking and knowing may combine to produce a greater number of questions, or the kinds of questions that a teacher may judge as inappropriate. In conversations, females more than males, ask questions and, even when stating a fact or opinion, may do so with an intonation that invites response. Nevertheless, there is substantial evidence that females ask, and are allowed to answer, <u>fewer</u> questions in class than males. (Sadker and Sadker, 1994, 1992).

Belenky et al. (1986) described four ways of knowing. Two of those ways may be more compatible with an interrogative, rather than a declarative mode. *Received knowers,* who see knowledge coming from outside authorities, may be uncertain of their knowledge and ask questions even when they think they have an answer. Their motive behind this questioning is reassurance. On the other hand, *connected knowers* may ask a lot of questions in order to make connections between different parts of their knowledge. Asking questions is intrinsic to this way of knowing. Thus some combinations of learning and speaking styles produce what a teacher, operating from a justice perspective, might perceive as excessive, unnecessary, or inappropriate questions.

It is not surprising that the student who heard her friend called "stupid" for asking too many questions was uncomfortable going to that particular class, or asking the teacher about something she didn't understand. This event had consequences beyond the classroom.

Well, I shouldn't blame it on the teacher, but let's say you're studying at home and I don't understand something. . . well I don't know who to go to if I don't ask him, or maybe he is right what he's saying, I'm stupid if I don't even know this. You know, like sometimes his voice will come back to you, even if you try ignoring it. He might have a point, maybe; he's a teacher and this is what he saw. You know, he's been here a long time, maybe he can tell you're stupid.

People of different ages, gender, and social classes are differently entitled and empowered to speak in public. The age difference between recent high school graduates and college teachers might be an important factor in the labelling of *stupid questions*. An older student returning to college to prepare for a career change contrasted her perspective with what she observed among younger students. It is important to note that both the older and the younger student are vulnerable to being "barked at" and labelled as stupid; however, the older student had a definition of the situation and a strategy that discounted these challenges.

I'm older. I've always been to a certain degree outspoken, but I think I'm more outspoken [now]. If I required additional help from a professor, I don't think - I don't see a professor as an authoritarian figure. My definition of a professor is an individual who maybe read a few more books than I did. Not necessarily. His job is to get [the subject] straight in my head. Therefore, if I require additional help, it's not that I'm stupid it's just that I don't quite click into this as fast as, maybe, I do in other subjects. I'm not afraid to ask a question. I don't see it as a weakness. . . Listening to some of [the other students], you know, they still see a teacher as an authoritarian figure. They're afraid to challenge them, to ask them, to infringe on their space. They're afraid to be ridiculed, of, sort of, being implied well, "Aren't you stupid, you don't understand this?" It's like, no, I'm not stupid, you just didn't explain it clearly enough. . . I've seen it with a number of them, you know, they say. . . "Well I'm very sensitive, therefore when a person, you know, barks at me, I cringe inside and that's the end of the discussion." My response, more like, is if you bark at me, I'll bark back.

Baxter Magolda's model of cognitive development

Baxter Magolda (1992) proposed a theoretical model that comprised four ways of knowing: absolute, transitional; independent, and contextual. Within each of these ways she found two distinguishable patterns, one more typical of women, and one more typical of men. Within *absolute knowing*, Baxter Magolda distinguished two patterns: *receiving* and *mastering*. In receiving, which

Baxter Magolda identified more often among women, the pattern was defined as an internal approach that "involves minimal interaction with instructors, an emphasis on comfort in the learning environment, relationships with peers, and ample opportunities to demonstrate knowledge" (p. 82). She contrasted this pattern, characterized by listening more than speaking, with mastering, where "students prefer a verbal approach to learning, can be critical of instructors, and expect interactions with peers and instructors that aid in the attainment of knowledge" (p. 92).

We first read Baxter Magolda's book in 1992 when we were doing pilot interviews for this project. At that time, the gender-associated patterns she described among Florida students sounded plausible, and her arguments, persuasive. When we returned to her study two years later, we were surprised to find a major difference between her findings and ours.

One difference between our students and those Baxter Magolda described was that the components of the received pattern were completely absent. Although we saw patterns of *absolute knowing*, we found in our all-female sample more *mastery-type* behaviors. We found no instances where "minimal interaction with teachers" was the preferred way of learning. In fact, the desire for contact emerged as a major theme in our data (as it also was in an earlier study of the transition from high school to college (Cornell et al., 1990). The students we interviewed placed a high value on interaction with instructors, describing as problematic those instances where it was missing or inadequate. Those students who avoided instructors did so only after uncomfortable experiences that taught them to be wary.

We speculate that there may be two sources of these divergent findings: clear differences in student behaviors, and differences in interpretation.

The received, absolute knowers described by Baxter Magolda "did not suggest any change on the part of the instructor or indicate any interaction with the teacher" (p. 83). In contrast, our students readily described the teaching that they liked and disliked in high school, at college, and even in recollections of elementary school). Those who manifested absolute knowing tended to assume, or at least assert, that the instructors knew their discipline. They also recognized those times when the knowledgeable instructor was not able to communicate with them effectively.

This second semester college student, like other students in our sample, criticized the teacher although at first, she was reluctant to do so:

> My teacher this semester, he's a very good teacher - Well, no, he's a very good physicist. But, as a teacher, not as good, because he doesn't give us theory. He just does - He does problems right away, but he doesn't - The thing is, he doesn't even write the questions on the board. So, we have to figure out when he's speaking, what we're looking for. What's the question now? Cause you're trying to figure out, you know, what the question is.

Alternately, differences may arise from the interpretation of the students' narratives. As a skilled, qualitative researcher, Baxter Magolda liberally quotes from her interviews. This allows the reader to reflect on other possible interpretations. We illustrate this with a quote which Baxter Magolda used to demonstrate the balance of listening and speaking out in class which represents for her, a case of received, absolute knowing.

> I like to listen to what the teacher has to say, and it depends on the class I'm in whether I speak out or not. In high school, I felt comfortable with everyone in the room, and we were encouraged to speak out. Some of these classes are larger, so you don't have a chance to speak out. I usually listen. But if I have an idea or I know what the teacher's asking, then I'll speak. I usually don't speak out just for the sake of speaking out.

Baxter Magolda interpreted this as "Amy saw no point in talking other than to offer an idea or an answer." She concluded from this and three other examples that "verbal participation was of minimal importance to them" (p.83).

Our interviews contained strikingly similar statements, but we heard them very differently. We couldn't hear Amy, but we saw in her words a desire to speak out that was stifled by feeling less "comfortable with everyone in the room" and less "encouraged to speak out" than in high school. She appeared to be inhibited by the structural obstacle of larger class size, rather than to act out of any individual preference for listening.

Baxter Magolda paid little attention to structural factors such as how teaching and learning are organized, and the power of the teacher to define what constitutes knowing. One of her important observations was that "individuals did not use only one pattern of knowing and reasoning all the time; some consistently used similar patterns over time, whereas others moved back and forth between patterns" (p. 13). Thus, it seems to us that, like confidence, ways of knowing are not a fixed or stable part of the self. They are tools that a student brings to learning situations. Clearly, not all students are equally proficient with these tools. To what extent do students' ways of knowing and learning depend on how they are being taught and evaluated? Most science classes in our institution

are taught and evaluated more as absolute knowing than as reasoning. Students are expected to know the facts and they are tested accordingly.

> I haven't done physics since last year. And the teacher I have is totally different than my high school teacher. . . Like, even formulas - like the same formulas but just with a different twist. . . I come in and it's confusing. But I went and saw [the teacher] right away. He knows I didn't take [the entry level course], so he helped me along right away. [How does the teacher decide what help is necessary?] He gave me the final [exam] from [a prerequisite course] to see if I could do it.

In her discussion of gender differences in students' willingness to ask questions, Baxter Magolda ignored the research on teacher-student interaction in classrooms which consistently documents the greater advantage and entitlement of males (Sadker and Sadker 1992; AAUW, 1991). In discussing gender differences in asking questions, it is essential to bear in mind who is more entitled to question.

Developmental factors alone are unlikely explanations for any differences in behaviour between the Quebec and Florida students. At the time of their first interview, our students were, on average, one year younger than Baxter Magolda's, the majority of which (eighty per cent) were eighteen at the beginning of the study. However, there may have been significant cultural differences that contributed to our students' more frequent criticisms of the teaching they experienced.

If the different findings arose through interpretation, it might be because our goals differed. Baxter Magolda sought to identify patterns, create developmental models, and classify students accordingly. Her main goal was to refine developmental theory by looking for patterns of gender differences in students' perspectives on knowing and reasoning in their college years. She expressed disappointment when she "had to accept that there was more similarity than difference in these women's and men's ways of knowing" (p.13).

Our goal was not to refine theory, or to look for gender differences, but to understand students' perspectives on their college experiences. We refrained from classifying each student according to any specific model of cognitive development, believing that detailing the realities of students can be of more practical use to educators.

feeling free to ask questions: confidence and trust

All the students in our study identified feeling empowered to ask questions as important to their success, and feeling unable or reluctant to ask questions as a serious obstacle to their learning. These feelings were central features of the stories told by successful students. Asked to talk about how her classes are going, one student began with;

> I like the teacher [who] seems to care; like. . . if you ask him questions, he's like. . . there's no dumb questions. . . . I'm shy anyways so I don't really ask questions, I feel that if I really wanted to, I could.

Even for a student who rarely asked questions, feeling that she could ask was an important part of being in a good learning relationship with her teacher. On the other hand, not being allowed to ask questions, being laughed at or given inadequate, sarcastic or condescending answers were discouraging experiences associated with not doing well, changing programs and failing grades.

Throughout these interviews, we see a clear path linking questions to confidence. It is not simply that asking questions requires confidence, but speaking, being listened to, and obtaining respectful answers actually builds confidence. Speaking requires trust that one will be listened to even before the question is asked. Teachers can create or destroy that trust by making the student feel inadequate; "You should know this already." Trust also fails when the teacher allows other students to show disrespect for a student's question. Students begin to trust when the teacher invites queries, and when they observe that when someone else asks, the teacher answers "whole heartedly and makes sure they understand." Ultimately, losing trust in the teacher blocks students' learning, while sustained trust builds their confidence in the teacher and most importantly, in themselves.

Relations with Teachers

> There's good teachers and then there's super teachers, and then. . . there's some teachers that will just teach you what you have to do and that's it.

In an earlier study on students' perceptions during their transition from secondary school to college, we often heard them lament the loss of being known as individuals as they moved into bigger, more impersonal, institutions (Cornell et al., 1990). The students told us that if college teachers would only learn their names and say hi in the corridors, they would feel more comfortable. The developmental model we used to understand these statements was one where students should progress from being dependent and teacher-focused learners in high school (homework was seen by

students as doing work for the teacher), towards a more independent mode of learning at college. We believed this process of maturation prepared them for the impersonal setting of most universities, where students are expected to be autonomous learners with little professorial contact or encouragement.

During this longitudinal study we spent many hours listening to interviews with college students. We also met with older university students at workshops and presentations that we gave concerning the project. We have seen that most female students welcome their autonomy and blossom with increased responsibility. However, statements about the centrality and importance of solid learning-relationships with teachers did not diminish with the age of the learner. Student narratives convinced us that having contact with, and encouragement from, their teachers empowers students of all ages to learn and persist in their studies. Alternatively, distant and impersonal teaching is associated with failing grades and program switches.

liking the teacher and "staying in relation"

If I can go up to them and feel comfortable and talk to them, then it's a lot better for me. . . Whereas, if they just look at you like a student and you just got to learn - But I guess I gotta learn that way! [laughs]

That's how I feel, like if they don't know you, they're just gonna do it as fast as possible and they're not gonna care on how they show it to you.

Students' relationships with teachers greatly affect their motivation to learn, and the choices they make at college. During their interviews, students regularly included "I like the teacher," as they talked about doing well in a course or a discipline. Should students base their choices of courses and programs on such factors as liking or not liking a teacher? One of our colleagues explicitly warned students against choosing a field of study taught by a favourite teacher. How would they know, he cautioned, whether they like the subject or just enjoy the teaching?

ways of knowing

In studies of women as learners, Belenky et al. (1986) distinguished between *separate* and *connected* knowing. Separate knowing is using the procedures of critical thinking which are characteristic of academia. Connected knowing, which involves both feeling and thinking, is rooted in relationship. Belenky et al. adopted the terms separate and connected from Gilligan (1982a,b) Lyons (1983), and Surrey (1991), and have used them to describe different ways of conceptualizing and

experiencing the self. *Separate knowers* are essentially autonomous, while *connected knowers* are essentially in relationship (Belenky et al., p. 102).

These concepts have been incorporated into relational theory, a perspective on women's development deriving from the work of Carol Gilligan (1982a, 1988a) and a number of people working through the Stone Center at Wellesley College (Jordan et al., 1991). According to relational theory, being *in relation* with others is a central motivation for women. Being in relation is to have an inner sense of connection that is based on mutual trust and respect (Surrey, 1991). According to our research, being in relation, and feeling a connection with a teacher, appears to increase students' motivation to learn.

A core concept in relational theory is *self in relation*. This term signifies that the self is created and sustained in relation to others. Crises can occur when one loses touch with one's own thoughts and feelings, becomes isolated from others, and/or becomes cut off from reality. These events signify the state of being disconnected or out of relation. To be in relation requires consistency between one's own thoughts and feelings, the thoughts and feelings communicated by significant others, as well as prevailing definitions of reality. Gilligan (1991) asserts that relational tensions are prominent in the area of knowing, particularly when there is a misfit between what one knows and what one is told by someone with whom one wants to stay in relation. This can lead to disavowing or denying aspects of one's self in order to maintain the relationship.

Our initial interviews established a clear picture that students prefer to learn in the context of relationships with others. Analysis of these interviews provided convincing evidence that this is not a developmental stage which students outgrow, but rather, a strong and enduring preference that should be honoured. In light of this, relationships with teachers and peers becomes much more important, indeed pivotal, in student decisions to continue in science or change programs.

Relational preference can be distinguished from cognitive development because it persists through different learning styles, developmental stages, and ways of knowing. We believe it is central to motivation and persistence because students who deny, or are unaware that their relations with teachers are important, don't do well. Only when they accept or recognize this preference, do they begin to succeed.

The pertinence of relational theory gives meaning to data that initially appears discrepant (for example discovering that second year college students, even graduate students, had not outgrown their desire for a feeling of connection with their professors (Sorisky, 1993)). Rather than labelling this as a

developmental deficiency in students, we argue that a student who wishes to be *in relation* with others while learning should have her preferences acknowledged and respected.

College may be problematic for a student's development as learner (and to general psychological development) if the student is forced to become a *separate learner* rather than supported to learn the procedures of *separate knowing*. A science program may exacerbate the desire for connected knowing and learning with others because science teachers place such a high value on notions of objectivity, separate knowing, and individual work. One reason female students switched out of our college science programs might be that they were unable to establish the learning relationships they valued.

Such relationships have, in the past, been labelled immature and dependent. One second-year student found that "If I'm able to relate to them as not just a teacher, but also a human being, I do well." Far from immature, she was exceptionally mature in the organization of her studies, in her sense of responsibility and in her sensitivity to other people's needs, including those of teachers. "I know it's school and I should be learning at school, but just… saying, 'How's the family?' or something like that helps, you know."

> If I can go up to them and feel comfortable and talk to them, then it's a lot better for me…
> [If] I'm able to talk to them… like joke around with them, it's easier… whereas if, when
> they just look at you like a student and you just got to learn. But I guess I gotta learn that
> way [laughs].

