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Themes in the career decision-making of undergraduate women in science

by

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Dedication

I dedicate this to my parents, Josephine and Carmine Ciccocioppo, who have always trusted in the career decisions I have made and supported me at every step on my career path.

Abstract

Career decision-making has often been characterized as different for women because of factors such as balancing a family life and a career. The choice of a non-traditional occupational field (i. e., science) may also require that obstacles such as sexism are encountered. The process by which women decide to pursue and remain in postsecondary science programs is complex and worthy of greater understanding. This study utilized semi-structured focus groups to examine the factors that affect the career decision-making of women in undergraduate science, engineering, and technology programs. Qualitative analysis (as per Vaughn, Schumm, & Sinagub, 1996) uncovered eight themes: Transition from high school; Educational influences; Family and community influences; Academic issues; Coursework management; Gender issues; Creating a successful student environment; and Looking back, looking forward (advice for students and suggestions for change). These findings are summarized and discussed along with implications for the education and counselling of women in science.

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Chapter I: Introduction

Many factors are involved when one chooses a career. The environment, the influence of parents, teachers, and peers, sex-role socialization, and heredity combine to shape attitudes toward certain occupational choices. The reality of those choices is then tested by experience. The career decision-making process may be different for women, as factors such as their perceived ability to combine work and having children are additional elements in their consideration of different career options (Fitzgerald, Fassinger, & Betz, 1995). For some women, the choice of a non-traditional occupational field such as science requires that they deal with obstacles such as sexism (Kahle, 1996; Vetter, 1996). This study involves an examination of the factors that affect the career decision-making of women in undergraduate science, engineering, and technology programs.

An examination of women's career decision-making in science is important since women enter and remain in science careers in much smaller numbers than men, in spite of the fact that women today have expanded their studies and employment into broader areas. Women have become increasingly more visible in the sciences, engineering and technology, as indicated by the steady increase in the number of female science and engineering students registered in North American universities (e. g., Vetter, 1996). However, by the time women come to college or university, their interest in science remains well below that of men (Astin & Sax, 1996). A 1994 study by Astin, Korn, Sax, and Mahoney found that only 4 percent of women (versus 18 percent of men) reported plans to major in physical science, mathematics, or engineering. A good proportion of those women who start degrees or diplomas in the sciences do not complete their education (Astin et al., 1994). At one Canadian university in 1986, one quarter of female students who entered science degree programs with high entry averages had transferred out of science (Madill et al., 1998). Vetter (1996) discussed the National Center for Education Statistics report (1994) which indicated that women represented less than one-sixth of the graduates in these fields, even at the bachelor's level. Rayman and Brett (1995) described findings of the

1991 report of the National Research Council of the United States, which indicated that women received only 31 percent of degrees in computer and information sciences, 30 percent in the physical sciences, and 14 percent in engineering. The report also included the finding that at the graduate level, the numbers of women entering or finishing science programs decreased sharply .

The author's interest was to learn more about the experiences of undergraduate female students pursuing science-related majors in Canadian post-secondary institutions following a review of the literature on women's continued underrepresentation in science, engineering, and technology programs. Focus groups were chosen as a preferred approach to this inquiry. They have been described as "small, informal assemblies of target persons whose points of view are requested to address a selected topic" (Vaughn, Schumm, & Sinagub, 1996). This approach to data collection was advantageous, as the group format encouraged interaction among the participants and moderators, and the inclusion of as many points of view was possible.

Relevance and Implications of the Study

The continued dearth of women in many science, engineering and technology majors is of concern and requires further examination for several reasons. There is a general decline in the total number of students selecting science majors in the United States, yet there will be an estimated 27% increase in the number of science-based jobs and a 36% increase in the number of jobs requiring significant math background by the year 2000 (Betz, 1997). Betz (1997) also found that the sciences have the highest defection rates of any undergraduate major and the lowest rates of recruitment from other fields. Previous Canadian studies have found similar patterns (Industry, Science and Technology Canada, 1991). Betz (1997) stressed the importance of the participation of women and minorities in the sciences as they are potential sources of additional scientific talent.

Given the differential impact of influences on women's career development, such as the larger influence of home/family issues (Altman, 1997; Astin & Sax, 1996) and internalized sex role stereotyping and elimination of certain career choices (e. g., Betz, 1997), there is a need for further research. Inquiry into the complex nature of women's career decision making in science without diverting attention to a gender comparison is the focus of the current project. This type of research is also important in that much of the research in career development has been conducted in the United States and has been done predominantly with males. Studies such as the current one need to be done in Canada to determine the unique experience of women studying at Canadian postsecondary institutions.

An examination of the themes and issues described by women as playing a paramount role in their decision to pursue a career in the sciences and engineering could lead to a better understanding of how to encourage more women to pursue these fields, to determine what the obstacles are, and to learn of options to overcome them. This, in turn, may lead to changes in educational policy. Findings may have implications for vocational guidance with women, the promotion of science courses at the high school level, and accessibility to programs by women at the university level.

The Research Questions

The purpose of this study was to answer three questions:

1. What encourages the entry and persistence of women in undergraduate science, engineering, and technology programs?
2. What prevents highly capable women from completing their undergraduate science, engineering, and technology programs?
3. What implications are there for women's career development theory, for vocational guidance, and for decision makers in education and government policy?

Answers to these questions were sought by examining theories of adolescent and career development and by examining relevant studies in the field. This information was compared to what the focus group participants in the current study have said about their experiences as a woman pursuing a career in science, engineering, or technology. These three nontraditional fields are referred to as "science" or "the sciences" throughout the manuscript.

Overview of the Thesis

In Chapter 2, the pertinent theories that attempt to explain women's career development, particularly in the fields of science and engineering, are reviewed. Theories of career development as they apply to adolescents/young adults and to women are explored. Key influences on women's career development in science are discussed, including family, school environment, and cultural influences. Obstacles to women's initial selection of, and retention in, science fields are also discussed. These include the influence of inadequate pre-college/university preparation and guidance counselling, a lack of role models, perception of the incompatibility of family life, low self-confidence in scientific abilities, and gender and race discrimination.

Chapter 3 contains a discussion of the methods and procedure used in collecting and analyzing the data. Focus groups were used to collect qualitative data on women's experiences in science, engineering and technology programs, and the rationale for choosing this approach is discussed. The data collection and participant characteristics are described. The approach used for data analysis (based on Vaughn, Schumm, & Sinagub, 1996) is discussed in detail. The boundaries and limitations of the study are outlined.

In Chapter 4, the pertinent findings across participants and focus groups are described, using relevant quotes to aid in explaining the first- and second-order themes that emerged through the data analysis. These findings are then summarized within the context of the literature in

Chapter 5. Chapter 5 concludes with a discussion of the implications of the findings for career development theory, education, and counselling.

Chapter II: Literature Review

The process by which women make career choices in the sciences and engineering, and continue to remain in these fields, is complex and may be influenced by a number of interweaving factors. In order to better understand how women choose to enter and remain in educational programs leading to careers in science, an examination of theories related to adolescent and early adult career development, particularly as they relate to women who make nontraditional career choices, is initially discussed in this chapter. Influences on young women's career development are also reviewed and include family of origin, the educational environment, and cultural background.

Not only is it important to consider what factors influence women who choose and persist in careers in science and engineering, but it is also necessary to find out what factors influence other women to change from a science-oriented career path, or to be discouraged from this career path altogether (Betz, 1997). Obstacles to women pursuing and persisting in scientific careers, reviewed in the literature, include inadequate and sex-biased precollege preparation, features of undergraduate science education and affiliated extracurricular activities, the nature of guidance counselling received, sex-role stereotypes, women's self-perception of scientific abilities, the anticipation of incompatibility with family life, a lack of role models, and issues of gender and race discrimination. Relevant comprehensive studies exploring the complexity of women's experience in pursuing science, engineering and technology programs are discussed. A discussion of the assumptions which guided the formulation of this study and an exploration of my presuppositions conclude the chapter.

Career Development in Adolescence and Early Adulthood

Many career development theorists have focused their attention on adolescence, as it is the time when educational commitment to career choices is made (Sharf, 1992). Adolescents' course of vocational development appears to parallel the development of other areas of identity development, including the religious, ideological, and sexual aspects of their identity, with the common feature of uncertainty (Raskin, 1994). Raskin refers to career exploration and tentative choice as one of the main tasks of adolescence, and states that early, successful exposure to and participation in the world of work will likely lead to more certainty about one's interest in and ability to do work, thereby laying a foundation of self-efficacy.

Super's (1957, 1983, 1990) developmental theory is based on the assumption that physiological aspects (such as genetic predisposition), along with geographical aspects (i. e., country of origin) have an impact on other areas of career development. Such areas include the development of psychological characteristics (e. g., development of needs, values, interests, and aptitudes) and the socioeconomic environment (including one's community, school, family, and peers, as well as the state of the economy and labour market). Super asserts that as individuals learn about themselves and their environments, they go through developmental stages in which they evolve a concept of themselves. His theory then attempts to explain how career identity develops over time and through five career stages which we can recycle through several times during our lives (Super, 1990). These stages include *growth* (birth to age 14); *exploration* (age 15 to 24); *establishment* (age 25 to 44); *maintenance* (age 45 to 64); and *disengagement* (age 65 and beyond). The exploration stage is the focus of this study, as it is most relevant to the period of adolescence and young adulthood, when many people are making career decisions.

During the *exploration stage*, associated with ages 15 through 24, the adolescent or young adult is exposed to a wider variety of experiences through which he or she further defines the self-concept, learning more about his or her abilities and interests. The tasks associated with the beginning of this stage include assessing one's interests, abilities, needs and values, and the conclusion of this stage often involves the selection of an initial full-time job. Super suggests that as most adolescents and young adults have not yet had the chance to explore their available occupational options, they often are not ready to make definite career choices until the later part of this stage.

Krumboltz (1979; Krumboltz, Mitchell, & Jones, 1976) approached career development from a social psychological perspective and developed a theory of how individuals make career decisions based on the learning theory proposed by Albert Bandura (1977). Bandura's theory maintains that individuals' personalities grow from their learning experiences more so than from their genetic or intrapsychic processes, and that positive reinforcement was integral to learning. Krumboltz's subsequent social learning theory of career development was designed to address the question of why people enter particular educational programs or occupations, and it emphasized the importance of behaviour (actions) and cognitions (knowing or thinking) in making career decisions.

This theory described four basic factors that play an important part in the eventual selection of a specific career choice:

(a) genetic endowment, which refers to the aspects of the individual that are inherited or innate rather than learned (e. g., sex, race, and physical characteristics, as well as inherited abilities in the arts, music, athletics, etc.);

(b) environmental conditions and events, many of which are outside the control of the individual, including social factors (e. g., technological developments, community resources), educational conditions (e. g., availability, affordability and salience of higher education; influence of teachers and other resources), and occupational conditions (e. g., the number and nature of job opportunities);

(c) learning experiences, which influence the development of career preferences and skills and the selection of a particular career. Mitchell & Krumboltz (1990) indicate that through these learning experiences, occupational stereotypes are formed which often last a lifetime and which can have a significant effect on career decision making;

(d) task approach skills, which are critical to career decision making and include goal setting, values clarification, generating alternatives, and obtaining career information.

Krumboltz (1979) asserted that the method in which individuals apply their prior learning experience and use their innate abilities has a direct effect on career choice. Individuals may make observations about themselves and their environment that will be incorporated into their career decisions.