In the next quote, we see that this student has been thinking about this problem, and discussing it with other (male) students to try to understand why the learning conditions she desired were so difficult to attain. Differences in age, experience, and power, compound the difficulties for female students in their attempts to establish the learning relationships they need. Clearly all students don't outgrow their desire for learning in relation; although they may learn to keep quiet about it because it is not "how you're supposed to learn."

> I don't know if it's just with girls, like, or if it's just me, but… I was just talking to some
> guys and they said "Oh, just teach me the stuff. I don't care about anything," you know. I
> was just wondering maybe it's girls that say - Girls relate better, or do better under
> conditions where it's more… just more friendly… It puts me at ease and I feel like I'm
> not scared to go and talk to [the teachers]… It's hard to explain… I feel better and -
> [pause] I guess, also a lot of my teachers are male, and… I don't know if that's a factor,
> [but] if they're mean and cold to me, I'm like - I'm petrified of them and I won't go near

them again, you know. But, if I'm able to - They're my teachers but they're also like my - like some of my teachers. . . say "Come on [name] , you can do it. You're really good at this. . . " Just a little bit of praise helps, you know. . . like it gives me confidence, I guess. And, I don't know why, I just. . . find I relate better if somebody - If there's - It's not just - I don't know how to explain it. [laugh] It's not just the school there, if he's also saying to me "Okay, as a person you can do it. Go for it," you know. "Or, maybe you should, you put some more work into it" and stuff like that, you know. But, I hate when the teachers, you go to them and they're just - They look at you like you're a lower form. [laugh] I mean, I know I'm eighteen and some of them, well they're older and of course they have. . . I mean, they have more experience and stuff but, don't make me feel like an idiot and all - that's not gonna help, you know. I'm not gonna learn by that. Or, even if the teacher just says "Hi" to me in the hall, or just something, you know, like, I just feel better. I dunno what it is.

not understanding

A student who understood what learning conditions she preferred, even though she could not easily attain them, was still advantaged compared to a student who did not recognize or understand her preferences.

I'm doing the best I can now [to raise] my marks, but my marks from last year are lower than my marks this semester. Probably because I'm learning what kind of teachers are best for me. I kind of regret that too. Cause if I would have had, or if I would have known what type of teachers I prefer, at the very beginning, maybe I wouldn't have failed those courses. . . Science is like, if you don't understand something, you wouldn't like it. It's when you understand it, you like it.

We have argued that asking questions is an important route to understanding. Having relationships with teachers that made it possible to go to them for explanations was advantageous for students because understanding and believing that one could understand was at the core of their feelings of confidence. "Confidence is tied to both how well I do and how well I understand. So, if I didn't understand, then I wouldn't have high confidence."

This student explained that part of her preference for physics compared to biology was influenced by the teachers.

I had two good teachers. And they, you know, they encouraged questions. Their lectures are not lectures they're more like discussions, or they make it lively, so you don't feel like you're sitting in a lecture. And, you're interested - I'm always - I always listen. . . And I go to class regularly. So, like, definitely there's like a teacher's influence on the subject.

The priority ascribed to encouraging questions was echoed much later in the interview when she described another teacher who was "awful":

Definitely did not encourage questions. Would embarrass people if they got the question wrong, or if they put up their hand and asked a question he was reluctant to answer them. The discussions - Like, the lectures were lectures, it was just writing on the board and us copying. There was no - There didn't seem to be any effort on his part to help students. Like, he just was there to do his job, to write things on the board. I guess that's what he thought his job was - to write things on the board and that was it. There was, like, no encouragement from him for students to learn things.

Finding that the teacher did not encourage in-class questions, but determined to get her questions answered, the student went to see the teacher outside of class:

I went to ask him and he couldn't explain to me. I honestly - I can't say that he didn't know the answer, because he has a Ph.D in [discipline]. So, I thought maybe it's just he didn't remember or he was not willing to tell me the answer. Because, I asked him outright, "I don't understand this. Can you explain it to me?" And he was like "Well you know that's not really important so don't worry about it." I was like, "Well, I want to know the answer, even if it's not useful for this lab. I have a question now and it's related to [the discipline], directly related." He couldn't answer me, so. . . I was like, "Okay, you don't want to put in the effort for me, I won't put in effort."

Another student had a similar experience with teachers in other disciplines:

I find last year why I was discouraged - I wasn't doing very well. And I don't, like I don't wanna blame the teachers, but I do find like a lot of my understanding depends on the teachers. . . Like, I know from my math and physics when it didn't click, it was because of the teacher. Cause when I had another teacher I did really well and I understood

everything. There was nothing, you know, that wasn't clear. I guess it's just the way some teachers explain. Not that they don't know their stuff. Like the teachers I had that I didn't understand, they knew everything. They just - it just didn't click the way they taught.

The two teachers with whom it "just didn't click" shared one characteristic: they stifled student's questions and wouldn't or couldn't answer their questions. This student was trying to create or achieve understanding through asking questions. Unanswered questions blocked her understanding and with it, the hope that it could ever be achieved.

> And if you went to him he - It was if he didn't want - He wasn't interested in you. He didn't, he wasn't, interested in you knowing the material. He was just interested in teaching so, you know, he could get paid. It was his job, so he did it. I found that if you asked him, he wouldn't try different ways of explaining. He would just say the same thing over and over; explain it the same way. So you wouldn't catch it [pause]. My second semester in [another course], I found that teacher - I would ask her for help outside class, because she didn't like to explain why things were done. She just wanted us to learn it. Saying that the understandment of the problem would come in [the next course]... She said, "You'll understand it the next time. For this course just learn it and memorize it." So I went to her outside class, thinking she'll go into detail outside class. Cause I explained to her I needed to understand something, to learn it. And she refused me. She said "No." So I was really surprised at that. Cause I thought outside class she would, and she said "No!" So I was surprised at that.

The narrative of this insightful student also illustrates how not doing well in one or two courses can have depressing and demotivating effects. Putting in an effort becomes more difficult. Such failures may lower marks in other courses in two ways: a student may concentrate on a difficult course and neglect others, and grades may slide as a result of "being sad every day."

> I got a feeling of what it was to have low self-esteem. Like. . . hate school and be discouraged. So, I'm so happy I'm over that. Being sad every day, it was so - Like it was always a nagging feeling. And it was always telling me, whenever I went to school, it was like, "You're not good." I was so mixed up, I didn't like it at all. . . Everything I did, it was - I'd study for a test, I'd get it back and I'd do really badly. And it was just always constantly nagging at me. It was always like I had failed. It was so frustrating. It was so sad. Everything I'd hoped for - I always wanted to get accepted at university, and even to

graduate CEGEP, it was like looking pretty - Well, I was sure I was gonna graduate CEGEP, but I mean it wasn't enough just to graduate, I wanted - I had goals for myself and I wasn't reaching those goals. Even coming half way to those goals. It was really depressing and it was always nagging at me.

Students who require a more in depth explanation in order to understand certain concepts may be particularly at risk.

But, that's why I say it is - It's the teacher, because other teachers I get along [with] really well; I do really well in their classes. And that's why last year, I didn't like science as much. I was just in it and just going through the steps. Because, I thought I wasn't good at it. I thought it was me, and that I just wasn't good at anything. And now I see that I can do well and it's. . . When you don't understand something and you know you can't get help, you don't wanna sit down and really learn it on your own. Like, I find when I see I've done well on one test in [discipline] this semester, I really want to make sure I do well on the next, to keep the average up. But, when you're already down, you don't really, you don't wanna work to get it.

This student, who said her confidence "soared to an all time low," had a very difficult first semester and switched to social sciences in the second year. Her story of how she found out she "couldn't do it" began, "I didn't have the greatest science teachers, you know. . . " However the lengthy and more elaborate part of the narrative focuses on "not understanding."

I'd always go home, or I'd go to my boyfriend's house, whatever, and I'd just start to cry. I just hated it. And, I dunno. I wouldn't wanna get up and go to school in the mornings. It was such a drag. . . I hated, like, not understanding. It was really frustrating to me. Like, I couldn't understand it, no matter what. It's just. . . Or, I could just, just, just grasp it, you know, and pass, but barely.

Ultimately this student used the theory of different abilities to explain why she was not understanding (see p. 31). She said that when she was thinking about "Why can't I get it" she found herself making excuses. "I don't have the proper mind or something. I think you have to have some ability to get it. Like you know, 'cause some people are stronger at other particular things than other people."

Such a narrative increases our understanding of the complex realities that get whittled away in survey research. We might predict this student would circle "lack of ability" rather than "poor teaching" as the reason for switching out of science, even though she mentioned the teachers first in her account of how her confidence "soared to an all time low".

Students had multiple explanations for not *getting it*. These included family problems and a general lack of interest in school. However in their extended narratives we can trace a chain of factors that appear to go back to not understanding, not being able to relate to the teacher, and therefore not being able to get the explanations they needed. In the third semester, this student was finding the work harder. Notice how she links not liking the teacher with not understanding his teaching.

> It's a lot harder. . . all the sciences classes, I find, there's a big difference. . . Between second and third (semester) I found there's a lot of things that are a lot harder. Cause in one, I don't like one of my teachers. . . and I don't understand how he teaches. I find it makes it hard and the material is harder. The concept of what we're doing, I don't quite get. . . and I didn't understand almost anything. I actually failed my first test in my whole life.

We identified in the interviews two prescriptive beliefs that underlie and direct the plot of this story. One is "you don't want to blame [badmouth] the teachers." The other is "a good student should be able to learn from any teacher." These two ideas correspond to what Chanfrault-Duchet (1990) calls collective myths, and Somers (1994) calls public narratives. These shared beliefs guide or set boundaries for individual accounts of experience. Statements such as these, often repeated, directed the explanations for "not getting it" to the student and away from blaming the teacher. If a good student can learn from any teacher, then those who cannot must be poor students. The different abilities explanation may be understood as part of the process of making sense of how a smart student might fail; she may still be smart, only in different areas; or may not be smart enough or good enough to learn science from any teacher.

In their second interview students were asked to respond to a global question about changes in their levels of confidence and events that made them feel especially bad or good. The following account represents what a good student *should* be like - she should be determined and impervious to *bad* teaching or other obstacles.

There's nothing that really made me feel especially bad or good. I mean, like I'll do, you know, my sciences because that's what I want to do. You know, as long as I have the marks and like, you know, the interest to do it. And if I get a bad teacher or something then, fine, that's what I got stuck with. . . but I'm not going to let that stop me, you know. Like I'm not going to - you know if that's what I enjoy doing and that's what I'm interested in, I'm not going to let a bad teacher or someone who says, "No, you can't do it." I'm not going to let them stop me, you know.

Another woman was less invincible. [Was there any time you felt last semester, "I don't really belong here?" Any time you had that feeling?] "Not last - this semester [discipline] is awful. I hate it. I don't hate - I really like it, but I just, I find the teachers can, for me anyways, make me like or dislike the course?"

We indicated with a question mark an upward inflection at the end of the student's statement. This questioning tone and the parenthetical "for me anyways" are signals that she believes her response to teachers is a personal quirk that may not be safe or acceptable to reveal. Gilligan (1991) drew attention to two significant phrases that pepper the talk of girls'; *I don't know* and *you know*. "Girls use the phrase 'I don't know' to cover knowledge which they believe may be dangerous, and the phrase 'you know,' correspondingly to discover what it is possible for them to know" and safely reveal to other people" (p. 11). We learned to recognize such phrases as well as hesitations, false starts, and questioning as audible signals of a student's on-going struggle to discover what she knew and what is safe to say she knew.

As this story of the course that the student dislikes continues, we notice the *supposes* and *guesses*, which are indications of something she should say or believe, but is resisting. She acknowledges with a "suppose" that she may not be entitled to criticise because she is not doing well, but becomes more definite as she specifies the teacher's actions that she dislikes; "He barely looks at the class." Like other students, she finds it difficult to learn something (the theory) that she cannot connect to the task she must do (solving the problem).

And, I suppose it helps that I'm not doing very well in it either, but I just - he's terr- I. . . He stands at the board and he derives one equation from another and he writes stuff down and he barely looks at the class? You could be sitting there a good 15 minutes with your hand up and he wouldn't even know. And. . . you're finding a lot that you're not gonna use now. It's not, I mean, apparent. He says he wants us to learn the theory be-

cause later on we're gonna need it? But, to learn it now, when I have to do a problem that has nothing to do with the theory, you know I - I suppose it's important later. . . I'm gonna be thankful, I guess, but right now I find it's kind of useless.

This student takes responsibility. She says that she did poorly because she "let" a certain course affect her motivation. The student "ruined", "did so poorly," "should have done better" and "let" one awful course affect her; but we notice that she still says she "can't blame it all" on the course.

I kind of ruined that semester in a way. Like I did so poorly when I really should have done better. . . So I kind of regret letting [that course] - [How do you make sense out of that somehow, that it went so poorly?] I didn't work. Do you mean like why I. . . ? [Yeah . . . what would you attribute that to somehow?] A lot to myself. I let [that course] affect me too much. And then I didn't work as hard as I should have. It wasn't all [that course]. I can't blame it all on that. I think it was just a portion of it.

Relegating questions to private times and places outside of class time, may contribute to the feeling that "I'm the only one who doesn't understand." Note that this student "looks at the teacher with this blank look" signalling not only that she doesn't understand but also a disconnection. Consequently, she doesn't "really talk to the teachers" and doesn't like speaking up.

I feel as though I'm the only one who doesn't understand. And, I don't know, I just look at if the teacher [laugh] with this blank look on my face and I just - I just kind of - I don't know - It just doesn't feel good. Sometimes I wonder if sciences are for me and if I'm in the right program and if, you know, my grades are good enough to get me into the better schools. I still don't know what I wanna do and I don't know if sciences are my - should be - my field. I don't know, sometimes I wonder, when I don't understand what's going on - I feel as though I'm the only one and everybody else does - And, if I don't, then I shouldn't be there and - UGH!

Understanding the course material was central to sustaining motivation. The student who felt that she, alone, was not understanding while others were, was more discouraged than the one who believed that not understanding was shared. After being told repeatedly they should be able to learn without their preferred relationship with teachers, many students continue to cope. However, some feel that they shouldn't be in science, and change programs; others leave school altogether.

having a place in science

In their interviews, students regularly and explicitly linked understanding, feeling comfortable with teachers, and asking questions to doing well. As described above, many students find asking questions in class problematic and prefer to approach a teacher one-on-one. To establish a learning relationship, a student might go to the office of a teacher, and ask a question in private. If the teacher responds in an encouraging way, the student may then feel empowered to ask questions in class.

> If a teacher doesn't know who I am at all, then I'll go and ask a couple of times, so that they know who I am and it just makes it easier I find. . . cause I don't just like feeling like I'm one of the crowd. . . I like to have a place, you know. It doesn't have to be the top or the bottom, or anywhere, just a place somewhere. So that people know who I am and I know who they are. I like it.

Having a place is important to everyone, male or female. In this gendered world, men more often feel entitled to a place. In science, especially, having a place is problematic for women who must always ask: am I allowed, is it safe? One way women negotiate and establish their place is through asking questions. Asking a question tests or explores a teacher's willingness to listen and readiness to respond in a connected way, and to enter into relationship. When one student is empowered to ask questions, the atmosphere may change, allowing others to feel it is safe to ask theirs also.

One student told us that because she was determined to do well in math, she persisted in attempting to establish the relationship she knew she needed in order to succeed. The following quote illustrates that it is not only the answers or "doing the problem" that she valued, but the "pat on the shoulder."

> [I] didn't do well on this last test. . . so I started. . . I had questions so I kept on going to him. And at first he was kind of cold. . . he was just [let's do it] quickly. . . He'd do the problem for me and I was scared to ask him, "Well, how'd you get that?" or "I kinda missed that." But I kept on going and going and eventually he wasn't as bad. . . he began to - he was really nice actually in the end. . . It took a while, like, I was scared to go and see him. . . Well, I wasn't going to fail my math, that's the main thing! And at the end, at the exam, he was like "Come on, [name], you can do it. I'm counting on you to do well."- In the exam he came up to me and goes "Keep going!". . . and he gave me a pat on the shoulder and just - so that was good.

sexual harassment

After we recognized the strength of some students' preference for relational learning, we began to understand how such a preference could make them vulnerable to sexual harassment. Relational learning behaviours may be misperceived or misunderstood by teachers, particularly males, who may expect a more distant, separate relationship between teacher and learner. Some teachers may interpret relational behaviours as invitations to intimacy. Weiler (1988) quotes a woman who had an affair with one of her college professors:

> When I was in college I had an affair with one of my professors who was 28 years older than I and it was a terrible experience because I was 19. I've since read articles about this and books, you know, about girls in college having affairs with their professors. I think these professors, they leech onto their really good female students. To a boy student they'd be a mentor, but to a girl student they're a lover (p. 87).

Alternatively, some male teachers claim to have reacted to sexual harassment guidelines by maintaining greater distance between themselves and female students. Such a practice was reported by some university undergraduate students whom we encountered at one of our presentations. They claimed one of their male professors used fear of being accused of sexual harassment as an excuse to exclude female students from informal, after class gatherings. If this is true, it may make the kind of connection students desire even more difficult to attain.

accept your limitations

Previously, we described a category of questions defined as *stupid* (see p.49). Students believed that a *you are stupid* label was implicit when a teacher would not answer a question or provide an adequate explanation. In an earlier narrative, the stupid label was explicit and the teacher's authoritative voice undermined the student's confidence. The next story is similar in that the student was struggling with the voice of a teacher. This time the message was not *you're stupid* but rather, *accept your limitations.*

This student had gone repeatedly to a teacher for help with a subject in which she was working hard to improve her quiz scores. She believed she could do so even though her "self-confidence towards this subject" had been slipping during the semester. The teacher refused, laughed, and told her, "you have to accept you limitations." This lengthy narrative offers insight into some of the ways that a competent student, with consistent grades in the 80's, could develop lower self-confidence towards a particular subject.

Students used shared definitions of *smart* and *stupid*, as well as their own past experiences in a complex process to place themselves in *the hierarchy of things*. In this quote we see a comparison between *a good student* and people who are *extremely intelligent.*

> I'm always around people who are extremely intelligent so I just see myself as a good student. I don't see myself as like - cause I guess, like, for me the definition of being intelligent is being, sort of, *up there*, [waves hand above her head] you know and I just see myself as being good, you know, [in] the hierarchy of things I come a bit lower. . . I'm not like a sixty per cent student, who wants to go into - you know.

At the request of the interviewer, the student described the signs she used to decide that she was "just a good student" as compared to those she waved at "up there."

> Well, they figure [things] out, they catch on to things faster. They see it when I don't see. They're just a split second faster than I am and, gosh, I want to be that - you know [laughter] [pause] - that split second faster also! Cause I was talking to my [discipline] teacher about this. I was very devastated around three weeks ago, because I had been studying for, like, one week. I didn't do [my other subjects]. . . I just did the bare mini- mum for [other subjects]. I was just doing [this subject] the whole week. We had a quiz on Friday and I still wasn't able to do the quiz, like, I was still, like, doing it wrong. I was so upset.

At the upper end of the hierarchy students are sorted by "split seconds." This student wanted to be "that split second faster also" and she was working at it, not saying she didn't have the ability. She described the dialogue between herself and the teacher when she went to talk to him after the latest quiz.

> "I went to see you so many times this week. I don't seem to be grabbing it." I go, "Could there be, like, could you give me more exercises?" He goes, "Well, you just have to notice that, you know, that some people are better than others." I said "Well, obviously, I realize that, you know. I don't think I'm like, that fantastic. [This subject] has never been, like, my really strong point. I don't think I'm that fantastic, you know. I wasn't implying that, but I'm pretty good in it, if I can actually follow what you are saying in

class. Could you give me, maybe, a lot of problems to do to get my level up there?" And, he's like, "Well, no you have to accept your limitations." I go, "Oh my God!" [laughter] Like, he's telling me off very politely.

As she continued the story she revealed the standards the teacher might have used to define her limitations:

> And, you know, as he spoke on, I don't think he meant it in a condescending way. . . 'Cause he's extremely intelligent. One of those [points above her head] - you know. He told me that all through high school he was getting 100's and all through college he was getting 100 per cent - and he goes "that was totally unheard of." Maybe he saw himself in the hierarchy of things like, up there, and everyone else is just sort of low. I was, like, just so shocked, you know. Like "accept my limitations!"

The student searched for explanations and made excuses for the teacher's remark, but returned to her first reaction of shock. Subsequently she compared herself to another student who "just doesn't grasp it" or "maybe doesn't do his homework" and acknowledged that *that* student *should* accept his limitations. In this segment we hear echoes of the different abilities belief "he'd probably find something else he'd do better." However, she rejects this explanation for herself.

> Well, take an example, like sometimes when you realize you are not good in something, you have to accept your limitations. Cause there's a guy I know he's - I don't know why he's in science, he can't do math. You show it to him and you explain it to him and he just doesn't grasp it. . . Maybe he doesn't do his homework. I don't know what it is. . . I can see that point, like sometimes it's very devastating, you know, you have to accept your limitations, but he'd probably find something else he'd do better. But I'm like: I can do [this subject].

As she continued, she said that this class had lowered her self-confidence in this subject and described the criteria she used to judge her performance: understanding, doing well, as compared to others, and keeping up with her work. She also reported that "half the class failed."

> Cause like my - the way I regard it, my self-confidence towards [this subject] has been very low ever since I started this semester. So it's like, "No it can't be that way!" So I understand what I am doing. I do well in his class compared to. . . half the class failed,

you know. I am keeping up with my work. Maybe it's just because it's a bit harder, [the second level than the first level], you know? Maybe I don't - like sometimes you have better study skills in certain subjects than others.

She defined the problem as a harder level course, perhaps needing more specific study-skills, and thus she still had confidence that by the final exam she would "know everything." She resisted taking his laughter personally, but did so anyway by looking for explanations in her own actions and the "type of person" she is. Notice how her self-confident statement that "she will know" circles back to how hard it is this semester, and then relates this directly to the teacher.

I know that by the time the exam rolls around I'll know everything. I just know that's the way I am. I may not grasp it now. Like, I learn most of my mistakes by the tests and by the quizzes and then I see things. . . And it's hard. It's hard this semester. But that teacher - I don't know why - I can't figure it out. Yesterday I went to go ask him a question, just a simple question before I packed up my books. He just started laughing. Like, "Why are you laughing?" I just looked at him. I looked very serious - "Sir, I'd like to ask you a question" and I asked my question and it's like - stop laughing. "Why is he laughing?" you know. Maybe I tend to be the type of person that puts on a comical face sometimes if I don't understand something - the way I look? - maybe. Cause I know people who some-times laugh, because the way I am reacting to something, but I don't know. I can't under-stand that. I'm not going to take it personally. Maybe, he just acts like that towards every-one. I don't know!

Earlier we learned that the teacher's own 100 per cent perfection is the top of a finely-graded heirarchy. Teachers and students take minor differences in marks seriously . In the next sequence we see a mark of 88 per cent denigrated with the modifier *only*. Concurrently, we see the student searching for ways to interpret the teacher's actions as not *really insulting*.

No, because I was talking - when I went to go talk to him about why I am not doing well in [the course] he goes, "It's still too early in the semester. You did well last semester you are going to bring your mark up close that; maybe one or two points lower." That's what I mean. That's why I don't think he was really insulting me. He's thinking more like, "Well, you know, [this subject] isn't maybe one of your courses that you are going to get a high mark in. It's going to be more like - accept your limitations." What I think he meant more - Like a friend of mine, she had him last semester and she chose to take him

a second time, because she liked him as a teacher. And, he goes, "Well, you know, so-and-so, she got accepted into med." I go, "Yeah, I know, she's a very good friend of mine" and he goes, "Well, do you think she had a very high average?" He goes, "She only got an 88 in the course."

Spontaneously, the student directed the story away from her friend to the consideration of whether the teacher expects limitations "because you are a woman."

But I don't know whether he expects that because you are a woman. I really don't think so, because he's friends with this other teacher and this other teacher really promotes - he pushes you - like he's glad - he likes me as a student, because, you know, "she's a woman, she's doing it - " and he's got daughters and he's pushing them to go into science. I don't really think he is condescending towards women too much. But it's just his way.

After the interviewer commented that the situation sounded "like you are swimming up stream" the student replied: "That's a very good analogy, yes. Going against the current, yeah." Then she concludes with a look into the future.

Well, if I go into engineering, what do I expect to find? It's male dominated for God's sake, you know! It's like, I'm going to have to learn to deal with people, deal with men, deal with arrogant men! [laughter] You hear stories about this - [pause] Just dig in with it and don't let it bother you too much. Those successful women, you know, they don't listen - they might call them bad names. I find if a woman's being aggressive or assertive they call her bitchy, you know, or she's a bitch, you know. And I don't think - you sort of - like, I like watching movies and you sort of see that the main character is very strong if she's a female, she's very strong and she doesn't let that bother her too much. Or, if it does, she's gets over it. It's important to - you have to work on it.

Working with this interview we were fascinated and puzzled by the interpretive work the student described. Why had she ruminated so? Why did she search for interpretations that excused the teacher, excluded gender bias, or even made her own actions responsible?

Relational theory supplied a framework that increased our understanding of these puzzling behaviours. We speculate that this science student was talking about an experience of disconnection that she was still processing. She resisted rejecting the teacher because to do so would sever a connection that she needed in order to learn. We have sometimes heard colleagues express opinions

such as "an effective teacher is a brutal teacher," or students "don't have to like me, they have to respect me." Our data convince us that for some students this is untrue. To learn comfortably, to learn the way they like to learn, they have to like the teacher. Therefore, they expend considerable effort in establishing and maintaining a connected learning relationship.

We can illustrate the difference between maintaining and severing the connection with the teacher by comparing the reaction of this student, whose teacher advised her to accept her limitations, with the reaction of Malcolm X to receiving similar advice from one of his teachers. In this passage from his autobiography, Malcolm X recalls a teacher, Mr. Ostrowski, who advised him about his future:

He told me, "Malcolm, you ought to be thinking about a career. Have you been giving it thought?" The truth is, I hadn't. I never have figured out why I told him, "Well, yes, sir, I've been thinking I'd like to be a lawyer." Lansing certainly had no Negro lawyers - or doctors either - in those days, to hold up an image I might have aspired to. All I really knew for certain was that a lawyer didn't wash dishes, as I was doing. Mr. Ostrowski looked surprised, I remember, and leaned back in his chair and clasped his hands behind his back. He kind of half smiled and said: "Malcolm, one of life's first needs is for us to be realistic. Don't misunderstand me, now. We all here like you, you know that. But you've got to be realistic about being a nigger. A lawyer - that's no realistic goal for a nigger. You need to think about something you can be. You're good with your hands - making things. Everybody admires your carpentry shop work. Why don't you plan on carpentry. People like you as a person - you'd get all kinds of work." The more I thought afterward about what he said, the more uneasy it made me. . . I was smarter than nearly all those white kids. But apparently I was still not intelligent enough in his eyes, to become whatever I wanted to be. It was then that I began to change - inside. I drew away from white people. (Weiler (1988) p. 139-40.)

The teachers in both these stories can be seen as well meaning, in the sense that they believed they had better or more realistic information about what their students should aspire to than did the students. However, both teachers are *very politely* telling these students where they belong. (Note that in both cases, the teachers' advice to their students maintains the "hierarchy of things".) Neither student accepted this advice, and in both cases there was a disruption in the student-teacher relationship. Malcolm X identified this experience as a time when he "began to change inside. . . and draw away." In contrast, the science student tried to maintain her relationship with the teacher by interpreting his statements in a way that did not violate her sense of self, or the role of the teacher as

someone she could relate to. One approach was to acknowledge her limitations while still aspiring to do better.

When seeking an acceptable context for the teacher's refusal to help, she looked for justifiable meanings in their larger conversation. "And, you know, as he spoke on, I don't think he meant it in a condescending way." She checked with friends and looked for reasons about the "kind of person" the teacher was; "I have friends who have taken him before and they say the same thing. He puts his foot in his mouth most of the time." She explored and rejected the interpretation that the teacher imposes limitations if you are a woman. "I really don't think so, because. . . I don't really think he is condescending towards women too much. But it's just his way."

At the time she chose to believe that her limitation was in being "just a good student" compared to others (including the teacher who presented himself as a perfect 100) who were "extremely intelligent." She might have reacted, as Malcolm X did, by severing connections and withdrawing. For the time being, however, she appeared to be maintaining a belief in herself as someone who could "get [her] level up there," while keeping her relations with the teacher intact. Being *in relation* was important to her learning, and in order to maintain that, she could not contest the limitations imposed by the teacher.

These expenditures of time and energy would be unnecessary if the student did not value the relationship and could *draw away*. Maintaining the preferred relationship with the teachers can be very costly for the students as they work through and reinterpret hurtful experiences. These stories help us understand how "not being able to relate to the teacher" made a student feel "extremely lazy" and drained of energy (see p. 95).

A New Model: The Confidence Triangle

In her empirical observations of students engaged in learning math and sciences, Shelia Tobias shifted the focus from the individual to the "relationship between people and subjects." Expanding the concept of relationship to include the "learner's experience with the subject," Tobias argues that math and science are more than subjects; "They generate relationships between people and subjects." In order to *fix the learning*, she says, "you have to look at it as a combination of the learner and the subject" (Hoots, 1992, p. 302).

Our interviews with science students remind us that learning and teaching generate relationships between student and teacher, and that these relationships may encourage or inhibit learning. We have to expand the combination of the learner and the subject, to include the teacher. Our students' stories indicate that the three come together most significantly around student-initiated questions. "It wasn't just enthusiasm for the material. He offers enthusiasm for the students. . . . "

The concern over questions and satisfactory answers that our students explicitly linked with *doing well* echoes the themes of silence and voice that Gilligan says are central to development. Engaging in the act of learning, our students, like the adolescent girls interviewed by Gilligan, struggled to claim a voice. "When someone refuses to listen - signalling a failure to care - adolescent girls speak of themselves as coming up against a wall. Silence can be a way of maintaining integrity in the face of such inattention, a way to avoid further invalidation. But the willingness to speak and to risk disagreement is central to the process of adolescent development . . . " (Gilligan, 1988a, p. 17).

Addressing "les emotions" is one of Barbeau's important contributions to our thinking about motivation. Barbeau suggests that "il semblerait que ce sont les emotions, plutot que les perceptions causales qui sont les motifs immediats de l'action; and argues that "les eleves repondent affectivement aux resultats qu'ils obtiennent et ces emotions influencent positivement ou negativement leur engagment cognitif" (1993, p.23) Our own research leads us to extend this model to include students' affective responses to teachers. Their relation to and engagement with the teacher are essential factors in motivation.