These theories outline different ways of conceptualizing career development in adolescence and young adulthood regardless of gender. As this study focuses on the career development of women, it is important to take a closer look at how theorists have examined the unique experiences of women and have incorporated them in their understanding of career development theory. A discussion of theories of women's career development follows.

Career Development Theories Pertaining to Women

As women have gained a stronger presence in the workforce, it has become increasingly important to theoretically and empirically examine women's and men's career development experience separately. Fitzgerald and Betz (1983) described some of the sex differences relevant to vocational choices and patterns. These differences include (a) the relatively restricted range of occupational alternatives pursued by women (often stereotypically female occupations) in comparison to the much larger range pursued by men; (b) their disadvantaged position in the labour market, as women professionals are concentrated in professions of lower pay and status than men, or at lower levels within the same occupational field as men; (c) the underutilization of their capabilities, as women's intellectual capabilities and talents are often not reflected in their educational and occupational achievements; and (d) the need for decisions concerning the role of career involvement in their lives (i. e., whether or not to work) as well as making a career choice, whereas men are expected to work and whether they will work is not in question.

Super (1957) has often been credited as being the first theorist to meaningfully discuss the career development of women. He viewed women's lives as primarily organized around homemaking and childrearing roles, and secondly as participants in the labour force, and as a consequence he created descriptive categories to characterize the distinct nature of women's vocational behaviour. The 'stable homemaking' category referred to women who married immediately after completing their education and did not enter the work force. 'Conventional' women worked until marriage, when they left the work force to devote their time to home and family. The 'stable working' category referred to women who never married but were employed their whole lives. Women who managed both work and family fell into the 'double track' category. The 'interrupted' career category referred to women who returned to the workforce after staying at home with their young children. Finally, other women fell into the 'unstable' or 'multiple trial' career categories which described unstable and irregular job histories, respectively. Super (1990) has acknowledged that these career patterns described in the late 50's are probably quite different now, as many changes in society have taken place to allow women to enter a much broader spectrum of careers. Osipow and Fitzgerald (1996) describe numerous studies that have confirmed the validity of these categories despite the shift of representation of women in each category (i. e., less women in the 'stable homemaking' and 'conventional' categories and more in other categories such as 'double track', 'interrupted' and 'unstable').

Psanthas (1968) reinforced the important roles of marriage and family in the career development of women, stating that marriage was a method of status attainment and that women's career choice was largely affected by the potential proximity to desirable mates, which he says may explain the large numbers of women in fields such as nursing and secretarial work. He emphasized that to understand women's lives we must examine additional factors that are not important for men, often related to broader environmental forces such as family, social class, and social mobility.

Zytowski (1969) also emphasized the role of homemaker as the predominant one for women and how this role was incompatible with serious career pursuits. He characterized women's career patterns in terms of their age of entry into the workforce, span of participation, and traditionality of occupation. Three patterns were proposed: mild (very early or late entry, brief span, traditional occupation); moderate (early entry, lengthy span, traditional occupation); and unusual, a controversial term used to describe women in male-dominated fields (early entry, lengthy span, nontraditional occupation). Betz and Fitzgerald (1983) criticized this model as an inadequate one given the many women who enter male-dominated occupations. For example, a female scientist would be unclassifiable in this framework unless she enters the workforce early and works continuously.

Several other contemporary career development theories addressed the changes in women's occupational aspirations that have taken place in the past few decades. Betz and Fitzgerald (1987) hypothesized that a woman's experiences with work and academic success, perceived encouragement, and influence of a positive role model will affect her attitudes toward work, self, and gender roles. These attitudes then influence her life-style preferences regarding work, family, and career choice. Fassinger's (1990; as cited in Osipow & Fitzgerald, 1996) contribution to this research also underscored the importance of ability, a sense of personal agency, and gender role attitudes as influences on career decisions.

Hackett and Betz (1981) applied Bandura's theory of self-efficacy (1977) to the career development of women. Self-efficacy refers to our beliefs about our competence to engage in certain behaviours. The theory states that self-efficacy determines whether we decide to initially engage in a behaviour, how well we perform, and whether we will persist when faced with obstacles. Our beliefs about our competence in different areas of behaviour will influence decisions to avoid areas where we feel incompetent, even if in reality we could perform the behaviour if we tried. Bandura maintained that self-efficacy expectations were developed by (a) performance accomplishments (experiences with successfully performing the given behaviour); (b) vicarious learning or modeling (observing others successfully performing the behaviour); (c) freedom from anxiety with respect to the behaviour; and (d) verbal persuasion and support from others.

Hackett & Betz (1981) assumed that gender socialization influenced beliefs and expectations of one's personal efficacy (i. e., beliefs about whether a person will be successful in certain tasks), which influence career decision making and adjustment. They hypothesized that women's low expectations of self-efficacy in careers that historically have been male dominated account for most of the gender differences in career choice and development. A later study on college students by Betz and Hackett (1983) found that when responding to questions about their capabilities with respect to traditionally male- or female- dominated occupations, men showed similar levels of occupational self-efficiency regardless of the stereotype of the occupation, whereas women rated themselves significantly higher or lower depending on whether the occupation was stereotyped as being a "male" or "female" - type occupation. They also suggested that low self-efficacy expectations with respect to nontraditional areas reduce the chance that they will be seriously considered as career options. Betz and Hackett implied in their theory that Bandura's (1977) concepts of vicarious learning, modeling, persuasion/encouragement, and emotional arousal can intervene and increase women's self-efficacy.

Social learning theory (Krumboltz, 1979; 1976) has also been applied to the career development of women in the context of its four basic components: genetic endowment and special abilities, environmental conditions and events, learning experiences, and task-approach skills. Although individuals do not have control over genetic predispositions (e. g., gender and race), they may have some degree of control over environmental conditions and events, and over their learning experiences and task-approach skills. Mitchell and Krumboltz (1990) discussed how social learning theory can be used to recognize and predict the environmental learning conditions that women and visible minorities may encounter so that obstacles to their career development (e. g., discrimination) may be removed. Social learning theory also calls attention to the importance of modeling and learning experience in women's career decision making, and this emphasis may enhance opportunities for those who may otherwise have limited career choices and opportunities due to discrimination (Mitchell & Krumboltz, 1990).

Gottfredson (1981) also discussed gender issues related to the career development of boys and girls, further extending Super's (1957) initial references to a life-stage theory of women's career development. Her theory emphasized the important part that sex roles and prestige play in making choices, and she suggested four stages of cognitive development in children that affect their career development. The first stage, which occurs between the ages of 3 and 5, is the orientation of young children to the concepts of size and power, as they notice the differences between themselves and adults. The second stage, from ages 6 through 8, is when children develop an orientation to sex roles and become aware of the different roles of men and women. Their ideas of career choices are influenced by their perception of these sex roles. The third stage takes place from ages 9 through 13, when children are affected by abstract ideas such as social class, and prestige becomes an important consideration when making a career choice. In the fourth stage, starting at age 14, adolescents become more self-aware and develop more insight into their career choices, while keeping sex role stereotypes and the prestige of occupations in mind. This theory is important as it indicates that sex roles as they apply to career choice are developed at an early age, and thus that early exposure to non-traditional fields is crucial.

Other important aspects of Gottfredson's (1981) theory that are relevant to women's consideration of nontraditional careers, are circumscription and compromise. Circumscription refers to the assumption that gender will influence occupational preferences from age 6 and up, and that prestige will affect these preferences from age 9 and up. These factors limit, or circumscribe, career choices. Compromise refers to the necessity for an individual to modify career choices due to limiting environmental factors, such as a competitive job market. Gottfredson hypothesizes that sex type, prestige, and interest will be compromised in such a way that individuals will compromise their interests first, then prestige, then finally sex type when making a change in career choice. This theory would seem to indicate that children value and hold on tightly to sex-typed career choices, and thus addresses the difficulty in encouraging girls and women to consider nontraditional careers, such as those in science fields. While research on this theory has been inconclusive (see Osipow & Fitzgerald, 1996; Sharf, 1992), it provides an appropriate emphasis on how obstacles to choosing a career in a nontraditional field such as science are established early on in life.

Influences on Women's Career Development

Several specific influences on women's development have been discussed in the literature. Family members, particularly fathers, were found to have a large influence, particularly on female students in nontraditional programs (e. g., Berkowitz, 1993; Betz & Fitzgerald, 1987). The school environment was seen as a major influence, including the attitudes of peers (e. g., Berkowitz, 1993); classroom experiences, the mathematics and science curriculum, and extracurricular activities (e. g., Matyas, 1985); and especially teachers, because of daily class contact and the potential for them to be a major source of information (e. g., Berkowitz, 1993). Sociocultural influences, including sex-role stereotyping also were an influence (e. g., Matyas, 1985), as was exposure to role models (e. g., Betz & Fitzgerald, 1987). The subculture in which a woman was raised, including socioeconomic status, race, ethnicity, and religion were also seen as influencing career choices (e. g., Betz & Fitzgerald, 1987). Betz & Fitzgerald (1987) also indicated that future plans for marriage and children influenced women's perception of career options. The influence of important factors such as family of origin, educational environment, and cultural influence are discussed in this section.

Family of origin.

Dacey and Kenny (1994) outlined how several researchers have placed emphasis on how the family system influences career selection. Families develop their own unique sets of rules and boundaries that influence the roles (including career roles) of all family members. For example, some families have rules stating that the children will grow up to become doctors. During adolescence, such family rules may become more flexible, allowing children to explore and form their own vocational identities. Despite this, parents continue to influence adolescents and young adults in the models they present for them, their wishes, hopes, and aspirations for them, and their motivational influence (Dacey & Kenny, 1994). Betz and Fitzgerald (1987) discussed several studies that indicated that daughters of working mothers are more career- versus home-oriented than are the daughters of homemakers, and are more likely to pursue nontraditional occupations. Fitzgerald and Betz (1983; also Betz & Fitzgerald, 1987) found in a comprehensive review of the literature that there is some evidence that girls' career choices are influenced by the occupational level and, particularly, the educational level of their fathers. Their findings also pointed out that having a highly educated professional father appears to facilitate women's pursuit of male-dominated professions, including those in science, engineering, and technology (also Berkowitz, 1993).

Altman (1997) examined how family of origin relationships and experiences influenced the process of career development of male and female interviewees. In her study, family was found to be a dominant influence in their career process. Common themes among interviewees included (a) support (or lack of support) from family, especially parents; (b) role of siblings and sibling relationships; and (c) stressful family environments (i. e., poor economic conditions, death of a parent, parental alcoholism, child abuse, marital instability, and teenage pregnancy). Altman stressed that families are probably the most powerful influence on the career development of young people, including young women. Two means through which parents can influence their children include encouragement to enter nontraditional fields, and high expectations of their children's success in nontraditional fields. Betz and Fitzgerald (1987) found evidence in the literature that family encouragement was reported to be a major facilitator by high school girls planning careers in science, and by women pursuing male-dominated occupations. Nontraditional women have also reported higher expectations from their parents in terms of educational attainments and occupational involvement (see Betz & Fitzgerald, 1987). Matyas (1985) reviewed research indicating that parental attitudes toward girls' science classwork affect girls' choices of science classes, their confidence in math classes, and their perception of science as masculine. Lack of parental encouragement for women to pursue the sciences has been found to operate as a factor in the attrition rate of girls from science majors in college (Graham, 1978; as cited in Matyas, 1985). Generally speaking, researchers suggest that it is important for parents to take an active interest in the science education of their children.

Educational environment.