Recent work by Louise Lafortune (1992) addresses the interactions between motivation, anxiety, and self confidence. Her research with adult learners manifests awareness of the importance of the affective dimension of learning, and like Tobias, limits the focus of this affective dimension to the relationship between student and subject. However, our conception of confidence leads us along another path. The model of confidence that informs Lafortune's work assumes a separate self that is either dependent or autonomous. Lafortune defines "l'autonomie" as "la capacite d'une personne a fonctionner et a decider par elle-meme *sans recours a autrui* et de satisfaire elle-meme ses besoins particuliers" (p.22, emphasis added). When analysing the affective dimension of students' responses, she classified which of them accord importance to good teacher-student and student-student relationships. Students with a preference for relational learning may exhibit many behaviours which qualify as dependent within such a scheme. Our work suggests it is important to distinguish between *dependence* and *learning in relation* and not to label students' relational behaviours as dependency. To illustrate this distinction, we might recall the student quoted above who perservered with her "kind

of cold" math teacher. She actively created the learning relationship through her own efforts, both by engaging the subject (mathematics) and by engaging the teacher (see p. 68).

Saint-Pierre (1993) presents a model for learning which places the teacher, the student and the content in the corners of a triangle. The teacher facilitates the student's learning of a subject by assigning appropriate learning tasks, thus focusing on both learner and subject. The connecting arrows are unidirectional, signalling action rather than relationships. The emphasis is on the learning task, with the goal to produce autonomous students.

The model we suggest emphasizes relationships; between student and subject, and between student and teacher. Like Saint-Pierre's model, it is a triangle with student, teacher, and subject at the three corners (Fig.3). However, in our model there are strong, bidirectional links between the three entities, and these links, representing relationships, are developed and maintained in dialogue, especially the question-asking and answering process. When teachers use their discipline as the only link with the student, as found in the traditional model of post-secondary teaching, the motivation, learning, and growth of the student may suffer (Kubanek and Waller, 1995a).

Given that the relational interpretation is plausible, some teachers may doubt that they can find extra time for such relationships. Being *in relation* does not require intensive or sustained interaction between student and teacher. Students use examples of "asking how's the family" or analogies "like a friend" to talk about the relationship they prefer because that is the vocabulary available to them. They are not seeking hand-holding, or intimacy, so much as approachability and practical help. We were reminded of this when an interviewer rephrased a student's statement about how a teacher influenced her liking for a subject. "It sounds from the way you're talking about this that it somehow gives you a feeling that they're interested in you?" The student agreed, but hesitantly: "Yeah. (pause) Well, (pause) yeah." Then explained what she had in mind:

Figure 3
The Confidence Triangle
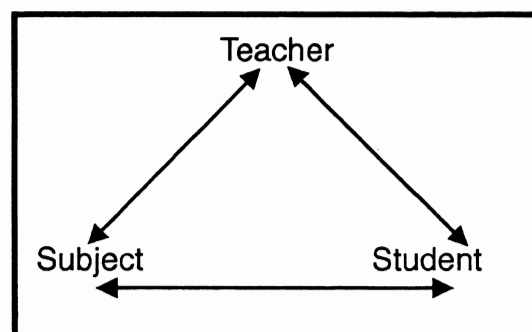
It's nice when the teacher sees you in the hall and recognizes you. And, he knows that you're in [his] class, you know. Then if you ask him a question he's like "Oh, hi [name]. How's it going?" You know, "Oh, you have a problem? Okay let's deal with it." Rather than "Oh, you're - What number?" [laugh] "Oh, yeah, you're in my class? Oh, okay"... you know. So it makes it a little easier. He's more easy to approach...

The student described basic sociability ("saying hi," knowing her name) as factors that made it easier to get practical help ("Do you have a problem? Okay, let's deal with it"). Similarly, she missed having friends in classes because she wanted to ask "how do you do this?" Again, she wanted practical help, not some amorphous camaraderie or the comfort of a shoulder to cry on.

Nel Noddings has written about *caring* teaching and describes it this way: "I do not need to establish a lasting, time-consuming personal relationship with every student. What I must do is to be totally and nonselectively present to the student - to each student - as he [sic] addresses me. The time interval may be brief but the encounter is total" (Noddings, 1984, p. 180). We believe that "nonselective" or nonjudgemental aspects of these interactions must be emphasized. In addition to low grades and not understanding, students recalled being most discouraged by instances where they were explicitly or implicitly told they were undeserving of a teacher's attention or effort.

A teacher can point to a gap in a student's knowledge in a way that leads the student forward; "I guess you haven't learned this yet." The *yet* leaves the future open to possibility, whereas *you should know this by now* only blames and blocks. For example, a student interpreted a teacher's exasperated comment, "Oh, you *still* don't understand" as a signal that she, and the other students, were inadequate; "Well thanks for making us feel totally stupid."

We have argued that opportunities to ask questions are indicative of *being in relation*. Asking questions is one way of establishing, testing and sustaining a learning relationship. However, leaving aside the relational interpretation, opportunities to ask questions are essential to learning. The overwhelming evidence of our data tells us that students want to ask questions and have them answered respectfully. This increases their learning and sustains their motivation to persist in their science courses.

RECOMMENDATIONS

Readers often turn to the end of a report like this one looking for recommendations on how to correct problems identified in the study. We chose not to end with such closure; it was never our intent to formulate solutions that could be applied generally in various learning institutions. The strength of a qualitative study like this one is its ability to raise new issues, to bring out new viewpoints and frameworks for interpretation, and, above all, to report clearly what we heard from the women who participated in the study without excessive interpretation. We feel we have done so in our liberal use of direct quotations and in highlighting the way these women prefer to learn: actively, through asking questions in an open and accepting relationship with teachers and peers.

Most college teachers are individualists who are used to managing their classrooms without much interference from administrators; few are willing to listen to educational researchers. We teachers do not often respond well to suggested changes, even when the reasons for such changes are well documented. We are sceptical about studies that lead to general recommendations, and doubtful about their successful implementation.

Most teachers, however, are enthusiastic about their teaching. When made aware of problems in their classrooms, they might be willing to look for solutions that work for them. Therefore, we are confident that some of our colleagues, who read this report, will respond with ingenuity and will be inspired to make changes that benefit their students. We would like to hear from them.

Other educational researchers who are more excited about quantitative research than we are, might develop new hypotheses by reading this report, and go on to test them on a bigger sample. Such data might lead to recommendations and policy changes. We would be delighted if this happened.

Our main hope is that young women will read this report and feel supported through discovering that their experiences as science students were shared by others. One day we hope to collect stories from this study and present them as a *Guide for Survival* for female science students.

THREE PERSPECTIVES ON CONFIDENCE IN SCIENCE

The following section includes three articles written for special purposes such as journal publications or conference papers. Each presents data from a different perspective: **Career and Life-Choices: Mixed Messages and Problematic Notions, Staying In or Switching Out**, and **In Science There is No Gender?** While there is some overlap between these articles and previous discussions, for example, some quotes appear in several places, their inclusion enriches the overall data analysis.

Career and Life-Choices: Mixed Messages and Problematic Notions *

Most of the themes emerging from the analysis of the interview data centred around classroom events and interactions with teachers. This agrees with the findings in a recent study of student attrition in science-based fields, where both switchers and non-switchers cited problems with learning experiences and pedagogy as the most common complaints. (Seymour, 1995). However, at an early stage of our study it became apparent that certain issues around career and life-choices were central concerns as these young women moved through the college years (Kubanek and Waller, 1995b).

mixed messages

In what social and historical context do these young women formulate their career aspirations and choices? They are making career choices at a time when the expectations of women are changing while many of the realities for women are not changing, for example the constraints of child bearing and child rearing (Cole & Zuckerman, 1991). They are choosing within a social context where science and science related careers are portrayed both as prestigious and promising the best job opportunities. In their educational institutions, science programs, and those who enrol in them, are ranked higher than non-science programs.

As Bruner (1986) has pointed out, the images and narratives in a culture provide "a map of possible roles and possible worlds in which action, thought and self-definition are permissible (or desirable)" (p.134). The metaphors these young women use and the stories they tell about their career and life-choices paint a vivid picture of a new generation of women in the process of creating themselves.

* A different version of this paper was presented at the *Women, Gender, and the Science Question* Conference at the University of Minnesota, May 1995. A shorter version was used as a basis for a workshop given at the ACCC Conference in Ottawa, May 27, 1994. (Kubanek and Waller, 1996).

Listening as they discussed career issues, a complex picture emerged as they approached real life problems. Gerson (1985), discussing her model of career choice, pointed out: "The process is dynamic, not stable and fixed. It depends on how women define and perceive their situation as well as on the objective circumstances that structure these perceptions" (p.213). Referring to young women's thoughts around career and life options, Jane Gaskell (1992) expressed a similar notion saying, "within the world as they experience and know it they do their best" (p.135).

Briskin (1990), in her discussion on the gendered classroom, documents a set of powerful and contradictory messages. As the young women in our study pondered their choices around studies and careers they faced a series of *mixed messages* from teachers, counsellors, family members, friends, and the media. These created tensions around their choices as they weighed the contradictory messages coming from the outside, against their own feelings, experiences, and expectations. We summarize these conflicts as a set of six problematic notions, each one introduced by a set of paired phrases representing a mixed message.

Notion 1

Girls have to be recruited into science.

Girls are interested in science.

We often hear we need to go out into the elementary schools and promote science if we want girls to choose science programs and aspire to careers in science. This reflects the assumption that girls' interests lie towards languages and social sciences and therefore away from the natural and physical sciences. Contrary to this notion, most of our students recalled an early interest, sometimes a passion for science.

> When I was in elementary, they dissected a frog. I was really interested. I can tell, I like that better than anything else, more than history. I prefer biology. As I went on in high school I liked it more, got interested.

> [I have been interested in science ever] since I was maybe nine, eight - everything I've ever wanted to be in life. You know, when you grow up, you say, I want to be this, I want to be that. People usually change their mind. It's been a nurse, a vet, a paediatrician, a gynaecologist, and now I want to be a physiotherapist. Always in the sciences, never outside sciences.

They were not only attracted to health science fields. Some of them described childhood dreams of wearing hard hats as future engineers. The notion that girls need to be recruited into science places the *fault* with them; their lack of interest in science. If we allow ourselves to see that young girls start off with a keen interest in science, we are confronted with the question of what happens during their school years that discourages them or makes them loose interest.

Notion 2

Science is a pragmatic choice - it opens doors.

Science must be a passionate choice.

The students were told by high school counsellors, teachers and also parents that those who could, *should* study the sciences; science is a *safe* choice, it keeps the doors open to secure, well paying jobs.

> Well, like they say, it keeps the doors open. So, I don't know, people always say, as long as you have your science background, then you're safe, kinda thing. So I just figured I'd try it, but it wasn't for me.

At college they experienced a science program that was very demanding; they felt they had less free time than their friends in other programs and were told "it's a lot of work and you have to be willing to devote yourself." They came to believe that only those who are really dedicated and willing to "put their entire life to it" would succeed. Students who came to college with a tentative interest in science usually ended up switching to other programs.

> Initially I'd taken pure and applied because I didn't know where I was going later on. And I took it just because they had said that it opens all the doors - you can mostly do anything starting from there. . . . I was alright in science in high school but I said, "No, I'm not going to suffer for two years with three pages of equations and all this."

Notion 3

You can be anything you want.

Science is only for the very best.

We love to tell young girls: "All fields, including scientific ones, are now open to women. If you work hard and want it badly enough you can go as far as you wish. You can be anything you

want." Our students were aware that they might have to work hard to achieve their goals but they felt it was within their reach. Not surprisingly, they started their college science program with high expectations.

> I don't mind hard work, 'cause I know at the end it's worth it. The person that takes the easy way out never gets anywhere, but in the future I see myself in my own clinic, my own patients. I'm married and have kids. I want to have it all.

At college they encountered an educational environment that was much less supportive than at high school. The new message was that science is only for the very best, those who can catch on fast, others don't belong.

> Actually our teacher is very uhm - I don't know how to explain it, but he just says to us, if you can't do it faster, maybe you shouldn't be in the sciences, maybe you should go find something else like English to do. Like he is very quick to tell us you shouldn't be here. He said a few times, if you fail the first test, maybe you should just get out of [the course], or maybe sciences all together.

Instead of telling them they can be anything they want, some teachers now tell them to *be realistic* and *accept your limitations*. When asked during their first interview (usually six to ten weeks into the first semester) what had been the most discouraging event so far at college, many of them described times when their dreams about a special career had been crushed, either by remarks from a teacher or by receiving poor marks on a test. Seldom did they hear there might be more than one route towards a particular career. They were left to review their goals without clear directions of how to go about it.*

College seniors in Seymour's (1995) study expressed the suspicion "that most of the overpacking of the syllabi in basic science classes is maintained for *weeding out*, rather than for sound pedagogical purposes." (p.396). In the belief system that science studies require an innate ability that you *have* and *cannot learn*, mathematics in particular is often seen as a measure of that special talent, and is used to weed out those who do not belong. Tobias (1990), has pointed out the great potential loss to science by the exit of many talented students due to this practice. One of our students expressed her disdain for the weeding out process.

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* We see a great need for career information and counselling at this time of transition.

I know that if that [career is] something I want badly enough that I should be willing to
go through the chemistry and all this now to get there, so I don't know whether I am
going to regret it later on, saying "Why didn't I just stick with it? Why didn't I just do
it?". . . it's so annoying because you find out most of the teachers [say] - "You're never
going to have to do this, but here 'test'. You're never going to have to use it." Like my
[subject] teacher said "You're never going to have to use [topic]. It's never going to
come up, but what companies want is they want to see that you're able to go through
that kind of mental process." [laughter]. Thank you!! Great!. . .You're never going to
have to do this, but if you fail [laughter] but if you fail - great, you know.

We do women a disservice when we perpetuate myths and half-truths that encourage them to
believe "they can have it all." We need to discuss barriers to success openly and realistically. Briskin
(1990) points out what happens when we fail to do so. "The dictum that all is possible - every choice
available - is coincident with the view that lack of success is a result of laziness or personal failure.
If a woman does not make it, it is because she has not tried hard enough - is a thinly disguised
version of blaming the victim" (p.7). We see this *self-blaming* in many of our students' stories.

Notion 4

Scientists work alone.

I want to work with people.

Our students had an image of science as a field where you work alone at a desk or in a lab.
This erroneous image is still perpetuated in the media; the fact that many scientists today work in
multi-disciplinary teams is seldom discussed. Most of our students dreamt about a career where they
could "work with and help people." Medicine was the first and only choice of a majority of the
young women in our sample.* They could not reconcile their "people" preferences with the notion
of science as a loner's field.

My dad's a scientist and he works in [field], a researcher - and I've talked to him about
things like that and, like, I know I want to deal with people. I don't want to sit in a lab all
day and look at chemicals kind of thing.

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*A name check of students accepted to medical shool after the fourth semester (ie: spring 1994) showed that none of
our students were in that select group.

Reinforcing this image of the physical sciences as particularly remote and impersonal, their college science courses seemed far removed from their life experiences.

[Biology] seems more directly related to me. Like rather than chemistry, which is all these equations that - Like, what does that have to do with - ? Like, when am I going [to have] to understand that? Or, what does that have to do with everyday life? More - biology, it's about me. It's about my cells, my life. Or, just more - I understand it more. I'm more interested in humans than like chemicals, or whatever. I know they're sort of related in a way, but, you know.

Another student described her experience during the first week of college and decided right then that science was not for her. "I just turned off when I sat there and all the people were taking their notes and the equations started coming and that was it for me. . . . " Still this young woman, coming from a family where science was esteemed, expressed a lingering regret a year later about her exit from the science program, saying, "I'm the only one [in my family] who did not turn out right."

Notion 5

Women should do science.

Science is a man's field.

I saw a girl I knew from high school on the bus. . . She's [says], "Well, I was in this sort of engineering but I was the only girl so I got out of it. . . . "And I'm like, "You really shouldn't have done that. . . . " I'd like to see it change. I'd like it to become more equal, you know, a lot more girls going into the sciences. . . . There's a lot of articles I find in the [newspaper] about that and how more women should go into the sciences. My sister cuts them out all the time [laughs] and puts them on the board.

My mother, she supports me. My father doesn't so much show it like towards me; like maybe [when] he's talking with his guy friends [he] goes; "My daughter. . . wants to go towards engineering. I'm hoping she can maybe go towards the nursing. . . " He doesn't expose it to me, but I can hear it sometimes. . . . He says it's hard to find a job now, for electrical - like for engineers, and he just doesn't want me to get caught up without a job when I grow up. But it could be a male's job also [laugh], that male thing in them, I don't know.

The young women experienced the tension between what they heard they **should** do, that is have a science career, and the reality around them that tells them that science still is a man's world. Most of them go through the whole college program without having one female science teacher. Images in the media continue to perpetuate the stereotypical scientist as male. The women did not often seem aware of overt discrimination but did see the milieu as male dominated.

> I think most of - Well, except for my first [discipline] teacher, you know, they've all treated us like we're all equal. [Was he particularly hard on the girls you think?] No, he just kind of ridiculed. Like when we asked questions. Kinda like a 'guy' person. You know, male bonding type of thing. I donno. . . . He was a nice enough guy out of class, but I just didn't like him as a teacher.

Although many science classes, particularly introductory ones, have approximately the same number of female as male students, this student felt she didn't fit in.

> I remember the first day of biology, I was really nervous. I walked in I saw only - there was a lot of guys, more guys than girls. So I sat there. That was a little discouraging. I was just like, "Am I the only girl?. . . . " I don't feel uncomfortable with guys. . . [but] you'd be sitting there and you don't know where to fit in. . . . I was really surprised, I said, "Oh my god, there's not a lot of. . . women in the sciences." I've met two [women]. . . and [one] said she was in health, and she'd dropped and she's in nursing. And I was very fascinated and I said, "Whoa, what would make someone go from health to nursing?" [She said] "I don't know, I felt more comfortable there, I felt that's where I belonged more."

Jean Baker Miller (1986) warns us that "today. . . some people advocate another form of 'the right thing' [for women], as in 'the only right thing to do is to strive unstintingly for a high-powered career'" (p. xii). Not all women necessarily desire such careers. In our efforts to appear egalitarian, it seems as a society, we have gone from a belief system that said "women can't do science" directly to the present one "women should do science" without allowing women to experience the intermediate position: "Women may do science if they choose."

The last problematic notion touches directly upon the roles which have been prescribed for Canadian women in the nineties.

Notion 6

Women should have a career.

I want to raise my own children.

In discussing gender-role development, Cheryl Washburn (1994) argues, "because the social structure devalues traditional female roles at the same time as prescribing them for women, females experience conflicting messages between what it means to be an adult on the one hand, and female on the other. They attempt to satisfy both sets of expectations by aspiring to career and family without consideration for how to integrate these" (p.153). We heard these sentiments in the students' narratives as they used expressions like *just a housewife*, or talked about a stay-at-home-mother as someone who *watches soaps all day*. Their struggle around the mixed messages they received was evident.

> I'm determined to have a goal in life cause I hate to sit around doing nothing. . . I have
> to have a goal. . . I know sometimes I'm going to. . . wish I was a stupid housewife
> sitting doing nothing, but we need something to do. [What kind of work would you like
> to do?] Something - I'd like to have a big family, and something that would give me
> some lee-way to do that. . . . like my own [photography] studio, or have my own practice
> in psychology, or, if I was gonna be a vet, have my own veterinary hospital, something I
> have to own for myself.

We see this dream of having your own practice or being your own boss as an attempt by the young women to find a solution to the conflicting demands of career and child care that will allow them to gain control over their lives. During their high school years, motherhood was not uppermost on their minds. However, by college age, issues around child care took on new importance. They saw their own mothers struggling with demands of care giving while working outside the home. They argued with friends about the roles of women.

> I have a friend [who] thinks mothers should stay home and raise the kids. . . and I've
> argued with him over this so many times because my mother worked the whole time I
> was a kid. . . . and I have a better relationship with my mother than most of my friends. .
> . So I don't think it's such a terrible thing for a mother to work while the kids - Yeah, it's
> possible for a woman to work and still have kids. And he says, "Well I'm not going to let
> day care raise my children for me."

Young people, like all social actors, think for themselves, but they do so using language and ideology shared with others, particularly their peers. In the students' narratives, we found the recurring ideological formulations "I want to raise my own kids" and "I don't want strangers to raise my kids." The term *stranger* calls to mind a featureless shadow figure. It distances and taints professional child care workers and obscures the reality that child carers always become known to the parents. By rejecting the day care institution they will surely create a dilemma for themselves. The young woman just quoted who first seemed very assured, had changed her stance markedly in the second interview at which time she was much more tentative in her plans about having a career.

> I go back and forth, sometimes I think "Oh, I'd like to establish my career and then stop and have a family. . . " Cause I wouldn't wanna do both halfway. I would want to raise my children, because I think that's really important. You're not away at work during the day and they're with someone else. But, then I think "Oh, but then I'm stopping my career and I won't be doing what I really enjoy." Like career-wise. I go back and forth.

As they tried to make sense of many conflicting messages about child care they were presented with an image of science that requires many years of study and total dedication.

> Well, at some point I'd like to get married and have kids. [pause] But, it's hard when I'm planning to stay at school for another eight or ten years, if it takes that. . . Ten years is a kind of. . . But, if I'm going for a doctorate in something, it'll be a while more going to school. I don't know. . . I wanna have - I would like to have kids when I'm relatively young. Like before I turn thirty or whatever. But I don't know if that's a realistic goal. Depending how things go. . . It's just that if I haven't got a career established so I know I have the means to take care of children. So - . . . Uhm, I don't know. In an ideal situation I'd like to be able to take maybe a year off work, or a year-and-a-half, two years to raise children when they are very young. But that may not be possible, so I'm not against using day-care [or] whatever. . . [pause] Uhm.. I don't know. I guess there are some added pressures on women.

> I love chemistry and math, but then it was my first year in physics and I was struggling and I really don't know what it was, I kind of, I mean, I started to think too - I mean this may sound stupid at my age, but I'm thinking well, do I want to put in all these years of work, because I want to have a big family and all this, and. . . I'm going to stay home like my mother. . . all these things are going through my head. Is it worth it to do all this

schooling and then just stay home? But now, I don't know, just through this summer I just decided I'm going to do it.

In this latter quote we see clearly how the broken and hesitant speech pattern reflects her struggles around her choices. Despite her certainly during the second semester that she had finally decided on a career (in medicine), this student left the science program after the first year.

Science teachers might at times be surprised and disappointed when accomplished female students opt out of science and choose careers in more traditionally female fields, such as office technology or elementary school teaching. On December 21st, 1992, the Montreal Gazette carried the headline "Science Superstars." The story was about three young women who were at the top of their graduating class in chemistry at McGill University. One of them spoke of the reluctance to pursue graduate studies. She wanted to get married after her bachelor degree and start a family. "I don't see my education as wasted if I don't continue. . . . I have gained some knowledge. And I can help my kids." A male university professor, quoted in the article, criticised such career choices: "I suspect that many of these women are turned off by the thought that they have to give up family life to succeed. . . it's just not true" (p.D3). Contrary to the male professor's opinion, this is *exactly the truth* as experienced by many young women.

We have to guard ourselves against assuming that women who *opt out* suffer from misconceptions or limited aspirations. As Briskin (1990) puts it, "The problem is less one of vision than actual barriers. . . . [there is] a major gap between career aspirations and career expectations: young women aspire to careers as lawyers and doctors, but expect to become secretaries. This is not unrealistic. Young women have aspirations that their mothers may never have had, but they are adjusting their goals to what is realistically possible" (p.7-8).

Confronting the Myths around Women's Career Choices

The six pairs of problematic notions reveal the tension between societal beliefs and expectations, and young women's experiences. While the high school years were relatively conflict free concerning future career choices, at the time they entered college they were of an age when societal messages about what women 'should be doing' stand in opposition to reality as they experience it. Gerson (1985) noted that "intervening events, especially in late adolescence and early adulthood, when the struggle to establish an independent identity began in earnest, often shook up old assumptions. . ." (p.198). At college the *open doors* of science seemed to be closing to many of them. The young woman who, in the first interview, said with assurance, "I want to have it all,"

expressed the change that had happened in her thinking, "A woman can be anything she wants, but I don't think I can. I don't think I'd be able to stay eight years in school." This quote clearly demonstrates her change in attitude. Because the college years represent a particularly crucial time when important life decisions are being made, only a longitudinal study allowed us to see these dynamics at work.

We need to question belief systems that say "science is open doors and a safe choice," or "you can be anything you want," or "women *should* have a career in science." Such myths are easily perpetuated as Eileen Byrne (1993) suggests in her book, *Women and Science: The Snark Syndrome*, referring to the Bellman's cry, "What I tell you three times is true", in Lewis Carroll's *The Hunting of the Snark.*

Furthermore, we must challenge a reality where science is only accessible to *the very best*, as defined by the scientific community, and where science is taught in a disconnected way, far removed from the life experiences of young women. Scientifically trained women who "like working with people" can exercise their communication skills and their abilities to work well with others in university laboratories and industrial milieus. We need to emphasize that these skills, as well as scientific aptitude, are needed and valued in today's working world.

In a broader context, we need to examine whose interests are served by notions that day care means "strangers raising your children", and question why so many young men still assume that "raising your own children" means mothers doing that job.

These are some of the issues we have to focus on in order to achieve an equitable outcome for women in science. This goes beyond the removal of barriers, to promoting the visibility of women in key positions in academic, institutional and governmental settings. However, in this process we feel individual women's choices not to pursue science should be honoured and not condemned as failures.

Koertge (1995) has suggested that a feminist critique of science, such as the one we have outlined in our discussion, alienates women from the sciences. On the contrary, we believe that shifting the "blame" for women's low participation in scientific careers outside of the women themselves will encourage more women to persist in their science studies and provide additional support to them in their chosen fields.

Unfortunately, what we often hear discussed in the media and by some *experts* are issues that rest mainly with women themselves, such as the need to recruit girls into science at an early age, the importance of a supportive home environment, and, in particular, women's tendency to give up in face of adversity. This is not to say that those issues are not important. However, to make them the whole focus of the debate is like equipping a team with warm coats and protective gear before sending them out into a cold and hostile climate, when instead, you could choose to send them to a warmer and more welcoming place, where their experience would be just as rich or richer. The choice is thus between *fixing the women* by providing them with an endless supply of *protective gear*, or *fixing the ecology of science* to make it a place of greater diversity where many different species can flourish. We would argue that not only women but science and society at large have much to gain by the latter approach.

Staying in or switching out?

> I kept on hearing about people switching out [of science] and saying, "ah, that would never be me, that would never be me. . . ." Within a few short months - like I was totally - not slapped in the face, but in a sense, because I thought I would work well - I didn't do well, and, sort of thing, and it turned out that I was really bad, worse than average. And it was realizing what you are instead of what you thought you are, so. . . because in high school, I would be considered, you know, a good student, you know, I tutored people in chemistry and stuff.

It was stories like this one, related to us by students in our preliminary study that urged us to undertake this research project. Out of more than one hundred hours of interviews emerged what we see as some underlying causes of why these women persisted in their studies or switched out of science. They defined as pivotal factors the opportunity to interact with teachers in an open and friendly manner, and opportunities to ask questions and have them answered without judgment passed. They mentioned science disciplines taught with enthusiasm and made relevant to their experience and in a manner that left room for their individual talents. They talked about the tension created around study and career decisions by societal expectations of them as women and future mothers. Lack of confidence, they claimed, was not a cause of the difficulties they encountered, but the result of their experiences.

In the previous section on *Career and Life Choices*, we advocated moving the discussion on women's participation in science and scientific careers to these external issues rather than continuing to focus the debate on the alleged shortcomings of women. Nevertheless, in this section we want to look at the characteristics of those students who stayed and those who left science. What kind of *protective gear* (see p.92) are the persisters equipped with? What are the vulnerable areas if any, of those who switch out? We present this analysis in the form of four profiles: *the happy switcher*, *the reluctant switcher*, *the happy persister*, and *the miserable persister*. Although one or two women stand out in our minds as particularly vivid representatives of each category, these profiles are composites that blend features of several students. We want to stress that we do not see these characteristics as causes for women switching out or staying in science, but rather as coping mechanisms they have or have not developed, and support structures that are available to some but not to others.

the happy switcher

> I just turned off when I sat there and all the people were taking their notes and the equations started coming and that was it for me. . . . I did not want to suffer for two years with three page equations and all that.

After one week of college science classes *the happy switcher* went to an academic advisor and asked; "Please get me out of science." At high school she had relied on her memory in her science classes and was not challenged to understand the underlying concepts. On the contrary, she was told by some teachers to memorize the procedures for solving problems, not to struggle to understand. "I was never actually thinking in high school." At college she quickly realized that a different kind of effort was required from her; "Now it's science, real science, you have to really understand and enjoy it." She was excited about her new program, liberal arts, "where all my classes are connected." Still, listening to her talking about her family where both parents have science careers, one could sense a lingering regret about her exit from science; "I'm the only one [in my family] that did not turn out right." She had initially chosen science because it promised better employment opportunities. "I figured I'll be safer with the sciences." When she switched out she was told everyone around her had expected it. It disturbed her to discover that others knew her better than she knew herself.

> My best friend said, "I was waiting for this. Ok, yeah, it was expected, I didn't think you were going to stay very long. If you were, you weren't going to do too well." And my boyfriend said, "yup, good choice." I don't know. It seems like everybody knew except for me.

There were several *switchers* who found enjoyment in a new program where they could "put more of themselves" into their studies. They enjoyed open class discussions and the possibility to present their points of view and having their views respected by their teachers. They said they "needed words to put with the numbers" in order for science to come alive to them. These students remind us of Tobias' *second tier* students who could do science if they chose, but who found science instruction intellectually barren and disconnected from their experience (Tobias, 1990b; Hoots, 1992). We believe their exit from science is a serious loss. Science could benefit from their writing and research skills and their willingness to engage in debates.

the reluctant switcher

I continued, because I thought, well. . . The thought of switching programs never oc-
curred to me. I just thought "Well, this is what I have, and I have to try and get through
it'. I did the second semester and then I was just, I was just not into the sciences. I felt
like I was too far removed. I wasn't - Not that - I guess that the interest really wasn't
there any more. Not the interest in sciences, but the interest in school. And then next
semester, the second semester of last year I had this humanities course and it was all
about economics and politics and a lot of history. And I became very <u>very</u> interested. . . .
We had a big book and I read the whole book. And suddenly I am asking myself "Why
am I doing homework?" I wasn't doing any other homework and I started to get into this
class. A lot of the issues were really interesting. We looked at the history of America
and how the economy worked and why it was a leading world power and everything. I
would go to my teacher's office and have discussions with him. And I thought "What am
I doing?" I was really, really into the class. And I thought, well, I was obviously inter-
ested in what I was learning about. I wanted to talk to my teacher more about it. And
that's, then I would get to my science class after. Like, I would go to my humanities; I
was on a high. Then I would go to like a chemistry class, or something, and I was just so
far removed. I wasn't interested really. . . I won't say I <u>couldn't</u> do the sciences. It wasn't
that I couldn't do it, I just became extremely lazy. And, I guess, probably that and not
doing the work. After going to class and you're not understanding, you can't really relate
to the teacher. There's something about me that I always like the science. . . I still want
to know about it. . . I do feel guilty about it [leaving science]. I mean, I'm enjoying my
year this year. I'll always feel guilty about leaving science. . . I always had science in
me.