The nature of the educational environment and its effects on women's choice of science as a career is another important factor to consider. As teachers spend the majority of their day, five days a week with their students in the classroom, they may influence their students' educational development in ways that will influence their future educational and occupational choices. Students majoring in science were found to be more likely than those in other majors to report a strong positive influence from high school teachers (see review by Blaisdell, 1995). Morse (1995) quoted a report by the American Association of University Women (AAUW) which indicated that teachers have a significant influence on girls' educational futures, more so than other role models or their peers. Matyas (1985) cited studies which indicated that high school teachers' encouragement, particularly when it comes from same-sex teachers, is paramount in students' choice of a career in science.

The school climate also can have an influence on both male and female students' aspirations in science as well as non-science fields. High school environments that promote academic achievement promote higher aspirations than do the majority of schools in which a neutral attitude towards achievement exists (Plucker, 1998). Plucker also found that both male and female students who develop relationships with adults who model effective problem solving and achievement also develop higher aspirations.

Culture.

Research on the effects of both ethnicity and gender on women studying in the sciences is rare because traditionally there have been few ethnic minority students, male and female, to participate in such studies

(Clewell & Ginorio, 1996). Foreign-born women or women whose parents were foreign-born were found to be more likely than women born in the United States to pursue nontraditional occupations (Betz & Fitzgerald, 1987). Betz & Fitzgerald (1987) speculated that families new to the U.S. may have a greater appreciation of the range of educational opportunities available to their children, and also that many other countries such as those in Asia and some of Europe do not have the underrepresentation of women in science as occurs in the U.S. They cite the example of Asian Americans, who do not show the disadvantaged position relative to men in mathematics participation and achievement often found in North American women.

The cultural environment has an effect on the kinds of role models with which one can come in contact. For example, some cultures glamorize certain occupations, while others will glamorize different ones. This is due to the different emphases on occupational values found in different cultures, e. g., financial prosperity, dedication to family, or religious service (Mitchell & Krumboltz, 1990).

Obstacles to Women Pursuing and Persisting in Scientific Careers

Influences affecting women's career development in science are both encouragingly positive and discouragingly negative. Unfortunately, the negative influences affecting women's entry and retention in science fields are as influential as those that are positive. The concept of *barriers* was created to provide a framework for understanding the development of factors which hinder women's career development, in order to develop interventions aimed at bringing down these barriers keeping women out of nontraditional career fields such as science (Fitzgerald, Fassinger, & Betz, 1995). Farmer (1977; as cited in Fitzgerald et al., 1995) was one of the first researchers to discuss barriers and categorized them into internal barriers (self-concept, e. g., low academic self-esteem) and environmental barriers(e. g., sex discrimination). Similarly, Harmon (1977; as cited in Fitzgerald et al., 1995) discussed what he called constraints on women's career development and categorized them as either "internal-psychological" and "external-sociological".

For the purposes of this study, the term *obstacles* was chosen in place of *barriers*, as barriers might be associated with an irrevocable, unchangeable and hopeless situation. Obstacles, on the other hand, are unfortunate and inconvenient but can be surmounted. Those found in the literature and discussed here include inadequate and sex-biased precollege preparation; features of undergraduate science education; extracurricular experiences during undergraduate education; guidance counselling; societal and occupational sex-role stereotypes; and women's self-perception of scientific abilities. Also discussed are the anticipation of conflict with marriage and children; lack of relevant role models; sexual discrimination and harassment; and racism. It is important to explore these obstacles, in order to anticipate them and minimize their interference in women's career development in science.

Inadequate and sex-biased precollege preparation.

In elementary school, girls and boys exhibit relatively equal mathematics and science ability, although girls express less interest in these fields. At the junior high level, girls and boys continue to do comparable work in mathematics and science, yet girls take fewer of these courses than do boys. Matyas (1985) discussed research showing that girls at this age hold less positive attitudes toward science than boys do, and participate in far fewer science activities both within and outside the classroom. By senior high, young women take far fewer courses in math and science than young men, view math as less useful, have had less experience with scientific instruments and materials, and score lower on science and mathematical achievement tests (Blaisdell, 1995; Matyas, 1985). Seymour (1995) noted in her findings that a common deficit in the precollege education of women was hands-on technical or laboratory experience, which contributed to fears of incompetence and doubts about "belonging". Farmer, Wardrop, Anderson, & Risinger (1995; as cited in Farmer, 1997) found that the most important predictor of persistence in a science-related career for women was the number of elective science courses they had taken in high school.

Majoring in the sciences requires that one have a strong high school record, especially in mathematics and science courses, and college science majors tend to be stronger academically in high school than those entering other majors. Math has been called the *critical filter* in career development, as it can dramatically filter out a student's postsecondary options (Astin & Sax, 1996; Betz, 1997; Betz & Fitzgerald, 1987; Bieri & Bingham, 1994). Astin & Sax (1996) describe research showing that girls tend to express lower opinions of their mathematics and science ability than boys even when they perform better than boys in these subjects. This lack of girls' confidence in their mathematical and scientific abilities may result in their reduced courseload in these subjects in high school. Consequently, the lack of preparation at the high school level prevents them from having the prerequisites they need to pursue scientific fields in college or university (Astin & Sax, 1996; Betz, 1997).

Features of undergraduate science education.

Women who do persevere and enter science programs in higher education unfortunately face additional obstacles to pursuing a career in science. Female students may face the obstacle of feeling alienated by science teaching practices that often encourage competition, that omit a discussion of how science is connected to social concerns, and that portray the unfortunate stereotype that science careers are lonely and excessively demanding (Astin & Sax, 1996). According to the findings of some researchers, students generally view faculty as unapproachable, preoccupied with research, and lacking motivation to teach well (Morse, 1995; Seymour & Hewitt, 1994; as cited in Astin & Sax, 1996). These obstacles may adversely affect both men and women, but are believed to have a more negative, non-"female-friendly" impact on women (Astin & Sax, 1996). Astin and Sax (1996) also reported their own findings that faculty in the sciences are much less likely to employ active learning methods in the classroom, such as discussions, cooperative learning techniques, and student-generated topics of discussion and learning activities. Morse (1995) believes that instructors who do not use such learning methods downplay science's creative aspects. Science faculty are more likely than others to depend on graduate teaching assistants to teach classes and labs, to prefer lectures to other types of instruction, and to grade on a curve, subsequently promoting competition among students (Astin & Sax, 1996; Morse, 1995).

The peer group during students' undergraduate education is believed to be a tremendous influence on both their academic and non-academic growth and development (Astin & Sax, 1996). For women in many areas of science, the peer group is mostly male. Seymour & Hewitt (1994; as cited in Astin & Sax, 1996) acknowledged that male peers may take women students less seriously, make them feel unwelcome, and may even treat them with overt hostility. Morse (1995) conducted a survey of 21 to 37 year-old females in science who were asked whether their elementary, junior and senior high school experiences were generally positive or negative. A common theme which emerged among these women was of feeling 'out of place', especially in the upper grades. As girls choosing to continue science and mathematics courses throughout high school may be viewed as non-conformists at a developmental period when conformity is highly valued by peers, they see themselves as less attractive to their peers, and hence many gifted girls do not enter accelerated math courses because of negative social consequences (Matyas, 1985). Sadly, one study found that male peers overtly expressed the belief that all women in their science, mathematics or engineering major were, by virtue of their having chosen it, inherently unattractive (Seymour, 1995). They also indicated that there was peer pressure *not* to succeed in science (Matyas, 1985). Morse (1995) found that the women in science that she surveyed had indicated that sexism was often present in postsecondary classrooms.

Extracurricular experiences during undergraduate education.

Astin & Sax (1996) discuss the consistent finding in their research that for both women and men, the likelihood of persisting in science depends on the experiences they have during their undergraduate years. They found that students who are more focused on course work and on the demands of science are more likely to maintain interest in science than are students with diverse interests or more time constraints. This would seem to indicate that students with a high degree of commitment to their program have little time to devote to other activities that would press on their time, and therefore have the best chance of succeeding in what is often a highly time-demanding career choice.

Students with time constraints were not necessarily shown to have an obstacle to their persistence in science, but the nature of their time constraint was an important factor in their ability to continue to pursue their science education. Astin and Sax (1996) report that academic and other campus-related activities tend to promote retention in the sciences. Students holding off-campus jobs were found to be less likely to persist in science than those not working; however, those working in on-campus jobs were *more* likely to persist in their science program. Other factors which were found to increase students' retention in science were participating in professors' research projects or independent research, helping faculty teach courses, and tutoring other students.

Guidance counselling.

Guidance counsellors and academic advisors at both the high school and university levels can have an imporant impact on students' career decisions. Although there are many talented guidance counsellors working in schools, researchers have recently shown that there are also many guidance counsellors who hold stereotypical views about career choices based on gender and race (e. g., Betz, 1997). Other researchers report guidance counsellors are often biased towards the encouragement of young women to pursue traditionally female-dominated careers rather than broadening their options (Berkowitz, 1993; Betz, 1997; Tomini & Page, 1992). Not surprisingly, many females with nontraditional career interests tend to find guidance counsellors less helpful to them when compared to other male and female students (Tomini, 1990). While these students didn't feel that their interests in nontraditional careers were actively discouraged by counsellors, neither did they feel that they were encouraged. Many of these students felt that high school teachers and university professors encouraged them more, and provided them with better advice on careers and postsecondary education (Alexitch & Page, 1997; Tomini & Page, 1992). Farmer (1997) found in her study of female science students that they had minimal contact with a guidance counselor during high school, and those who did have counsellor contact recalled that it was not very helpful. In general, it seems that the guidance counsellor's role (regardless of gender) is near non-existent for many students, and for those students who have had contact with guidance counsellors, it was not often helpful or encouraging of non-traditional options.

Societal and occupational sex-role stereotypes.

Traditionally, Western society has specified different life roles, personality characteristics, and acceptable behaviours for males and females. The norms that define the masculine and feminine images become a powerful force in the socialization of children (Fitzgerald & Betz, 1983). Such sex-role stereotyping has been cited in earlier research as one of the major reasons for women's avoidance of science careers, as girls view science careers as masculine and therefore avoid them (e. g., Matyas, 1985). For girls, this socialization tends to prepare and encourage them towards the role of wife and mother, contributing to the development of personality characteristics and behavioural competencies that will facilitate their performance of these roles. In many cases, young girls are therefore not socialized to prepare for career pursuits or to develop the characteristics and competencies necessary to such pursuits (Betz & Fitzgerald, 1987).

Also developed in childhood are occupational sex stereotypes that are normative views of the appropriateness of various occupations for males and females. These stereotypes are learned in a child's early years of life, prior to the maturation of their achievement strivings and career interests (Gottfredson, 1981). Fitzgerald and Betz (1983; Betz & Fitzgerald, 1987) outlined the mounting research indicating that both boys and girls favour sex-typed occupations; however, the smaller number and more limited range of traditional female occupations result in the limitation of girls' perceived options at very early ages (Betz & Fitzgerald, 1987). At the high school level, the available occupational informational literature has been documented to perpetuate occupational stereotypes in both text and illustrative material (see Fitzgerald & Betz, 1983).

Women's self-perception of scientific abilities.

Astin & Sax (1996) reviewed the common findings of several researchers that suggest women consistently express lower levels of academic, mathematic, and scientific confidence than men. Math self-confidence has been described as the most influential predictor of mathematics test performance, which in turn has been linked to women's entry into science fields (Ethington, 1988, as cited in Astin & Sax, 1996; Betz, 1997).