In the narratives of both happy and *reluctant switchers* we see all the central issues that we have
described in detail in other parts of the reports; the underlying issues we believe push students out of
science. This student talked in the first interview about how she preferred to ask questions of
teachers in private, because she did not want her class mates to know there was something she did
not understand. Not understanding made her very frustrated and she felt like crying. To learn, she
wanted the teacher to sit down with her and explain the concepts using concrete examples. She was
sensitive to class room atmosphere; "If the teacher just doesn't seem to want to be bothered with the
students or does not seem to be enjoying what they are doing, it makes the whole atmosphere, you
know - you don't want to learn." Her interest was gone, not her interest in science as she made clear,

but her interest in school. *Understanding* was central for her, to the point that *not understanding* could break an established connection with the teacher: "After going to class and you're not understanding, you can't really relate to the teacher." The stressful and competitive atmosphere in the laboratory sessions added to her sense of discomfort. It puzzled her that other science students would turn their backs on her when she asked for help.

Having, what she described as "a great teacher" inspired her to give science a second chance. The great teacher "makes sure everyone understands. . . he would stop the class to help one person. He was more of your friend. . . he used lectures that were not like lectures. He got to know everybody in class and the teacher changed my mind about [discipline]." Still, she eventually switched programs rather than endure the kind of teachers she had in the first semester. She believed that the kind of teacher who did not explain in ways that worked for her was more numerous than the kind represented by the great teacher in the second semester. Although the switch was reluctant, it was positive in that she followed her interest.*

Some of the *switchers* came to college with a strong high school background, having participated in special programs for gifted students. They may have had clear career goals but could not force themselves to scale the barriers that the science program presented (see quote p. 85).

> I know that if that [career is] something I want badly enough that I should be willing to go through the chemistry and all this now to get there, so I don't know whether I am going to regret it later on, saying "Why didn't I just stick with it? Why didn't I just do it?". . . it's so annoying because you find out most of the teachers [say] - "You're never going to have to do this, but here 'test'. You're never going to have to use it." Like my [subject] teacher said "You're never going to have to use [topic]. It's never going to come up, but what companies want is they want to see that you're able to go through that kind of mental process." [laughter]. Thank you!! Great!. . . You're never going to have to do this, but if you fail [laughter] but if you fail - great, you know.

There is a widely held belief that science studies require an innate ability that you have and cannot learn. From this belief it follows that scientific talent can and should be traced in children at a young age so that such children may be given opportunities to develop their *natural gift* for science.

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* We suspect that a student like this one might return to science studies at university.

Tobias (1994) discussed this propensity of scientists to see themselves as belonging to an inner circle, thus setting up a dichotomy between outsiders, and themselves, an exclusive scientific elite.

One indication of the *natural gift* for science is the ability to work at a rapid pace.

> Actually our teacher in [subject] is very - uhm - I don't know how to explain it, but he just says to us, if you can't do it faster, maybe you shouldn't be in the sciences, maybe you should go find something else like English to do. Like he is very quick to tell us you shouldn't be here. He said a few times, if you fail the first test, maybe you should just get out of [this subject], or maybe sciences all together. And then he says, if you can't hurry up and do the simplification faster, maybe you shouldn't be in this program, maybe you should be in something else. . . once I get past those [subjects] there's no problem, I'm in biology [at university], which I like. But I have to get past [subject].

Those who eventually switched programs sometimes gave a seemingly trivial reason for their exit. The student who "had always had science in her" left the program when she realized that persisting would mean staying an extra semester at the college to make up for a failed course. Although the majority of students take more than four semesters to complete their cegep diploma, this student had been given the message that staying an extra semester was indicative of failure.

the happy persister

Two types of students seemed to fare particularly well and have a positive experience in the science program. The first can comprises those who possess that special gift for science we discussed above. These students generally performed very well at high school and were used to being treated as *stars*, worthy of a teacher's attention, time and effort.

> The tests are awful. The first test I got sixty per cent. I was really mad and I went to see him [the teacher] and I complained a lot! [laugh] I was like "This is impossible." I'm not used to this. I studied a lot and - the average must be. . . I dunno, like fifty or something. I think four people in his two classes, or three classes, got 75 or more. So I went to him and like "This is impossible!" and I was almost screaming. But he has a good sense of humour so, I guess it didn't really matter. . . I went like "Next test, will it be easier?" and he goes "It should be." [student:] "Well you better make it!'. [laugh] You know, I was really mad - "You better make it!" But, I wouldn't say that to teachers that don't seem to have a good sense of humour. Like, I know he wouldn't take it badly. . . Then I would

> ask him more questions. Him I go and see often and ask him questions and he goes like "If you have any questions, come and see me" and I'm like, "Yeah, don't worry."

This outspoken student had all the characteristics, of a young woman who would be successful in her science studies; that is, according to our common belief systems. She talked about having been a *lego freak* as a child, and described herself as having a logical mind. She went to a private high school and had a father who played a prominent role in her life. "They [parents] never had to organize me. They let me do my own thing, so, that's what helps." Although she had her share of strained relationships with teachers she managed to work around that. It was evident from her stories that her teachers saw her as a *star student* and treated her as one.

> And they [other students] go "He likes you because you're the best." And, na, na, na. . . like, I don't care. Don't overdo it. It's like, it's fun. Okay, maybe I'm privileged because he is going to be a less harder marker on me, because he thinks I'm smart. I don't - maybe, sometimes you can take advantage of that, but don't overdo it.

She said she was quiet in class, seldom asking questions, but in the laboratory she used "a lot of space."

> Then [in lab] I ask a lot. I go like "Sir" and I scream it, because I want him to hear me. Usually, I'm very very like - I take a lot of space in the labs. I don't know why in the labs, particularly, but. . . I go like, scream it "Sir, come here." [Do you get what you want?] Yeah, exactly. And if he doesn't hear me, I go get him. . . I'm like very impatient. I dunno why. Everybody finds it really funny. They go like "Call the teacher now - Sirrrrr!"

This narrative contrasts starkly with the story of the *reluctant switcher* who was searching for somebody to explain an experiment and was longing to "steal a minute of the teacher's time" during the laboratory session. The *happy persister* was confident about her academic abilities in a matter of fact way. She could not identify with other female students who falter or habour doubts about their abilities.

> I'm very confident about my school work, that's for sure. I'm never nervous before tests, except chemistry, maybe a little bit. But, not that much. . . It's like - It gives me energy a little bit. . . It's no use being nervous, the test is gonna happen anyways.

If you work hard you can do what you want. . . They think they are not good after a few
years, or they go 'It's too hard for me. I'll switch . . . or they're not meant for that [sci-
ence]. Or they have prejudice that girls shouldn't go in there. I dunno. Most of my
friends when I was really young were guys. So, I was more like a little boy myself. So,
maybe that changed something. Now, my friends, they're more guys, 'cause, I dunno, I
can talk to them. And it seems I can talk about things that I wouldn't talk to a girl about,
so. One of my friends told me I'm a guy in a girl's body. [laugh] That was pretty funny.
I'm like "Okay. Thank you!" [laugh] He said, "Well, you like guys' stuff. . . "

The second type of *happy persister* had developed a coping strategy that served as particularly
effective protective gear. We labelled such students *relationally gifted*. They quickly recognized
teachers who "don't teach with their hearts" and sought those who did. It is apparent from our data
that most students thrived from having teachers with whom they could establish a good relationship.
The success of the relationally gifted students lies in their awareness of their preference for this
particular relationship. They actively sought out teachers with whom they could learn. When they
talked about "a good teacher," They focused on relational issues and the teacher's ability to explain.
They worked hard at establishing the kind of student-teacher relationship they preferred.

Cause like some students, some of my friends they are really really smart and it doesn't
really matter like who they have for teachers. But for me I think, good teachers, they
really make a difference. Like people say "If you are a good student, no matter what
teacher you have, you'll still do good. . . ." For me, I'd rather have a good teacher.

The transition from high school to college can be difficult for a *relational* student. "I never felt
so discouraged as since I've come to John Abbott. . . . I didn't want to be here." This student was
lonely, she missed the more personal atmosphere at high school. She felt "insignificant." Teachers
talked to her but there was no contact, no name, "anybody could be sitting in my chair. . . A good
teacher wants people to learn and even if I ask a stupid question, he explains over and over again to
me. . . they listen when I have an opinion. . . They remember your name. . . tell you as a person you
can do it. . . ." She wanted teachers "to see you as a human being not as a lower form. . . [Good
teachers] want to see us succeed, they like what they are doing, they are willing to put in the effort,
[make you feel] look, you taught me this, I'm going to do well for you."

Even when they were at the top of the class, these students enjoyed an egalitarian atmosphere more than a competitive one, where the best students are singled out. "He is also happy for all of the students. And he treats all students like really equal."

They sometimes saw their preference for that special teacher as a weakness, but still made getting what they needed their top priority even if it meant having late classes.

> I guess why they chose them is just for the schedule. Like my biology teacher now, he is really really good, but his classes are from 4:00 to 5:30. So for some people, even if they know that he's a really good teacher, they wouldn't want to take a late class like that. But, for me I'm willing to sacrifice the time factor, like, to have a good teacher.

the miserable persister

> So I feel I have to do everything so fast just to get stuff done and I don't really have the time to understand it. I don't like doing things fast. And, then I get like "Well, I don't really understand it" and I get mad. I get the feeling that - Anyway school is like- I don't know - Like you have to learn it so that you can be tested on it and do well when you're tested. But, you come to school to be tested, not to learn.

For this student there was no room for enjoyment. "I hate it, I hate it. . . physics and math are like - to do work in - I have to push myself. I don't like them. . . so then my biology gets left behind. [laugh]. . . that's what I would want to be doing!" Her introduction to college life was harsh in spite of her ability to achieve top-ranking marks:

> Like first semester I used to cry every night practically. . . . It was really annoying. . . . I wasn't the only one! Like, all my friends, they had to cry too. I could call them up on the phone and keep crying. Look, I don't know. It was just 'cause there was like "You have to do well." There was just such a pressure to do marks. I think marks count for too much.

Coming back after the first year was not easier, but she did find enjoyment outside the science courses.

> I didn't want to come back. I was so burnt out I had no interest in anything and I know I was doing very well. Like a [high eighties] average last semester. But, I didn't like

anything and I don't know how much I learnt last semester. I really like my [social science discipline]. I did well in that. It's very interesting. . . I like the subjects that we did. . . Like, you know, we learnt about it and then talked - And I really liked that one [course] 'cause it kind of like fit in with the sciences. . . There's a bit of science, a bit of biology in it and we did a bit of evolution in biology. Although we did it, like from the biological point of view. That was interesting too, because, you know, it's like, okay it's not just science, not just pure science. . . it actually applies somewhere.

Listening to this narrative we can make a link back to the *happy switchers*, Tobias's (1990b) *second tier* students. Those students expect to get enjoyment out of their studies and want something that actually "applies somewhere." In science they learned by rote; in their new programs they found that what they were learning made sense: "all my classes are connected."

This student persisted and got her science program diploma, but the cost seemed high. Despite her high marks she felt she could not judge her own performance in sciences. However, when she wrote English papers she "did not worry about confidence." She knew when she had done a good job.

persistence is a hard process to predict

We want to make clear that there is a group of students where numerous issues cloud their narratives so much that it is impossible to discern what factors most influenced their decisions to *stay in* or *switch out* of science. The problems might rest with the particular family situation or with friends and boy friends. The *reluctant switcher*, quoted earlier believed she lost interest because of family problems. However, the text of her story centers around teaching. Others persisted without pleasure because they saw no attractive alternatives.

So, I was really discouraged. But I knew I didn't wanna leave school. I didn't wanna just get a job, so I knew I had to stay at school. So I figured I just won't do well at school and I'll stay there. At least I'll get something out of it.

Persisting is a process. There are no clear boundaries between this group and the others, nor between the four categories as we described them; in all of them we can find some element of the others. The story of one of the persisters illustrates how difficult it is to predict the path of individual students. This young woman had developed a strong dislike for physics during her high school years because of a "bad teacher."

I started off with a really bad teacher in high school. Like, I didn't understand. Well, I
mean, I guess I understood most things. But, it was sort of "Do it by yourself." And like,
you couldn't ask my teacher for help or stuff like [that]. If you asked him a question he'd
[end up] yelling at you. Like [I'm] "Sorry." I wasn't really interested in finding out more
about [subject] because would have had to have been through him sort of.

At college she struggled with a lack of interest in chemistry and physics, but loved biology and
math and also English.

I like the challenge. I like, I like working with numbers. I like getting answers and stuff.
I dunno, it's something I was always good at like. . . but, this is the first time - my first
[biology] course and I really like it. It's hard. Like it's a lot of memorization, or a lot to
remember for each section. . . but it's interesting. I like it. I understand it more - It seems
more directly related to me. Like rather than chemistry, Which is all these equations that
- Like, what does that have to do with. . . ? Like, when am I going [to have] to under-
stand that? Or what does that have to do with everyday life? More - biology, it's about
me. It's about my cells, my life. Or, just more - I understand it more. I'm more interested
in humans than like chemicals, or whatever. I know they're sort of related in a way, but,
you know.

By the third semester she was easing out of science avoiding chemistry and physics courses
required for university science programs.

I just didn't like it. I found the labs a lot of work and they were really tedious. Like
uncertainties and all this and ten million graphs and calculations and it was just *blah*.
[laugh] So I just didn't wanna to have to do that in university. I figured that most pro-
grams would involve some sort of physics.

In her search for a university program she consulted an academic advisor.

Like, I said, well, I'm interested in subjects like biology and psychology and English and
some humanities. [laugh] So the advisor was kind of like "Well, this is strange. I don't
know what to tell you. . . " Cause I had like so many different interests. So it's basically
a matter of I'm researching by myself. And discussing with friends and family.

She found something that turned her around. Her assumption that all science programs would

require her to take physics at university was not correct. "I've been looking at a lot of different schools and programs and I realize that they don't necessarily have to do with that [physics]." She started exploring what she might want to study. "I'm looking at programs like biology or anatomy. Or there's one program. . . which is a joint bio-psychology. . . It sounds interesting, 'cause it's two things I enjoy, you know." She wanted to work in an environment where she can use all her talents.

> I'm more interested in working with people, sort of, but also sciences at the same time. so it's kind of, like I just want to find out how I can do that, like use it all sort of, not just one specific thing. . . Like I don't wanna sort of work - be in a job where I'm not work- ing with other people. Like, contributing together to get something done. As in - like if I was doing one thing by myself and that's my project and, you know. Like, I like to be a piece of something that people work together on you know.

Realizing that putting up with chemistry and physics would only be temporary, she re-evaluated her decision to leave the sciences.

> I guess at the beginning of the year, when I was registered in the physics and the chemis- try I felt pretty shitty, I guess. Because, I was thinking "Oh, god, I can't do this," you know, it's just too much. . . . Now that I see what I might do with it, then I think "Okay, maybe it's worth it, to try, even though it's really hard. . . . " I wanna do my math. Cause that's something I really wanna keep up. So then [to continue in science] I'd have to maybe take a summer course or something. Cause I know I couldn't take eight courses. [laugh] . . . I'd just be insane! But I think - like, I'm rethinking this struggle with phys- ics. Just to get through it, so I can do something else. So, I'm looking at my options. [laugh]

Despite her misgivings about taking eight courses in one semester she did exactly that, making up two missing physics courses in the last semester and graduating with a diploma in Pure and Applied science after two years. She attributed this display of perserverence to her own confidence and to people around her.

> [Do you have any idea where that confidence comes from?] I don't know, I think it's from myself and from some teachers who encourage me and my parents and stuff be- cause I've met - like I know I had one teacher who was like really great and like I did, like excellent in his class sort of and he encouraged the students and stuff and it made

me feel good and I felt good about myself. And my parents are always like giving me encouragement and stuff.

Although we find many stories of good pedagogy and exceptional teachers in the students' narratives, there are three issues that are particularly painful to discover in their stories. Because these issues often came up in the interviews in connection with students switching out of science, they are pertinent here.

One of the questions we asked the students was to recall an important learning experience. Hardly ever did their accounts include a classroom experience. They often related stories from their work places. Here they felt they had learnt something meaningful; something that made them feel good about themselves. They frequently described such experiences as a counter balance to school where they often felt discouraged. Certainly we can argue that students may find it easier to see the immediate benefit from a practical task learnt at work or, for example, while working on the family car. However, that the balance was so completely tipped in favour of experiences outside the classroom was both surprising and sad.

A second problem area concerns students who come from an environment that is very different from that of the college. These might be students from small, often rural high schools, or those coming from very protective environments either at home or at school. Byrne (1993) observed that the greater the difference between two learning environments, the longer it takes a new college student to adjust and start functioning in the new environment. We have observed that some, certainly not all, students coming from outlying areas experienced significant difficulties at college. We feel this issue needs to be addressed at the local level.

The third issue is the most difficult for us as teachers to discuss. It came as a surprise to us when many students talked about incidents with teachers that can only be described as direct put- downs, where they were intimidated, belittled, sometimes called stupid. These incidents affect not only the student who is directly involved but the whole class.

I saw that [put down] and that was it. I will never [ask him a question]. . . Then this last week [a friend] went to ask him something. He said the same thing: "You're so stupid. You don't understand? I can't believe you." So he did that, and I was beside her this time. I can't go to him. So, I don't even like going to class. I'd rather study on my own than go to him. That's what I'm probably going to do.

One such incident (we have labelled them "one bad experience") can be enough to make a student revise her college plans. We are not saying these incidents occur only in science classes. However, we have seen that they can have a profound effect on students. There might be only a few teachers who do not deal fairly with students, but over the four semesters at college, a student's chance of encountering one of these teachers is anything but small. No-one is immune to this kind of treatment. One of the most accomplished students in our study, a quiet, independent, extremely competent young woman with plans of becoming a research scientist, recalled her devastating encounters with a teacher, "I just got the feeling that he didn't think I myself was very intelligent. . . That affects me. . . they're in a position of authority over you."

Teaching enthusiastically, showing that we like what we are doing; those are things that inspire our students to learn. Few things are as demotivating for students as hearing that after the exam they will never again need to know what they are presently struggling with, but that they have to master it to demonstrate that they are *worthy* to proceed. Sometimes we use the argument of maintaining high standards to defend our high dropout and failure rates. Would we still do so if we were aware of the diverse reasons for students' programs switches?

Some of the students had access to good supportive structures, like the student who overcame her dislike for physics and finished her college diploma by taking eight courses the last semester. Her new-found career goals, an encouraging family and a special teacher helped her to pull through. Had she switched out she might have been seen as not quite *worthy*; a sacrifice to maintaining our high standards. Her results in the last semester showed otherwise; she got over eighty per cent in two physics courses. Her diverse interests and broad talents will be an asset in whatever career she chooses. However, we could wish that her experience at high school and college would have been more rewarding; not as "tedious" and filled with "ten million graphs." We wonder how many other talented young people are lost to other programs and careers (Tobias, 1992).

Science, particularly at the college level, does not have to be monolithic where only a few with a special talent can succeed. Society needs journalists, lawyers, and stay-at-home-moms with a science education. The scientific community needs researchers with broad interests and excellent communication skills.

In Science There Is No Gender?

In the introduction to this report, we gave our reasons for avoiding a gender comparison approach in the design of the study (see p.23). Nevertheless, we feel justified in devoting a section to gender-related issues and experiences raised by the students in the interviews. After all, such experiences impact on how they think, perform, and make their program and career decisions.

In the early stages of our data analysis, we did not immediately see many gender-related issues raised by the students; the issues were not explicitly discussed by them in these terms.* As our interview protocol developed, we included a question that asked if students could recall any times when they felt they were treated differently because they were women (see Interview Guide, Appendix). Usually the response was a convincing "no," although a few speculated that, as women in science, they might later have a slight edge over male friends when it came to being hired by a future employer.

> I think it would be better [to be a woman in engineering], because they want female engineers. And it would be an asset. Maybe not directly related to, like, working with men. It might be a bit of a disadvantage. But, as an employee prospect. . . You'd probably be chosen, possibly before a man.

As our analysis progressed we identified statements and more extended narratives which were clearly related to gender issues but were not a direct response to our probe. The students talked about discussions and incidents with friends, employers, parents, counsellors, and teachers which focused on expectations of them as women; what women could or could not do, should or should not do. When the incidents were unpleasant they were often brought up as something that had happened to a friend. They talked about their reactions to messages in the media. We coded these sections: "woman is." Together these narratives paint a picture of the gendered milieu in which young women work out notions of who they are, what is expected from them, and what places in society are open and welcoming.

It has been well documented that teachers pay more attention to male students, who are invited to answer more questions and contribute to class discussions. (Sadker and Sadker, 1994, 1992).

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* The absence of direct gender references in the students' narratives alerted us to the limitations of survey studies; few of the gender-related causes to women's feeling of unease in the science program would have been so labelled in a quantitative study.

Because ours is not a quantitative study, we did not report on the frequency of these events. However, the stories we heard illustrate that the classroom climate can be *chilly* for female science students.

gender inequity in the classroom

In an earlier chapter we outlined the story of a student who felt that "women don't get preferential treatment from teachers." Yet, another student revealed that "she did not feel comfortable" in her biology class (see p. 102). How can a student in our college not "feel in place" when the health science stream has almost as many female as male students?* It is quite likely that her reaction was part of a larger picture, where science is perceived as a man's field. With few exceptions, their science teachers at college were all male.**

Feeling that they belong, that there is a place for them, is problematic for female science students. Some expressed this need to feel included:

> Cause I don't just like feeling like I'm one of the crowd. . . I like to have a place, you know. I don't have to be the top or the bottom, or anywhere, just a place somewhere, so that people know who I am, and I know who they are. I like it.

Others felt silenced. "I have a sense some people take up too much space, their ego is too big. I just keep my mouth shut. I donno. I just move aside, I guess." Sometimes the reasons women felt excluded was a reaction to overt discrimination, as evidenced in these separate stories.

> I'm the only one who asks, the only girl in the class, who asks questions. Like, the other girls are just too intimidated. A friend of mine, like she'll ask so many questions all the time. In this one class, she just sits there quiet; she doesn't say anything. . . cause he likes it when guys ask the questions, you know. I find that, like, he sort of smirks, or whatever, but then when it's, like, a girl, when it's me, I tend to feel like he's like, "You should know this" and I'm, like "Sorry."

* It is possible that the particular section in which this student was registered had more males than females.

** In the fall of '94, only four out of thirty chemistry sections, and one out of 28 physics sections were taught by female instructors.

I remember he used to smile at some of the students. [laugh] I remember saying "Oh, look, he must be the teacher's pet, cause he actually made the teacher smile." I noticed, but maybe it was just coincidence that they were male students. And we were all female students, us in the group.

From informal discussions it appears that most science teachers at our college believe that the educational experiences of male and female students are similar, and that females do not need any special attention to feel included. However, accounts by the students did not confirm this. At times, teachers seemed to ignore the women in the class.

[One of my teachers] I don't know, he's - it's not - he likes, prefers the boys, but I just have a feeling, not for me. . . but for the other girls, I feel like he prefers the boys and that if a girl asks a question, then he's like, [mimics teacher's impatient sigh] he just, he won't explain it to her, he's very arrogant too, like my - well like my [other] teacher's arrogant on his test, he's arrogant in class.

At other times special attention from the teacher was unwelcome.

My [discipline] teacher, I'm never gonna see him. I really don't like him! I feel like he's [pause] doing favours towards girls, so I don't wanna see him. When he goes talking to the people in the group, he talks only to girls. . . he was talking mostly to girls. So I was like, "What is this?" And my friend she went to ask him a question. . . he was using examples like bras and things like that. And, I was like, "Oh, my god, I never wanna ask him any questions!" I was like - [laugh] So I don't wanna see that teacher, and I'm never gonna - He goes "Your marks will be pretty much proportional to the amount of the time you come and see me and ask me questions in my office. . . he goes "Maybe some of you are smart enough to figure by yourself." But he makes us seem like we're really stupid and very low.

This student was confident enough to seek help elsewhere. "I go see other teachers to ask questions. . . but, this semester I don't have any questions. I'm lucky."

science: a gendered field

A female image does not automatically come to mind when one thinks of who can do science. There continue to be scientists and women scientists, engineers and women engineers, in the same way there are nurses and male nurses.

Within the sciences, disciplines are gendered differently, and this gendering constitutes part of the overall *opportunity* structure.; physics is the most masculine, biology, the most feminine. It does not require any extraordinary motivation or explanation for males to take physics. Their presence in classrooms and laboratories cannot be questioned on grounds other than ability and willingness to work. Female students can not take for granted that their presence in the science classroom will go unquestioned or be equitably rewarded. They experience gender-based challenges, personal slights, and overt humiliations, and see them happening to other women. Claims of gender equity, even the favouring of females, encourage the belief that discriminatory practices belong to the past. It is becoming increasingly difficult to label these experiences as events that create disadvantages for female students.

When a woman was referred to in our study as being "the top female student," she was reminded that being female in a science program is not the norm. Even doing well could be construed as something a woman should *not* do.

> One girl. . . uhm, had gotten back - she'd done really well on a quiz, and he [teacher] goes: "Aren't you miss superstar?" or something like that, "Aren't you miss perfect?" or something, and she was kind of "What? What are you talking [about] ?" She was really mad.

For the young woman who related this incident, there was a clear double bind. The same teacher had admonished her for taking on the feminine role of data recorder rather than instrument reader in a lab.

> Yeah, I don't think he thinks I'm very smart [laugh], which I don't - and even sitting in the lab, like I'll be sitting down and my partner'll be like timing or something. I'll be taking it down, and [the teacher] goes "Oh, are you a little secretary?" Like, well yes, I am. I'm taking notes. And you know he says I should get involved in the labs? I'm working with a guy and he always [groan]. It's very frustrating, he, ahm - like he always does everything? Like you can't just say, excuse me, I would like to do this lab. Well, I

can, but I'm not gonna push him out of the way. . . [The teacher] came up and I go, "Sir, I'm not gonna push him out of the way and do the lab myself." I mean. And he goes "Oh, well you should do that. Everyone has to get their hands dirty in [this discipline]." Then it's like awwwwh! So I don't really - I don't like that class. It's very frustrating. I just got the feeling that he didn't think that I, myself, was very intelligent. Which I don't like to feel that. That affects you. Cause they are in a position of authority over you. . . It was just a general feeling. It wasn't - There were a couple of special events, but I think I probably - I dunno. It was just him. . . . It was just the feeling I got from him. He did not seem to think women had all that much to contribute. But that was probably just me interpreting that, you know.

Students and teachers, women and men tend to discount gender-based challenges and slights even when the actions are blatantly misogynist or hurtful. In this way, they redefine the event as a misunderstanding, or misinterpretation. The *fault* or error is thus displaced from the speaker or actor, who meant no harm to the listener; "that was probably just me interpreting that." For example, when a teacher jokingly asserted that "everyone knows that girls can't do science," he created a no-win situation for female students. If they object to the *joke* as being sexist, they may be accused of lacking a sense of humour or being *touchy*.

If a teacher's action cannot be reinterpreted, there is a tendency to discount it by defining it as unique or rare. It may be attributed to unusual circumstances (the teacher was having a bad day) or to unusual individuals. In other words, it was *only* the act of one old-fashioned, eccentric, or bad-humoured teacher. If sufficiently outrageous or clearly harmful, the action must be deplored by all normal, right-thinking people; there would be no reason to connect such an unusual action with any larger pattern.

Each of these actions creates inequality and adds to the accumulated disadvantages experienced by female students. In every instance the less-powerful (the acted-upon) rather than the more-powerful (the actor) must make the effort to excuse and understand. A more powerful person could demand a retraction or an apology. If the rethinking and reinterpreting are successful, the student may not consciously perceive that the opportunity structure is gendered. She will still experience it as unequal, however, to the extent that she must expend additional time and energy talking the hurt out of the experience. When it is paramount for the student to keep the relationship with the teacher unimpaired, an extraordinary amount of energy can go into maintaining the illusion that she is being treated fairly (see p.75).

interactions with peers

Being female and smart often created tension for the young women in their interactions with peers.

> I went through a stage in high school when my marks were extremely good in physics and sciences and I just - I just studied that. I loved it, you know. And I did not go out very much and I had people saying things [about me] like, "you know it's too bad [name]'s so strange or else she'd be really good looking" or you know, like so strange, meaning that I wanted to study so much, so I was odd, you know. [What people would these be?] Well, peers I guess, the same age, like the same age group kind of thing where I should have fit in but I didn't. . . They don't want to think you are smart, you know. . . They just don't want to believe that you fit into the smart category, you're either stupid or strange, but not, not smart. . . It doesn't matter what I do, I can't get into it.

> You had to prove yourself with the guys before you were, not accepted, but just like considered. Some guys consider women inferior, they are not smart. Men are physically stronger so they automatically believe they are better but that is not always the case. . . I know some of them [guys] who consider women inferior to them because they are not smart. But I - my friend, my best friend. . . she is smarter than all those guys put together.

At high school, being labelled *smart* can be problematic for both boys and girls. However, at college there appears to be a shift in expectations and being smart becomes more acceptable. However, the hierarchy of the male-as-more-knowledgable is maintained. If a female achieved higher marks, some males experienced discomfort.

> [In high school] guys would read quantum books. . . I wouldn't actually read them but usually when they were discussing it I would discuss it with them and ask questions and they'd tell me you know, what they'd read. . . [My boyfriend is] really smart and he gets furious if I beat him at anything. He's not furious at me, he's furious with himself. He knows that he should do better than I do; especially cause I don't study as hard as he does. I kind of expect [my boyfriend to do better than me] so I'm not terribly worried. I like to get as high as possible. It always makes you feel good if you get 95, between an eighty and a 95, it kind of makes you feel nice. But if he gets higher than me, then I know I can ask him questions. And he usually explains what I did wrong and that's fine.