Gottfredson (1981) discussed how young children initially have a positive attitude toward all occupations, and their occupational attitudes become gradually shaped by their developing self-concept. As the self-concept continues to develop, so does an increasingly differentiated set of occupational preferences. Occupations that are perceived as being inappropriate for one's sex or desired prestige level, or those requiring additional effort and preparation to enter the field, are eliminated. Over time, these preferences reduce, leaving fewer and fewer acceptable occupational alternatives.

Betz (1997) has described what she calls *psychological barriers to choice*, which are maladaptive thinking or beliefs young women hold of themselves in relation to science, math, and technological careers. These include: (a) gender or racial stereotypes or stereotypes of scientists; (b) low science-related self-efficacy expectations; and (c) beliefs that science wouldn't be enjoyable. Firstly, stereotypes of scientists have included that they are "old and White", usually bearded (hence male) and wearing glasses. They are often described as "nerds" and, science is believed to be "important but boring" by children who have had little understanding of what a scientist does day-to-day (Betz, 1997; Farmer, 1997). Matyas (1985) cited studies clearly showing that children's stereotypical image of a scientist is masculine. Morse (1995) found that women in science described the images of female scientists they have observed in the media to be unattractive, unmarried, subordinates, and "cold". Other words her participants used to describe scientists included "absent-minded", "crazy", and "megalomaniacal". It is easy to see why such stereotypes of scientist likely influence young women to avoid scientific careers.

Betz's (1997) second psychological barrier to choice is a low expectation of science-related self-efficacy. Hackett & Betz (1981) applied Bandura's (1977) model to women's career development in an attempt to explain women's under-representation in male-dominated career areas. They suggested that women's socialization led to insufficient exposure to information that would provide them with a sense of efficacy in traditionally male-dominated fields such as science and technology. The ensuing low self-efficacy expectations typically lead to the avoidance of math and science fields in high school and postsecondary studies. Research has shown that even when young women perform better than their male colleagues in science, they still tend to express lower opinions of their mathematics and science ability, i. e., self-efficacy (Betz, 1997). Betz and Hackett (1983) found that expectations and beliefs about self-efficacy in science were significant predictors of the career options actually considered by students, in spite of their actual abilities and interests.

The third psychological barrier identified by Betz (1997) is a perception among young women in the United States that science isn't interesting. This is reflected in the results of interest inventories (e. g., Prediger & Hanson, 1976; as cited in Betz, 1997) which indicate that while two-thirds of women preferred social occupations, only 8% of women preferred scientific occupations. Betz stated that this is most likely the result of gender, role, and cultural socialization. She identified a need for more research into why these barriers exist and how to address them.

In her review of research of women's perception of engineering and science careers, Blaisdell (1995) found that the perceived outcome expectation of becoming a scientist or engineer is not desirable. Eccles (1986; as cited by Blaisdell, 1995) had college women rate six occupations through a pairing of nontraditional and traditional occupations and suggested that nontraditional careers are seen as more difficult, but not more important, than comparable traditional occupations. Archer & Freedman (1989; as cited in Blaisdell, 1995) conducted a study which reported that the subjects of engineering, physical sciences, and math were rated as typically masculine by college students in England. Engineering was rated most often as masculine, followed by physics, chemistry, and math. Masculine stereotypes correlated with difficult; feminine stereotypes correlated with easy. These findings demonstrate that researchers need to address the issue of women's negative perception of science and engineering careers, as many women may be avoiding the field due to misinformation from societal stereotypes.

Anticipation of marriage and children.

Research shows that while considering career choices, women focus on their own marriage and children, and how conflicts will be resolved between commitments to a family and to a career. The perception that a science career is incompatible with raising a family turns many women away, including some college students who place a high priority on personal life and family responsibilities (Astin & Sax, 1996). Astin and Sax (1996) indicated that faculty messages about the strong commitment and hard work required by a scientific career, as well as the invisibility of female academic role models who could demonstrate success at having both work and family, contributed to this perception. Archer (1985; as cited in Balk, 1995) found that 90% of females interviewed within this study anticipated conflicts over family and career, and many of them were concerned about how to satisfactorily resolve the conflict. In general, it still appears that women tend to perceive the formation of values, goals, and beliefs in the context of relationships, and make career decisions in conjunction with family, marriage, and societal expectations (Archer, 1990; as cited in Bieri & Bingham, 1994).

Lack of role models.

Role models serve as a way for individuals to experience vicarious learning, as described by Bandura (1986). His self-efficacy theory (1977) described the importance of modeling, with same-sex models being more attractive (e. g., female scientists). Blaisdell (1995) described vicarious learning as a powerful source of self-efficacy, which she indicates to be a good predictor of women entering science fields. Astin & Sax (1996) found students who encounter role models from the scientific community were more likely to follow up on initial science aspirations. Brush (1979; as cited in Matyas, 1985) reported that the similarity between a student's self-image and her/his image of a scientist is a good predictor of whether that student chooses to take science classes. The presence of appropriate role models for women would seem to be what is needed to increase their presence in these fields. Unfortunately, such role models, especially female role models, appear to be scarce (Blaisdell, 1995; Fitzgerald & Betz, 1987; Morse, 1995).

The limited exposure of math and science to girls begins when they are young. One source of limited exposure starts with girls' and women's limited presence in photographs illustrating science textbooks, starting in elementary education (Blaisdell, 1995). Higher education also provides limited exposure to nontraditional female role models. Astin & Sax (1996) list several reasons why there are few potential female academic role models for women students. Firstly, non-traditional female role models in higher education are scarce. Blaisdell (1995) cited recent U.S. statistics, indicating that women comprised only four percent of engineering professors, and about nine percent of the physical science professors. A second factor is that women scientists in academia were found to earn less at every level of pay and were underrepresented in the higher academic ranks. Thirdly, women also were not promoted as fast as men, even when other factors (e. g., productivity, race, professional age) were controlled. Also, in nonacademic science industry, women earned less than men and are underrepresented at the higher levels. All of these factors reduce the chance for women science students to interact with and be mentored by same-sex leaders in their field (Astin & Sax, 1996).

Women in science are not necessarily *beneficial* role models for other women considering science fields. Morse (1995) found that the few women scientists that were mentioned by participants in her study were described as reluctant or poor role models, and that 'accomplished' female professors were described as bitter and unfriendly to women. These findings also indicated that older female professors were described as being less inclined to help younger women, as they had to fight so hard to get to where they are today.

Evans (1993; as cited in Blaisdell, 1995) interviewed undergraduate women in science and engineering about why they believed that women were so underrepresented in their fields of study. A large majority of the sample felt that a lack of contact with women within specific fields contributed to the under-representation of women in these areas, and many of these women felt personally affected by this lack of interaction. Many felt that teachers' discriminatory attitudes toward women, the competitive atmosphere in technical classes, and a lack of encouragement from teachers or guidance counsellors in high school were factors responsible for the under-representation of women in science and engineering. Studies such as these support the idea that exposure to science and engineering is an important influence for women entering these fields (Blaisdell, 1995).

Gender: Sexual discrimination and sexual harassment.

Sexual discrimination in science and mathematics, intentional or unintentional, has been shown to affect children as early as in elementary school, and is also contributed to by external societal factors. Numerous studies over the years have presented evidence of gender-based educational differences, especially in science, mathematics, and engineering (Kahle, 1996). Teachers of all ages and both genders discriminate in the classroom, as they share society's biased expectations about gender-based performance in science and mathematics, ultimately believing that it is more of a male domain (Sadker & Sadker, 1994; as cited in Vetter, 1996). Boys are called on and praised more than girls in science and math classrooms (Vetter, 1996), and so from an early age females are given the message that men are more talented in these subjects. Vetter (1996) also found that at home, many parents, especially those with sons, also discriminated against their daughters. They declined to pass on knowledge of tools and basic mechanical skills simply because of their sex. It is also likely that women who choose engineering do not have brothers, and their parents credit them with having the 'masculine' abilities required for engineering (Vetter, 1996).

Sexist attitudes learned in childhood remain prominent in the postsecondary years of study. Many of these sexist attitudes are manifested in subtle, yet significant ways in postsecondary classes. Female students have commented on science and engineering professors' ability to make them feel unwelcome by body language that implied their stupidity (Frehill, 1997); their feeling of exclusion from some class activities (Seymour, 1995); and toleration of male students' rudeness towards the few women in their classes by professors and their teaching and laboratory assistants (Seymour, 1995). Male peers also contributed to the sexist environment. In engineering programs, students' ineptness was equated with femininity by their classmates (Frehill, 1997). Female students have complained that male peers often took charge in the lab, ordered them about, gave them help they did not ask for or need, and sometimes took credit for work they had done (Seymour, 1995). Seymour (1995) found that in engineering, because women have traditionally been viewed as "tokens" the female students are less likely than those in less male-dominated areas to challenge what they may consider to be sexist behaviour.

The scientific industry may offer us some of the clearest examples of sexism in science. Vetter (1996) found that women and men with similar credentials do not seem to have equal employment opportunity in science and engineering, as women have higher unemployment rates at all levels. Discriminatory practice likely plays a part in this statistic, as well as other potential factors of family responsibilities and reduced mobility. Once employed, women scientists and engineers advance more slowly than men and thus are likely to make even less money than their male counterparts, further increasing the salary gap shown by many studies to exist in science and engineering (e. g., Vetter, 1996). There is often a perception that women are not 'permanent' employees, as they might leave for reasons including family commitments. Supervisors thus hesitate to give a female employee a major career advancing project in case they are unable to complete it (Vetter, 1996).

Frehill (1997) reviewed studies that show women in male-dominated workplaces must "prove themselves" and minimize the differences between themselves and their male co-workers. Women in the studies were described as "overexerting themselves" to prove they were just as capable as their male peers, and assimilated accordingly into the male work culture. They may face more frequent and higher hurdles to prove themselves capable of the job, such as an additional requirement of passing mechanical skills tests not given to men, as women often are assumed to be lacking such skills and be incapable of the physical effort required of some jobs (Frehill, 1995). Yet in other ways, employers and co-workers are inclined to give women scientists and engineers "lighter", more traditional female secretarial work, such as notetaking, when working on male-dominated working teams (Kite & Balogh, 1997). Meyers (1993; as cited in Kite and Balogh, 1997) in her examination of academic women's situations in engineering also found that women in engineering are overworked, because the female engineering professors are often "tokens" in the department, and are given additional "service" responsibilities as they are to represent the voice of all women on numerous committees. Her findings show that students also are more demanding of their female engineering professors by "testing" them, and calling them Miss or Mrs. instead of Professor or Doctor.

Racism.

As with sexism, racism is evident in the school system from early in elementary school. Minority girls are provided with few role models in person (Clewell & Ginorio, 1996) and in textbooks (Collins & Matyas, 1985), and a stereotype of math and science as "white" fields is perpetuated (Hall, 1981; as cited in Clewell & Ginorio, 1996). Once in high school, American-born minority females take fewer general or advanced science and mathematics courses than do either white males or females, and find science less useful outside of school. They are also exposed to more occupational sex-role stereotyping from teachers, who incidentally hold lower expectations for minority females (Clewell & Ginorio, 1996). At the postsecondary level, black female students are often neglected and overlooked because faculty believe them to be less committed to their studies. Their interactions with faculty have been characterized by excessive physical distance in the classroom, decreased eye contact, and fewer offers of guidance or criticism. It is therefore no surprise that they are more likely to attribute their successes to luck rather than ability (Collins & Matyas, 1985).

There is little information available on minority women scientists in the workforce. What is available is dated and suggests that minority women receive lower pay, slower advancement, less utilization of their talents, fewer rewards, less recognition, and less job security (Hall, 1981; as cited in Collins & Matyas, 1985). Hall also provided reasons for the inequities that minority women face in the workforce. Firstly, society's view of the minority woman scientist is negative, due to disapproval and resentment generated by the frequently encountered attitude that as minority women, they enjoy special privileges and advantages due to affirmative action or employment equity programs. This myth would contradict the rarity of changes noted in regards to the proportions of women and/or minorities in science departments. Additionally, minority women face all the obstacles that women scientists face in general (Collins & Matyas, 1985). As shown with female academics in general, black female academics serve as the "token minority female", and they are inundated with committee work to offer the "black woman's point of view", but seldom called on to offer their own personal opinions as a professional scientist (Hall, 1981; as cited in Collins & Matyas, 1985).

Relevant studies in this field

There are few studies which attempt to uncover the complexity of women's experience in pursuing science, engineering and technology as fields of study. Notable studies include those of Berthelot & Coquatrix (1989), Rayman & Brett (1995), and Farmer (1997). A discussion of their individual findings follows.

Berthelot & Coquatrix (1989) examined women' s experiences of training in a non-traditional program as part of their study of the positive and negative aspects of women's experience in non-traditional occupations. Non-traditional fields were considered to be those whose workforce was less than 33.3% female as of the 1981 census. When asked why they chose to train in their present field, young women at the secondary, college, and university levels all rated interest in the field as the most important factor. Then, in asking who stimulated their interest in their program, one quarter of secondary students, a third of college students, and about half of university students stated that no individual was responsible for bringing the program to their attention. The authors acknowledge this response as a reflection of the intrinsic complexity of career development, encompassing things such as socialization and personal experience.

When discussing the people who were influential in making their nontraditional career choice, guidance or academic counsellors were mentioned most frequently by the secondary and college students. University students' responses, however, indicated that fathers were the most influential on their choice of training program. When asked whether they knew anyone who worked in or was a student in the field they had chosen, the majority of the respondents indicated that they knew no one in the field. Among those who did have a personal acquaintance in their occupation, two-thirds of the college graduates and three-quarters of the university graduates said that the person was a man.

Encouragement from family and friends is commonly believed to be a key element in many women's career decision-making process. Berthelot & Coquatrix (1989) found that approximately one-third of the secondary school and university graduates and half of the college graduates indicated that they had received no encouragement from anyone when they chose their training program. This however does not necessarily imply that they were discouraged from continuing in their field. For those who were encouraged or discouraged, the major source of support or opposition mentioned were their parents. Support from the educational system (e. g., from teachers, professors, instructors, and administration) was limited, especially at the university level. Over 90% of the young women believed that their reception by the male students was favourable, and that this acceptance was usually immediate. As well, most of the young women stated that they were treated the same as males in the classroom by the instructors. This finding tends to contradict more recent research findings (e. g., Vetter, 1996).

When asked to define in their own terms the principal difficulty they encountered during their training, a large proportion of respondents reported that they experienced no difficulties at all during their training; this proportion decreased from the secondary to college to university programs. This might be because programs are more demanding at the higher levels of the educational system, and with additional education one is more likely to encounter difficulties. The difficulties cited most often were of a general nature and included things like anxiety about finding employment, excessive courseloads and workloads, and poor teaching. At least 80% of women in the secondary, college, and university training programs indicated that their success was mainly the result of their self-motivation and personal effort. When the respondents were separated by career field, graduates of applied science programs reported having few role models in the field, and in addition, suffered most from a scarcity of female classmates, unfamiliarity with the equipment, and slow acceptance by male classmates.

Measures were proposed by the respondents for encouraging non-traditional career choices for women. The first suggestion was that more and better information on non-traditional employment should reach female students earlier in their education. The second suggestion was to give women in non-traditional jobs a higher profile, as girls need role models who can provoke interest in a field or focus vague aspirations. A third suggestion was to have girls experience for themselves aspects of certain non-traditional occupations through visits, workshops or internships. Other suggestions included educating school staff, parents, and society about non-traditional career options for girls, and setting up a whole program to encourage girls to enter non-traditional careers. While these non-traditional careers encompassed occupations in diverse fields, a large proportion of these careers were in science-related fields.

Rayman & Brett (1995) examined the factors associated with persistence in the sciences for women who majored in sciences and mathematics as undergraduates in a women's college. The women were classified into three subgroups: those who left the sciences immediately after graduation (Leavers), those who switched to some other occupation at some point after college (Changers), and those who remained in the sciences (Stayers). Participants responded to questions regarding family background, precollege experiences with science and mathematics, college experiences, self-perceptions about ability, self-esteem, postcollege graduate school and work experiences, and values and attitudes toward work and family.

Results found that the Stayers were the group most likely to have received encouragement by both their college teachers and their parents, especially their mothers, to pursue a career in science. They also were more likely to have had a mentor in their undergraduate program, to have received career advice from faculty, and to have obtained research experience in their undergraduate program. The Changers were less likely to have received a lot of encouragement from their mothers and from their college instructors to major in science, less likely to have had a mentor, less likely to have received career advice from faculty, and less likely to have had extracurricular research experience in their undergraduate program. The Leavers were less likely than other groups to have had a parent working in the sciences, and were less likely to have received significant encouragement from their parents and instructors to pursue a career in science. Also, they were the least likely to have received career advice from advisors and to have done undergraduate research. Leavers took fewer science and mathematics courses than other science majors, and were the least likely to see themselves as having a high interest in science.

Overall, Rayman and Brett (1995) found that the odds of staying in science were greater if women had received a lot of encouragement to pursue a career in science from one or both parents; had taken more rather than fewer science or mathematics courses as an undergraduate; had received career advice from her advisor; and had received career advice from other faculty. Other findings indicated that females who majored in chemistry or computer science were more likely to continue in science than those in other majors. The perseverance of female chemistry students was attributed to the strong mentoring tradition and availability of female role models in the chemistry program at the study institution. The high numbers of female computer science students who stayed in the field was attributed to the field as being a "new science", possibly without the barriers to women found in more established scientific careers.

Farmer (1997) conducted a longitudinal study of women's persistence in science careers which encompassed nearly two decades, and obtained qualitative and quantitative data on individuals' career development from adolescence to adulthood. Her study involved a diverse group of participants, including many different ethnicities and occupations, immigrants as well as native-born Americans, rural and urban dwellers, and participants of different socioeconomic groups. Participants with these varying demographic variables were surveyed in 1980, at grades 9 through 12. Personal attributes (e. g., perceptions of success or failure), environmental features (e. g., parent, teacher, and counsellor support), and motivational measures (e. g. career aspiration/education level) were investigated.

Ten years later in phase 2, participants were surveyed on most of these variables, including variables that focus on the pursuit of science. Of particular interest were the factors related to women's persistence in their high school choice of a science career. The new variables included math/science utility to assess success/failure experiences specifically in math, math self-efficacy (based on Betz & Hackett, 1983), and math study skills. The number of semesters of high school and college math and science each participant had taken was noted. Participants indicated the financial support received for their college education, and the importance of this assistance to their ability to have attended college.

Phase 3 of the research (1991-1993) was intended to address some of the puzzling issues that were raised in Phase 2, such as the finding that less than half of the students aspiring to a science or technology career in high school had persisted in these fields 10 years later. This was done by selecting a subsample of participants for individual interviews. Of the 57 women interviewed during this period, 21 were employed in or completing training for a science-related career and were referred to as "science persisters".

The most important predictor of women's persistence in a science-related career was the number of elective science courses they had taken in high school. Most participants indicated that teachers did not play a significant role in their career development. The role of the guidance counsellor was not prominent either; most did not recall having any interaction with a counsellor, and those who did see a guidance counsellor found that they were not helpful with career guidance. It was very clear, however, that participants' families had a significant influence on their career path. Other characteristics of this group included that they did not give up when faced with serious obstacles (i. e., career barriers), such as racial or sexual discrimination, lack of finances, or family problems.

A substantial number of women from this interview group (25) had changed from their early aspirations of a science-related career to another career field. This group of women are referred to as "career changers". Many of the participants were only in Grade 9 at the beginning of the study, and most chose their desired occupations based only on perceived popularity of the area (e. g., fields such as computer science and engineering). Given the phase in their developmental process, that is, identity development, adolescents do not usually know what they intend to do for a career (Super, 1990). Many of the women interviewed who had wanted a science-related career early in high school eventually found a better fit for their interests and abilities in another field. For the women who had a genuine, informed interest in science in high school, there were factors that derailed their aspirations for a career in science. Again, the family played a large role for some women who did not persist in science, as these young women learned early in life that the most important thing for them to do was to marry and raise a family; roles that were incompatible with a science career. School experiences also seemed to be a big influence in these women's derailment from their science aspirations, with a fear of taking math-related courses such as statistics, sexist science teachers, and intimidating teachers all indicated as contributing factors.

<u>Assumptions that guided the study</u>

In reviewing the literature pertinent to women's career decision-making in the sciences, several assumptions were formed before conceptualizing the study. These included:

(a) the family played a prominent role in influencing young women to select and continue with careers in science and engineering (e. g., Altman, 1997; Berthelot & Coquatrix, 1989; Farmer, 1997; Rayman & Brett, 1995);

(b) teachers and university professors were seen as both positive and negative influences on women's career decision-making (e. g., Berthelot & Coquatrix, 1989; Farmer, 1997; Rayman & Brett, 1995);

(c) guidance counsellors had a minimal role in young women's career decision-making processes (e. g., Alexitch & Page, 1997; Betz, 1997; Farmer, 1997; Tomini & Page, 1992);

(d) cultural issues were an important component of the career decision-making process (i. e., what career choices are acceptable), and some cultures were more encouraging of women to pursue a career in science than others (e. g., Mitchell & Krumboltz, 1990);

(e) having a role model in the sciences, especially a female, was a positive influence on young women considering and persisting in a career in science (e. g., Astin & Sax, 1996; Bandura, 1977; Blaisdell, 1995); and

(f) participants will have experienced sexism in the sciences that may or may not have discouraged them from pursuing a career in their field (e. g., Frehill, 1997; Kite & Balogh, 1997; Vetter, 1996).

(g) the benefits of having more women in science include the ability for women to achieve higher status and better employment opportunities, and also to broaden the approach taken to scientific inquiry by including women's perspective (e. g., Morse, 1995).

Presuppositions

The nature of qualitative research requires that the researcher identify her own personal beliefs, so that she can approach the data in an objective manner, yet considerate of the influence of her own biases. While this subjectivity is not entirely separable from the process of data analysis, it is important for the researcher to recognize and examine his biases through a continual process of self-reflection and critical examination throughout the study (Bogdan & Biklen, 1992).

Prior to beginning the data analysis, I reflected on how I came to be interested in women's career development and how my own thoughts about women's experiences in science would affect subsequent career choices. My interest in the field of career development, particularly women's career development, developed through my experience of working in a university career resource centre during the course of my undergraduate degree. Students would ask for assistance in researching a particular career, and I often wondered how they came to be interested in that particular field. I noticed that men and women and members of different ethnic backgrounds often asked about certain kinds of careers. I also became aware of the different levels of occupational knowledge that students had, and the confusion and lack of career direction they experienced, even as they approached the completion of their undergraduate degree. I then became interested in how people decided what they wanted to do for a career, and the important influences in their life that led to that decision.