[One classmate] was acting so macho-male because we got back our chem test, and our group is three girls and he's the only guy, okay? And so we go, "How'd you do?" and he goes, "Well I did well." And we'd go, "What'd you do?" He goes 39. And we're like, "Really? Wow!" you know. And then he goes to my friend and he goes, "How'd you do?" She's like eighty. He's like, "It's not good enough." And we're like, "You're the one who got 39!" and he goes like, "Well I've got high standards - doesn't mean I meet them, but I've got high standards." But he's just joking around you know, and then he's telling us how we're jealous and we're like - and then me and my friend, we made the same observation about another guy who was talking to a girl and she had done better than him, and he also said that she was jealous! So we're like, "What's going on here?" you know. It's like the attitude they put on, you're not going to [show it] annoys you?

[When a classmate] did well in the physics test and I didn't - like, when it's going well for him he's happy, but if he hears that someone else is doing well, he doesn't want to hear of it, you know. It's like, I think we used to always compete in that sense. Then I did better in math so he didn't - I don't know if he felt like somehow he wasn't good in math or something - I found math challenging and if I find something challenging I want to do it even more. [Did something change in your relationship, or your friendship?] It's always, like, he'll only talk to you when things go well. [When things have gone well for *him*?] Him, and he won't talk to you too much on that and he just sort of wants to find out what is going on in your life, mark-wise, school-wise and that's about it. It's not a friendship. It's like "Okay, I'd like to be your friend, but if you feel that way, you know, fine. . . " [So he doesn't support you in the same way that your other friends do.] No. I would have supported him by saying "That's really good you know" whatever, but, like, he won't; and it's just like "Are you willing to say it?" you know. You feel like they don't want to associate with you because of this for some reason. It's just sad, very sad.

There are few incidents related by the students of direct harassment by peers. Those who are able to recognize sexism, and name it by fighting back, seemed to be less hurt than those who were less assertive.

Well there's one thing that I'm really adamant about is sexism, and I hate it. I hate sexist jokes. I hate everything like that and it's just one thing really ticks me off. . . uhm, sometimes guys will make little comments that - there was a boy with a locker next to me last

year and I was bending over putting some books in my bag and he said, "[Name], you've got a nice butt and everything but I'd appreciate it if you could move it." And I got so mad at him, and I just started screaming and yelling and I completely told him off, and he never said anything again. [He said] "It was nothing sexist. I didn't intend it that way. It was just a comment, I would have said it to a guy too." But I don't know, it's not the way it sounded to me.

career issues

Nowhere are gender issues clearer than in thoughts concerning career and family. The young women struggle with conflicting messages from the media, teachers, counsellors, friends, and parents as they work out who they are, what they want, and what they expect in the future. These mixed messages often conflict with the woman's experiences, as previously discussed (see p.81). Many of the women expressed a strong yearning for independence. They talked about wanting to move out, earn money, and have a place of their own.

> Like now, I'm gonna move out of the home soon; this summer. . . now, I'm keeping my money for university. And then I'll work for the apartment. I like organizing myself. [My parents] were like "Well is it worth it? You could take the train and. . . " They don't see the point there. I don't wanna stay home! [laugh].

The desire for independence is also evident when they talk about careers. They want to be their own bosses, and have their own businesses. Through part-time jobs, they gained feelings of competency. With few exceptions, holding an outside job was a positive and enriching experience even when they worked long hours. This is consistent with a study that found that female students benefited from holding a paid job regardless of the number of hours they worked. In contrast, the academic performance of male students suffered when the number of hours worked per week exceeded a certain level (Sunter, 1992).

superwoman

Common belief systems tell us that female students are more critical of themselves than their male peers, and that teachers expect more of them. These thoughts were echoed in the students narratives.

> Actually I think it's sometimes an advantage [being female] because they expect more of you. You know. [The teachers?] Yeah, because you know how women are trying to prove themselves, you know, in science. . . They apply themselves more to prove themselves.

The same holds true for the job market. Many of the students said, in effect, "girls don't want to do science unless they are really good at it, while the guys are not put off by poor marks." This does not necessarily mean that the female students are overly concerned with marks, as is sometimes stated, or that boys have the confidence to go into engineering with marks in the seventies, while girls do not. It is a reality that a woman in a man's field is hypervisible, and more is expected from her. Therefore a woman knows she needs "not just to enjoy it, but to actually excel in [her] field."

> My dad is an engineer at [company] he says that girls are usually better than the men. I
> don't know if it's because they know that they are in minority so they're working harder.

> If I was going into engineering, which I really wish I was good at, because I would
> definitely pursue it. But, I'm - I could probably get by and become a decent engineer, but
> I don't think I would really enjoy it. . . Because - I don't know. Cause I really like biol-
> ogy. So I guess - I dunno. If I ever decided to be an engineer, I might actually enjoy it.
> But, I guess I don't really know enough about the field to begin with. I've not really con-
> sidered it. But, I just wish - I guess, I think, cause physics, I can pull off an eighty,
> maybe eighty-five-ish. But, I'd wanna be able to pull off a ninety, no problem. You
> know. I guess cause I just think that I should be really good at it, in addition to enjoying
> it. Not something that I have to really, really work at to do well in. I like it to come
> naturally. But then I know people that have seventies in physics and they struggle with it
> every day and they're going into engineering, so. . . I guess it's not so much as - [Are
> these guys?] Yeah.

The speech pattern in this last quote reflects hesitation (I dunno, I guess etc.) and the tension between what she might really like (engineering) and the reality as she sees it; a woman has to be extraordinary talented to make it in engineering (Geppert, 1995).

Sometimes, other women's superior academic performance might put obstacles in the way of those who want to follow. For example, one student, who aspired to become a veterinarian, had been told that women were becoming too numerous in that field.

> [A veterinarian I know] keeps in touch with some of her teachers and things. And they
> say how at [veterinarian school] they are trying. . . They find they have too many fe-
> males studying for veterinary. They are trying - they wanna cut some out - But, she said
> she doesn't see how they can do that without being like, discriminating against females.
> Cause she said, usually the females have higher marks than the males. So, she said, she

doesn't know how they'll do that. [Did she mention why they didn't want to have female veterinarians?] No, She didn't say. I guess they figure that as females aren't as strong as males, that they'll get hurt more easily with the animals and things. [Do you think so?] Not really. But, like we have male vets that come. . . and female vets, but actually my parents prefer the female vet, cause they find she's a lot gentler. And the cattle aren't as nervous. When, like, the males come they're usually - Like if a male vet comes in the barn, the cattle, they can sense it right off with some of the vets.

raising a family

Combining career and family, caring for children at home or leaving them at a day-care, are issues that are on young women's minds already at the age of seventeen or eighteen. Their program and future career choices are influenced by how they see themselves solving the dilemma of dual responsibilities. Some of them feel "they can have it all," others believe they may have to choose one or the other, or compromise. "Well, what I really don't wanna do is, when I have children, is stop working to take care of them. So, the ideal thing for me would be that my husband would stay home for them! [laugh]."

A few women were not interested in having children of their own; "They get annoying after a while." The young women see their parents, particularly their mothers, struggle with conflicting demands, and do not understand "how they can manage" (see p.99).

> Yeah, I don't like to have kids and have a career. I don't know, I don't think it will work. [laugh] [What's the problem?] [laugh]] If I have kids I wouldn't want them to stay in daycare. I wouldn't want them to stay with a nanny - I think I have to choose between my career and my kids. . . I wouldn't put my kids in daycare. There are so many things against daycare, I mean, like those T.V. shows you see.

> I want to have a big family and all this, and when I have kids I'm going to stay home like my mother. She had five kids. She went to school and then she stayed home.

While we heard many stories of supportive parents, there was no consensus around women having a career and pursuing it while raising children.

> [My father] really believes that girls should have an education. . . he kinda says, "Do the sciences cause today, you know, it's a lot harder for women, you know, in the world, like to get places."

I wanna have kids eventually. But I'm not sure when. And I don't really know what I'm gonna do after. Play it by ear, I guess. [Will you keep working if you have a family?] Yeah, maybe. I'm not too sure. It depends how big a family I have, I guess. But two kids'll be enough for me, I think. [laugh] Depends if I really need to or not. But if I get bored I wouldn't have a fear of going back to work, you know, if I did stop working. I dunno, I just don't like the thought of sitting around the house all day and just watching soaps.

Stereotypes of housewives are well entrenched in the minds of these women, although most of them must have experienced the effort that goes into looking after a family. We were surprised how vehemently most of them rejected daycare. We wondered if a few sensational stories, reported by the media, have discredited all day-care institutions, which are generally staffed by well trained and dedicated workers. How are these beliefs and preferences created and perpetuated? Whose agenda is served by them? What role do mass media play in shaping these preferences? Eliminating day-care as an option leaves few paths open to them as they dream about their future. If they choose to have children, they can dream of a house-husband, or of a job where they have full control over their time? Neither is a likely scenario. What remains is a segmented career with periods off work for child rearing, and then "return to work if I can."

media

During the course of this study we collected an array of newspaper and magazine articles relating to science careers, the learning and teaching of science, and women's roles and participation therein. As the following selection of headlines demonstrates, the usual focus is on how women differ from men in performance, attitude, preferences, and treatment at schools and in the work place.

selected headlines on women in science

Why do girls shun math, science? Researches still puzzled? (1992, Sept. 28) *Montreal Gazette*, p. A4.

Why aren't women part of the formula? Surveys show that science is still an overwhelmingly male field. (1992, Oct. 26). *Montreal Gazette*. p. C1.

Women in sciences endure a 'gauntlet of abuse' (1993, Dec. 6). *Montreal Gazette*. p. F2.

Why fewer women stick to science courses. Study cites cold, rule-driven environment and overt sexism. (1992, Feb. 1). *Montreal Gazette*, p. A9.

Girls might excel at math if teaching wasn't so dictatorial. (1987, Sept.12). *Globe and Mail*, p. A2

Women scientists explore more ways to smash through the glass ceiling. (1992) *Medical News and Perspectives,* 268 (2), 73.

Why math class sets girls apart.(1993, Nov. 30). *Globe and Mail.* p. A11.

Bright assertive girls receive mixed messages. (1993, April 12). *Montreal Gazette.* p. D2.

Unequal footing: Video puts spotlight on sexism in classroom. (1993, Feb. 11). *Montreal Gazette*, p. A3.

The trouble with girls, esteem, and reality. (1994, June 11). *Globe and Mail.* p. A2.

School girls: Here's proof that despite pressures, girls are making the grade. (1994, Sept. 26). *Montreal Gazette.* p. D1.

Girls smarter than boys, researchers say. Females will soon beat males to the best jobs, British TV audience told. (1994, Oct. 26). *Montreal Gazette.* p. A8.

Girls' school try to address gender bias. Principals have formed a coalition to heighten awareness of students needs. (1994, March 14). *Montreal Gazette.* p. C1.

Job market tough on young women. (1994, Oct. 26). *Montreal Gazette.* p. F1.

How does such a barrage of articles affect these young women as they work, study and make their choices? A brief newspaper article can seldom do justice to complex issues. We have found a multitude of over-simplifications and hastily drawn conclusions. The headlines are chosen to attract readers and are often sensational and misleading. The following example illustrates this tendency of biased reporting.

On November 4, 1994, The Montreal Gazette carried an article entitled "Mother's education level affects child's mental health: study" (Bagnall, 1994). The article was sub-titled "Researchers can't explain high levels of depression, anxiety," and opened with this paragraph: "The adolescent children of university-educated women are at significantly higher risk for problems of depression and anxiety than those of women who have a CEGEP or community-college education, according to a study of the mental health of Quebec children." Later in the article it was mentioned that the adolescent children of mothers who had not finished high school were equally at risk for depression and anxiety. Nothing was mentioned about whether the father's level of education had an effect on the children's mental health. The researchers were quoted as cautioning against attributing causality, stating, "We can't talk about cause and effect. . . We can only talk about factors associated with mental disorder. . ." Still, the headlines did exactly that by claiming that mothe their children's mental health.

The accumulation of media articles, and sensational headlines in particular, have a cumulative effect on young women. Most articles about science education in the press centre around the problems encountered by girls and women. We argue that this kind of attention does not serve girls and women. It reminds them that they are different from the norm, which in science, is male. Should we then ignore women's struggle to be part of the scientific community? Certainly not, but it is a matter of emphasis and intent.

There are different ways of approaching this issue of inclusion and attention. The first can be labelled denial. When we refer to all students and scientists as *he*, we fail to recognize and acknowledge that the world is changing. In these circumstances, women feel excluded. When we state that all problems are *human* problems, and that all the solutions will benefit males and females equally, we display our ignorance and belief in the commonality of all experience. We patronize others, assuming that our solution to a problem will not only be right for them, but also welcomed. Gender studies that focus on how women are different from men, set women apart. Articles that headline women's problems with self-esteem and confidence do the same.

By listening attentively to the women in our study, we hoped to give them a different message. We wanted to listen, not to discern how their stories were different from someone else's story, but because the stories themselves had interest and value. By listening attentively, we hoped to inspire and encourage the women to seek solutions to their unique problems, solutions that would work for them.

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Key to Abbreviations

CACSW - Canadian Advisory Council on the Status of Women

AAUW - American Association of University Women

IEEE - Institute of Electrical and Electronics Engineers.

ACCC - Association of Canadian Community Colleges

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APPENDIX

Guide for Interview I

A. Introduce Coppersmith Self-Esteem Inventory (SEI).

The interview will be open ended, talk about your individual experiences. We also need some information common to all students. This is a short questionnaire that measures how confident you are feeling. Read directions to student. Put completed questionnaire directly in envelope.

B. Past

Recall when you first started being interested in something called science?

Probe for specific experiences and influences.

Can you recall a time when you felt "This is what I want to do"?

Were there times when it didn't feel right for you or you felt you would not want to continue?

C. Present

How is it going so far? (Focus on science courses now.)

Probes: What do you like most so far? What do you like least so far?

For each above probes, focus on:

How the class feels and what circumstances elicit those feelings.

Probe for: Encouraging events/experiences, Discouraging events/experiences.

How do you think you are doing so far?

Are you doing as well as you expected?

How do you feel about that?

What are you expecting in marks?

What are the lowest marks you would allow/accept?

D. Future

If there were no obstacles, if you could be there right now, what would your dream occupation be?

Science, how do you see it? When you think of doing science, what comes to mind?.

What images do you have of doing science?

What do you see as possibilities?

If you look ahead ten years, what can you see yourself doing?

What kind of future do you see for yourself in science?

Guide for Interviews 2 and 3

A. Begin this interview by focusing on the transcript of the first interview.
Any corrections, reactions, surprises?

B. Tell me about your first semester at college?
What were the times when it didn't feel right for you, or you felt you would not want to continue?
Can you recall a time when you felt "This is what I want to do"?
Can you recall a time when you learned some particular thing or maybe that you enjoyed learning or studying something?

C. Recall a time since you've been at college when:
Someone let you know you were doing well or doing the right thing (maybe a friend, another student, a teacher, a family member?)
Describe/recount the event.
How did you feel
How much/in what ways did you agree or disagree?

D. What are you doing now? How are things going this semester?

E. What are you considering doing after John Abbott? What do you see as possibilities?

F. When you think about careers and work you'd like to do, what appeals to you? What do you know you *don't* want to do?

G. Think about your own feeling of confidence:
How do you feel now?
Are you aware of changes over time?
What caused those changes?
Do you ever work on yourself or on feeling confident, e.g. pep talks, or *adjusting* your confidence, (e.g. "don't get big headed"?)
Do you ever help your friends or have others helped you?

H. Can you recall a time when you felt you were treated differently because you are a woman?