As a graduate student, my interests became more focused on the experience of women's career development. My involvement with WISEST (Women in Scholarship, Engineering, Science and Technology) at the University of Alberta as a senior research assistant has allowed me to empirically explore the influences on women's career development and how women have chosen to pursue such non-traditional careers as those offered in the science, engineering, and technology fields. As I reflected on my own personal experiences, I realized that I had never worked or studied in a non-traditional field. As a young child and into adolescence, I maintained excellent grades in all subjects, yet I found myself shying away from the 'hard sciences' in high school. I recall having the attitude that physics was 'difficult', as this is what other classmates had told me, and because of this I did not take that course. I found that my attitude towards science and math became more negative as graduation approached, and I avoided science courses in my undergraduate degree to the utmost extent possible. This negative attitude towards science stayed with me throughout my undergraduate psychology degree, as I debated which science course was 'most painless' for fulfilling the science requirement.

I believe that the attitudes that I formed regarding my ability to do science were based on many complex influences. Sex role stereotyping, career interests, peer influences, and lack of math- and science-related self-esteem have all influenced my own career development since elementary school. In the process of examining and interpreting the data, it has been important for me to remain aware of the presuppositions that have developed through my career development process, as they form the lens through which the data has been approached.

In summary, the development of the present study has been informed by a comprehensive review of the literature on career development theory and influences on women's career development. Specific influences on the career development of women in science have been discussed in detail. The methodological and research considerations of the present study are outlined and discussed in the following chapter.

Chapter III: Method

Many approaches might have been taken to examine the research questions outlined at the outset of this study. A thorough review of the literature led to the choice of a qualitative research method. Subsequently, focus groups were chosen as an effective vehicle for data collection. This chapter includes a description of the rationale for choosing a qualitative research methods approach, followed by a discussion of the specifics of data collection, a description of the participants, the details of the procedure taken to collect the data, and the approach taken to data analysis. Finally, the delimitations and limitations of the following study are outlined.

Choice of Qualitative Data Collection

The objective of this study was to document individual women's perceptions and experiences regarding choosing a career in the sciences. A choice had to be made between taking a quantitative approach with its emphasis on objectivity, logic and the statistical reduction of data into a set of numbers (Bogdan & Biklen, 1992), or a qualitative approach, which starts with an acknowledgment of subjectivity while allowing the researcher to explore the unique richness and complexity of human experience (Patton, 1990). Mason (1996) defined qualitative research as

> *Grounded in a philosophical position which is broadly 'interpretivist' in the sense that it is concerned with how the social world is interpreted, understood, experienced or produced... Based on methods of data collection which are flexible and sensitive to the social context in which data are produced... Based on methods of analysis and explanation building which involve understandings of complexity, detail and context. Qualitative research aims to produce rounded understandings on the basis of rich, contextual, and detailed data.* (p. 5)

Patton (1990) discussed how qualitative research methods emphasize the development of a holistic understanding of human experience, requiring the examination of important factors that may not be easily quantified. Such a holistic approach allows for the gathering of data on multiple aspects of the research questions under study to achieve a more comprehensive picture of the surrounding dynamics. Qualitative research allows greater attention to be given to factors such as nuance, setting, and context (Patton, 1990).

A qualitative approach to research was favoured in this study, as this approach was deemed appropriate in its ability to examine the experience of women in undergraduate science, engineering, and technology fields. Not only was it necessary to determine a quantitative versus qualitative approach in research, but also the method of data collection that is appropriate within the qualitative approach. The focus group method was chosen as a method of collecting data rather than individual interviews because it provides an environment where participants have the opportunity to share their experiences with not only the researcher, but with other participants. What often happens in focus group settings is that the participants' interaction among themselves almost replaces their interaction with the interviewer(s), leading to a greater emphasis on participants' points of view (Morgan, 1988). The information shared and exchanged between focus group members generates further relevant discussion, and stimulates further ideas that an individual being interviewed one-on-one might not have otherwise thought of and discussed. Vaughn, Schumm, and Sinagub (1996) described the "loosening effect" of focus groups, as participants sense a more relaxed setting with greater anonymity, allowing them to disclose more freely. As participants are not required to answer every question, it is likely that the responses offered are more genuine. A final advantage to collecting data in focus groups is the ability to assess the viewpoints of many participants within a brief period of time.

Data Collection

The data for the current study was collected as part of a research project, funded by a Strategic Grant from the Social Sciences and Humanities Research Council of Canada (SSHRC) for the years 1997-2000. This research intended to extend upon the longitudinal qualitative/quantitative study conducted by Madill et al. (1997) to examine the effectiveness of special initiative programs to attract females into science. Madill et al. (1997) found that qualitative data revealed additional rich information about participants' unique experiences as a woman pursuing a career in science. In many cases, quantitative data gathered from inventories does not convey the richness of unique experience.

The objectives of the larger research project are: (a) to determine whether young women's career paths are consistent with the theoretical perspectives outlined within the career development literature; (b) to contrast vocational interest patterns, career related values, role salience, and beliefs of females who participated in a special initiatives program with those who did not have that experience; (c) to contrast the initial career aspirations made by the female participants from the beginning of the longitudinal study with their intentions six years later; (d) to obtain young women's perceptions of educational policies at institutional and governmental levels and how those policies affect their educational/career decision making over a three year period; (e) to increase the awareness and appreciation of needs, values, knowledge, and educational experiences of young women in scientific disciplines within institutional settings; and (f) to provide guidance to those who design and implement educational, social, and cultural policy on the basis of young women's actual life experiences.

Focus groups were included in this research study as a way to explore influences on students' career decision making as they may apply to the longitudinal study group. These influences included the impact of influential individuals (e. g., parents, teachers, peers), the level of financial support available to the student, and the degree of gender equity expected and encountered. Focus groups were conducted in 1997/98, and subsequent focus groups have been planned for 1998/99 and 1999/2000 to track trends that may emerge over the three-year period. The researcher examined the findings of focus groups conducted during the 1997/98 postsecondary year. An analysis of the data from the 1997/98 focus groups partially fulfilled objective (a) of the overall research project. The results were used to determine the experiences of and influences on women who are pursuing careers in science, and these findings were compared to theoretical perspectives outlined in the literature on women's career development in the sciences.

Participants

Participants were female university students recruited from second- to fourth-year science and engineering classrooms from various postsecondary institutions in Alberta. The institutions selected for data collection included a large university (with approximately 30 000 students) in a major city, a small university (with approximately 5 000 students) in a small city, a technical institute in a major city, a university college in a town near a large city, and a community college in a rural setting. Institutions were selected on the basis of geographic diversity and the mixture of different levels of academic programming. Academic affiliates at the respective institutions asked interested students to provide their name and phone number to the primary researcher and to select the dates and times at which they were available to participate in a focus group. The intention of these groups was to discuss the career choices these students have made (see Appendix A). Focus groups of approximately 5 to 8 women were organized from this information, and participants were contacted to inform them of their session.

A total of 51 women participated, and focus groups were attended by one to ten participants per session. Some students who signed up to participate did not show, and other students came that had not previously signed up but who heard about the group from another source (friend, women's centre, etc.). Participants came from a varied range of fields, including agriculture, biochemistry, biology, chemistry, computer science, engineering, environmental science, forestry, microbiology, neuroscience, physics, pre-pharmacy, and technology. Although most students were in their first postsecondary program and were in a program they entered directly from high school, the age range was quite broad with students ranging in age from late adolescence through to mature students returning to postsecondary studies from several years in the workforce, now in pursuit of a career change. Five of the women indicated that they were married, and five of the women indicated that they had children (not a direct overlap).

Co-facilitators

Members of the WISEST (Women in Scholarship, Engineering, Science and Technology)/SSHRC interdisciplinary research team served as co-facilitators for the focus groups. Eight research team members shared in co-facilitating duty, and came from different disciplines. Six were faculty members in the departments of occupational therapy, educational psychology (two), educational psychology/educational policy studies, chemistry, and medical microbiology & immunology/women's studies. An undergraduate student in psychology and the author, a graduate student in educational psychology, also participated. The author co-facilitated six focus groups.

The co-facilitators concurred that no major differences in group characteristics were noted among the various focus groups, despite the uniqueness of each group dynamic. Focus groups in smaller postsecondary institutions were described as more friendly and talkative. In many cases, the participants in an individual focus group clearly knew each other as classmates, acquaintances, and friends. Co-facilitators unanimously described the focus group participants as co-operative and willing to share their experiences.

Procedure

Focus groups (N=13) were held in conference room and classroom settings at the respective postsecondary institutions and ranged in length from 45 to 75 minutes. Two to five focus groups were held at each postsecondary institution for additional breadth of coverage and to observe the expected saturation of occurring themes. Each session was led by either a male-female or female-female co-facilitating team from the WISEST research team.

The focus groups were semistructured, and guide questions were used that had been developed based on the literature on career development theory and adolescent development. The interview protocol and guide questions used in the focus groups are included in Appendices B and C. The participants were not limited to discussing the issues targeted by the guide questions; they were free to digress from the guide questions and discuss issues that were important to their own career development. The focus group sessions were audio recorded using an audiocassette recorder and an omnidirectional microphone and then later transcribed verbatim by a professional dictatypist. Transcripts were later reviewed for accuracy.

Prior to starting the focus groups, participants were informed as to the importance of the study, asked to sign a consent form (see Appendix D), and provided with a guide to the questions that would be asked of them during the session (as in Appendix C). Participants were asked to state their first name for transcription purposes only. Participants were assured that if they were quoted, specific details of their comments would be omitted or reported in a way that would not make them personally identifiable. They were informed that they could discontinue participation at any time without penalty and that they were free to not answer questions asked of the group. Refreshments were provided for participants. At the conclusion of each focus group, participants were provided with the research team member's names and phone numbers (and e-mail addresses for participants not in Edmonton) so that they could contact us if they had any further questions, or wished to debrief the group discussion content.

Data Analysis

Prior to the data analysis, each focus group transcript was reviewed in detail several times by the author and a colleague. At first, rudimentary themes were identified based on the guide questions asked of participants (see Appendix C), e.g. "role of guidance counsellors", "educational obstacles to participation in science", "being female in my field of study" and participants' quotes were grouped according to these themes. Significant ideas and phrases were noted.

Following these initial steps, data analysis was guided by the procedure outlined by Vaughn, Schumm, & Sinagub (1996). Vaughn et al. describe their procedure as an adaptation of two qualitative approaches that is useful for research in education and psychology: the Constant Comparative Method (Glaser & Strauss, 1967; cited in Vaughn et al., 1996), in which a continual process of comparison and revision of categories of data until satisfactory closure is achieved, and naturalistic inquiry (Lincoln & Guba, 1985; cited in Vaughn et al., 1996) which unobtrusively studies real-world situations as they unfold naturally, with a lack of predetermined constraints on outcomes. The step-by-step approach to data analysis used in this study is outlined below.

Step 1 in their procedure occurs during and shortly after the focus group interview. The researcher considered the participants' words, the predominant ideas in each focus group, the intensity of participants' responses and other non-verbal communication, and identifies the "big ideas" found in each focus group. These "big ideas" are subject to change with further analysis, but provide a framework or "big picture" for the findings. This process required the ability to distinguish strong themes from less significant ones by their importance and emotional effect on participants, and by whether such trends and patterns reappear across focus groups. The ideas identified in this stage are considered to be hypotheses requiring further investigation.

The second step consisted of a process of identifying units of information that will later become the basis for defining categories. To be considered a unit, the information should help the researcher to better understand the research question. A unit should also be the smallest amount of information that is informative by itself, for both minimally informed observers and scholars who are well-read in the field. Thirdly, the size of a unit of information is variable, from a phrase to a sentence to a paragraph. Finally, the unit of information should, whenever possible, include a direct quote from a participant in the focus group so as not to lose any of the richness or accuracy of the data. In this study, units of information were cut from the transcript hard copies and coded according to transcript and location within the transcript. This process continued until all the relevant, coded information units were separated from the text. Categorization of the units began at this point.

In Step 3 of Vaughn et al.'s data analysis method, the units that were identified in the last step are now sorted into relevant piles that will eventually represent themes or categories. Rules that describe category properties are defined to justify the inclusion of units into that category and also to serve as a basis for later tests of intersorter reliability. For more detail on the category-forming process, see Vaughn et al. (1996).

Step 4 involves a second data analyst who assists in checking the consistency and internal validity of categories as determined by the principal data analyst. In this study, the second data analyst was a co-researcher from the WISEST research team who had co-facilitated several of the focus groups, and was familiar with the focus group data and research objectives. Following a comparison of the two researchers' coding and categorizing in a sample transcript segment, a colleague in the doctoral program assisted with the determination of category titles and the criteria for inclusion of information units in the categories. Information units were sorted in the various thematic categories until the categories were exhausted. As several focus groups were conducted in this study, an additional task was to identify common themes and categories across focus groups after deciding on the themes, categories, and supporting evidence for each individual focus group.

The fifth and final step involves re-examining the ideas generated in the first step, to consider if any of the big ideas initially established are supported by the categories generated. The reframing and restating of the big ideas creates themes. The researcher needs to identify the themes and determine the extent to which categories support these themes.

Delimitations of the Study

Prior to discussing the limitations of the present study, it is important to outline the delimitations of the study in terms of what it did and did not intend to accomplish. This study was intended to explore the experiences of women studying in undergraduate science, engineering, and technology programs, and therefore a male-female comparison was not sought. Researchers already have examined the sex differences between males' and females' career decision making (e. g., Farmer, 1997), and the intention of this study was to develop a greater understanding of female science students' career decision making process, and the factors that have influenced their experience. While this study included the exploration of areas already investigated, such as gender issues influencing their experience, these influences have not previously been examined thoroughly from a Canadian perspective. Additionally, many of the factors that affect women's career development in science may also affect men's career development in science, and may be a part of the experience of women in other non-traditional or traditional career choices. This study solely focused on the experience of women in undergraduate science programs, so a comparison between these participants and individuals who are male and/or are pursuing other career choices was not possible.

Limitations of the Study

Focus group research has a number of positive features, making it a desired method of data collection. The ability of focus groups to solicit the experiences of many participants in a brief period of time, in an environment encouraging the stimulation of and genuine expression of thoughts and feelings fostered by the presence of peers in a similar situation, is a definite asset when conducting qualitative research. There are, however, limitations to this research method which are important to consider when trying to make sense of the data.

A primary limitation evident in the current study is that in qualitative research, the research design, data collection, and data analysis are influenced by the researcher's presuppositions and biases. Through outlining my presuppositions, continuous self-reflection (bracketing), and having a co-researcher participate in checking the credibility of the data analysis, I have attempted to minimize these influences. It was essential to explain the perspective from which the study was approached.

A second limitation of this study was the variability of focus group moderators across focus groups. As many of the focus groups were held at geographically distant locations, it was not possible for myself as a full-time graduate student and for a professor with multiple academic commitments to be the sole co-facilitators for all focus groups. While I co-facilitated a large proportion of the focus groups analyzed, and one of the professors on the research team co-facilitated approximately the same number of focus groups, other professors on the research team and one research assistant were involved to a lesser degree in moderating the focus groups. Despite the semistructured nature of the focus groups, it is possible that the various biases brought into the group by the members of the interdisciplinary research team affected the type of information elicited from participants.

Thirdly, there are limitations resulting from the use of secondary focus group data that were beyond the control of the researcher. As described earlier, this data was originally collected for purposes of a larger research project, and was not intended for rigorous data analyzing purposes. For this reason, the systematic collection of demographic information from each participant, including dates of birth, ethnic origin, and family situation was not accomplished. The available demographics were extracted from the interview transcripts. Such descriptive data would have been beneficial for the purposes of this study.

The fourth limitation of this research is that the participants were self-selected for participation in the focus groups. Contacts at the various post-secondary institutions recruited participants in science, engineering, and technology classrooms, and women who were interested in the study signed up to participate. It is possible that the women who participated differ in some way from those who did not choose to participate, and that subsequently, the diversity of representativeness of the participants may be decreased. It is possible that women with part-time jobs and women who are mothers may be on campus less and may therefore not have been able to participate in this study. There may also be cultural differences between those who participated in the focus groups and those who did not. Members of certain cultural/ethnic groups might not be as apt to participate in a discussion where they openly share their positive and negative feelings towards their experience. The scheduled times offered for the focus group sessions also may have inadvertently excluded participants from certain departments that typically have classes scheduled at the times offered.

The rationale for using qualitative methodology and focus groups in the current study, the approach to data collection and analysis, and a description of participants and co-facilitators of the focus groups have been presented in this chapter. The delimitations and limitations of the present study have also been outlined. The analysis results of the data acquired as described in Chapter 3 are presented in Chapter 4.

Chapter IV: Results

The data from the focus groups richly illustrate the experience of women who have chosen and are persisting in their pursuit of a career in science, and the complexity of this process. The responses from women who studied at different postsecondary institutions in Alberta reflected many common themes of influences on their choice of and persistence in careers in the sciences. These themes present both personal (e. g., balancing family and career) and environmental (e. g., role of teachers) influences on their career decision-making.

Despite the breadth of representation from diverse science programs and a range of ages, the themes became repetitive across data from different focus groups. After two thorough examinations of the transcripts by the author and a third examination by a second data analyst, relevant units of data were grouped together in first order themes. These first order themes (sub-themes) were then clustered into broader categories to form second order themes. Because of the complexity of many participants' responses, many of the units of data reflected ideas that were relevant to more than one theme. This data was re-examined and categorized under the most relevant first order theme. The results are organized and presented under headings matching these themes. These themes are outlined in Table 1. As shown in Table 1, the main theme under which all first- and second-order themes were categorized was "Experiences of women in choosing and maintaining a career in science".

It is important to note that there is no hierarchy to the order in which second-and first-order themes are presented in Table 1. Each of the eight themes is considered equally important in the experience of women's career decision making. "Transition from High School" was chosen as the first theme to be discussed, as it included participants' discussions of the beginning of their postsecondary career in science. "Looking Back, Looking Forward" consists of the participants' recommendations for other young women considering their field of study, as well as suggestions for change aimed at those who are in a position to facilitate changes in the postsecondary experience (i. e., teachers, educational policymakers, politicians). When possible, first- and second-order categories were placed near other categories with which they are closely associated.

Not all quotations under each theme could be included. The quotations presented have been chosen either because they are representative of a number of voiced experiences and perceptions among the participants, or because the participant has shared a distinct yet noteworthy experience or opinion. In some cases, nonessential or identifying details have been omitted in order to protect anonymity. All names have been changed and references to specific postsecondary institutions have been omitted to protect the identities of participants. Participants from the college have been given pseudonyms starting with "C"; those from the large university have pseudonyms starting with "L"; those from the small university have pseudonyms starting with "S"; technical institute participants are represented with pseudonyms starting with "T"; and university college participants have pseudonyms starting with "N".

Table 1

Experiences of Women in Choosing and Maintaining a Career in Science

1. Transition from High School
    - Choice of College vs. University
    - Cultural Changes
    - Adjustment to Academic Lifestyle
    - Academic Challenges

2. Educational influences
    - Teachers
    - Professors
    - TA's
    - Guidance Counsellors

3. Family and Community Influences
    - Parents
    - Siblings
    - Peers
    - Extended Family and Community

4. Academic Issues
    - Choice of Specialization
    - Course Scheduling and Requirements
    - Coursework Continuity and Transferability
    - Program Competitiveness
    - Tuition Costs
    - School-to-Job Relevance
    - Success in Viable Post-Graduate Employment

5. Coursework Management
    - Learning Efficient Time Management
    - Developing Academic Coping Skills
    - Meeting Academic Work Requirements
    - Study Skills Development

6. Gender Issues
    - Equality of Gender
    - Advantages of being Female
    - Disadvantages of being Female

7. Creating a Successful Student Environment
    - Changing Living Arrangements
    - Support System
    - Financial Issues
    - Personal Resources
    - Balancing Family and School

8. Looking Back, Looking Forward
    - Reasons for Recommending/Not Recommending their Program
    - Advice for Prospective Students
    - Suggestions for Change

1. Transition from High School

A prominent overarching theme in the experience of participants' studying in science, engineering, and technology is that the transition from high school into a postsecondary program has greatly affected their career decision-making. Prominent sub-themes of discussion in the focus groups emerged in the data analysis. These included participants' choice of college versus university, cultural changes experienced as a result of pursuing a postsecondary education, the adjustment to the academic lifestyle and the consequential independence and responsibility for one's own progress, and the academic challenges that coincide with being launched into a postsecondary area of study.

Choice of College versus University

The majority of participants who highlighted the differences between college and university were from colleges or small universities. From their perspective, the choice made between a larger university (in which a student may feel anonymous, irrelevant, and oblivious to the professor) and a small college (in which a student is known by other students and the professor) can have a large influence on their overall postsecondary experience, and in turn impact on their career decisions.

Most of the participants who commented on their college experience found it to be positive, and believed that they were getting a better overall experience than if they were attending university. A strong and common belief among participants was that smaller postsecondary institutions were favoured for the small class sizes and friendlier environment, high quality of instruction, and approachability of professors. According to the participants, such qualities can ease the sometimes difficult transition from high school to postsecondary institutions. Celine explained how similar qualities in her college have been beneficial to her:

> *You can get help from the instructors any time. You don't have to make an appointment or wait. You can get help whenever you want, and the classes are*

smaller, so you can ask more questions. It's just a friendlier environment, too. And it helps going from high school. It would be hard going from high school to classes of 300, sometimes.

Many participants saw the role of college as being a "stepping stone" to help students ease into the postsecondary experience. Carla explained that as a student from rural Alberta, she has chosen to study engineering in a town that is geographically close to home as she benefits from her support systems. "At least here, you're halfway -- you're around your parents, I guess. You can go and beg for food." Despite her belief in attending college before moving on to university, Carla still anticipated difficulties with the university transition:

...one worry I have is about the transition to university, how difficult, how smoothly it will run. Even though we've been following the same courses, I'm sure they've highlighted different things, and that might be a problem. And just fitting in. Here, we've all got to know each other and it's a rather close-knit group, at least in engineering, but in university, it's going to be a whole new ball game. At university, they might have got to know each other then, and we might be the outsiders, or something.

Many students perceived that when they transferred to a university, they would encounter obstacles not present at the college level. Large theatre-sized classes and unapproachable and/or unavailable professors at university were anticipated by many participants from college programs; this finding echoes the findings of previous studies (see Astin & Sax, 1996; Morse, 1995). Corrina, a pre-pharmacy college student, expressed her impressions of what was to come for her at university:

I'm kind of worried about that, because here, the teachers, if I have a problem, I can just go and have a chat with them, but there, they're not going to be available, as much, I'm sure. It will be more independent learning. At university, if you don't get it in class, you have to go learn it yourself, from a textbook or whatever. Here you have the more one-on-one, because classes are only 30 students .... whereas at the U. of A., where I'm sure there's 200 or 300 people in a class in some cases, and you don't get the same [learning experience from the professor]...

Another concern mentioned by many participants is that of perceived language barriers with many of the T.A.'s at larger universities.

Some participants indicated that they have had both university and college experiences, and that they have observed the differences between the two postsecondary environments. Nduka, an international student studying chemistry at a small college, described her experience of taking summer classes at a large university and explained how she preferred being at the college:

> *I made a few friends over the summer, but the atmosphere wasn't very friendly. And, okay, I could go up to the professors and ask them questions [at the university], but over here, if you have a problem, you can go over to their house and they explain it to you. They're happy to help you. You're not just a number to them. Basically, they know your first name.*

Sara is taking her biology studies at a small university now, and explained the difficulties she has experienced with large universities after initially attending a small college:

> *...I went to the college first, (a) because it was close to home, (b) it was smaller. After college, I applied to Edmonton and Calgary, and I moved to Edmonton. One week before school started, I chickened out, and I moved here because it was too big, because I cannot stand to be lost in a crowd. I am loud, I admit, and I will never be lost in a crowd, but I need to know you know who I am, and you care about how I am doing. At the college, because there was no professors doing research, that was their world -- was you. In here, because it's such a small school -- it's about the same size as a college, it's only 5000 students -- there's still very much the teachers know who you are. It's very easy to approach somebody who knows you, whereas when somebody has no clue who you are, it makes it much more difficult to go ask for help... ...I made sure I had a small place, where they'd know who I was or they cared what I did, and where it mattered how well I did.*

Participants also were very aware of the differences in tuition fees between colleges and universities. Some of them had indicated that they chose college because of the more economical tuition costs. However, other students attending small schools said that they had higher tuitions that they were "willing to pay".

While many of the differences cited between colleges and universities were in favour of colleges, some participants outlined specific potential drawbacks to being a student in a small college. Participants said that the often smaller size of the college departments meant that there were less faculty to teach the required courses. As one explained, "you had to get along [with the professors], because you're going to see them again down the road. There's only so many profs."

Cultural Changes

For many participants, the transition from high school to postsecondary education involved other cultural changes, such as leaving a small-town home to move to a larger town or city, or even moving to Canada from another country. Sara, who is now studying biology at a small university, described her transition to college as being extremely difficult. She indicated that because of her loneliness, she commuted from her college's city to home, a farm in a rural area, every weekend.

> *My first year in college, I couldn't stand. I didn't have any friends, I didn't know anybody. I'm loud, but I'm shy, and it's hard for me to meet people ... ... So I found my first year really, really hard. I didn't know anybody. Those people I did get to know, I didn't call them friends, because I'm not comfortable enough to phone somebody and say, "Let's go out". I didn't think of them as good of friends as they do. So I went home every weekend, and I'd just turned 18, so I'd drive back Thursday night, go out with my best friend, boot it back for class for 8 o'clock the next morning. I never missed a class, but I had some really late nights. But I'd go back Friday. I was done Friday at 5 o'clock, and I'd go back to the farm Friday night. I did not spend a weekend in the city my first whole year. If I had to, I was in tears.*

Only one participant identified herself as an international student. Nduka, a chemistry student at a university college who came to Canada from Nigeria with her family following high school, discussed the differences between the Canadian and Nigerian education system and how she found that education is much more rigorous in Nigeria. She said that because of this, she didn't take her schoolwork seriously, and it was tougher than she expected. The most difficult thing about moving to Canada for Nduka was "...leaving all my friends that I have known for 16 years, and coming here. That was hard. If I was to transfer to a [4-year degree] university, I'd have to start all over again, trying to adjust, trying to make new friends."

Adjustment to Academic Lifestyle

Some participants commented on the difference between high school and university in terms of being able to make choices in your program in university. Reflecting back on her four years in college and university, Sara emphasized how not having choice and then having choice has impacted on her as a student. She said:

> *Actually, I didn't know how fun it could be. It took till this year to get as fun as it is. But the first couple of years, I think you leave high school -- and I know I left high school thinking -- the minute you get to university, it's your choice. You're taking what you want. You get your pick. And that's not true. That's still not true. The first 2 years, you do what they tell you. It's the third and fourth year that you do what you want ....*

Carolyn, a general sciences student, also indicated how compared to high school, the college expects you to be independently responsible for your own motivation and progress:

> *During high school we always had teachers making sure you had your assignments in. This [college] is totally self-dependent. You have to do it yourself, and you have to motivate yourself to do these assignments, otherwise you don't get marks for them...*

Academic Challenges

A large part of the transition between high school and university/college for the participants has been overcoming many academic challenges. They described the much heavier work load, lower grades, and apprehension about approaching professors as factors that made the transition difficult. As the participants were in their second to fourth year of postsecondary study, many of them described themselves as having made a positive adjustment to their program by developing study skills and by becoming familiar with campus resources.

Many participants expressed a belief that their high school did not adequately prepare them for the nature and amount of work that they would be doing in university. Leslie, a second year biochemistry student, described her high school lab experience as "inadequate", as she felt very unprepared for university labs:

> *I found a couple of my labs were pretty discouraging, because it was my first university lab and there was just so much and I totally ran out of time. It was like a 5-hour lab scheduled in 3 hours. I found that was not a good thing, because it took away a lot of my confidence in the lab. And I didn't have time to actually think when I was doing the experiments. It was more like racing the clock, and there were these chemicals everywhere. That was a bad experience. I felt really nervous about labs.*

Leslie's lack of pre-university laboratory experience, and her resulting lack of confidence in her scientific ability, was similar to previous findings (Seymour, 1995).

For many of the participants, a big part of the transition was getting used to not performing as well academically as they did in high school. Most of the participants were accustomed to excelling academically, and achieving lower grades in university was described as "traumatizing" and "shocking". Noreen, a biochemistry student, used these words to describe the experience of failing her first chemistry midterm in her first year of university. As she had never previously failed on any test or assignment, this one incident of failure propelled her to switch majors from chemistry to biology. She expressed that she wished that she had stayed in chemistry. Loretta, an engineering student, also shared regrets about her first year in university. She described switching not only her major, but also switching to a technical institute to cope with her academic suspension from university:

> *I started at university right out of high school. I did 1 1/2 years, but I had a very difficult time in terms of transition from high school to university, and especially since I went straight into engineering back then. I don't know why I did. I think I thought engineering was structured; I wouldn't have to decide on what courses to take. It was already there for me. I ended up not doing well at university. I got the Dean's vacation [suspension]. I applied to SAIT. I decided to finish engineering, because I didn't think I could fail at something. I couldn't work with the failure, I guess. I completed 2 years of chemical engineering technology, made a transfer to here [another university], and they accepted me.*

Some participants described how they learned to adjust their expectations in order to cope with lower grades. Laura described how she initially had high hopes of achieving excellent grades, and how she is now "...hoping to do as best I can. I'm not going to pressure myself. I did that last year and it wasn't worth the stress and the worry."
Carla described her own approach to coping:

> *... I got into the habit of comparing myself against myself, not against others. So when I started doing badly, my expectations just immediately went down...they went down because it really wasn't a big deal. I'd been warned beforehand that this would happen. It was, 'Oh, okay, they're right'.*

Many students stressed how difficult it was to approach professors, both in class and after class, to ask questions or to seek help with course material. Sara explained her process of becoming more comfortable with getting the assistance she needed to understand the coursework. She said:

> *... I learned in my first 2 years that you had to speak up and that you had to ask questions, and I don't mind looking stupid, so I don't mind asking the simple little question, because I know somebody else is thinking it, and it takes your first two years to get to the point where I know -- and I still do it a lot. I'll still ask a question, and think, you guys are all going to think I'm stupid. And that's how I usually start my question: 'You're all going to think I'm*

> *stupid, but I want to know this.' That way, I've already said it. They don't have to say I'm stupid! I'm the one making the joke, they aren't.*

2. Educational Influences

Educational influences were shown to have had a major influence on participants' decisions regarding pursuing their choice of science field. High school teachers, postsecondary professors or instructors, teaching assistants (T.A.s), and guidance counsellors/academic advisors were often cited as having been key influences, either encouraging or discouraging participants from continuing in their respective programs. These areas of discussion formed the sub-themes which are further discussed here.

Teachers

Teachers were often mentioned as being a key influence on participants to consider pursuing science in college or university. They were described as being a positive influence by many participants, but a small minority indicated that they felt discouraged by some high school teachers. Lisanne, a biochemistry student, indicated that "...I've had a couple of good teachers along the way, and a couple of really bad teachers, too, and that's almost as big an influence as a good teacher". Those who felt their teachers encouraged them indicated that their teacher was approachable, encouraging, knowledgeable, and willing to spend time helping them. Laura described how her high school biology teacher encouraged her to pursue biology :

> *I chose biology because of my Biology 30 teacher. She was really an inspiration. She was great. I just really liked the course ... I had biology the year before with someone else, and it just turned me off. I thought, 'God, he's not that great, I like math better'. But then I took Biology 30. I think the teacher or T.A. or whoever's instructing or even the people you're with in the class make a big difference. Like, if you don't feel intimidated, or they're not condescending. I found that my Bio 30 teacher was almost a friend.*
> *She'd sit right down with us on the desk and joke around and it would be very comfortable ... I thought it was neat how my perspective on the subject changed. I didn't think I liked biology, as a person, I didn't like it. But then*

> *having a different kind of teacher changed my view entirely... I think it makes a big difference.*

Many participants indicated that their teachers instilled in them the confidence they needed to consider science as an option. Stella indicated that because of the one-on-one attention and assistance given to her in high school math, she attained the skills and confidence to become a math major in university.

> *I was really impressed with my high school math teacher. I thought he was great. I had never considered myself to be anything in math, until Grade 12. I went for a lot of extra help, and he was available and very patient in explaining things. I learned a lot about just how to study for math in Grade 12.*

Another participant described her high school calculus professor as being helpful in providing resources for her to read and with suggestions for career choices in math-related fields. Christy described how a high school teacher gave her some career guidance:

> *I had a calculus teacher who had been a professional engineer, and once I had decided I wanted to pursue a math-based career -- it was a toss-up between Math and English -- I asked him what he recommended, and he threw out a bunch of suggestions, but he also mentioned engineering, so I borrowed a few of his old textbooks and looked through them and they seemed quite interesting -- and so -- here I am.*

Another participant indicated that a female science teacher was actively promoting science in high school, and that this teacher influenced her as well as many other students. She said: "I had an instructor in high school, actually, and she was a girl and really into this, and pushed a lot of people toward science. She really had a good influence on a lot of people and going into science was what she wanted." The role modeling, individualized assistance, and encouragement provided by these teachers (especially female teachers) appears to have increased participants' math and science-related self-efficacy expectations (Bandura, 1977; Betz, 1997; Betz & Hackett, 1983; Hackett & Betz,

1981) and increased their pre-college preparation. Consequently, the participants were able to avoid the filtering out of math- and science-related postsecondary options (e. g., Betz, 1997).

Professors

Participants also commented on positive and negative experiences with university or college professors. Approachability and knowledge of professors and instructors were major themes among participants. Participants used words such as "funny", "interesting", "approachable", "helpful", "positive", "supportive" and "enthusiastic" to describe professors that have had a positive influence on their career planning. Some participants emphasized the influence of the professor in whether or not a student likes a course. Carmel indicated that a different instructor completely changed her experience of taking the same course in her general studies program at a college:

> *I find in some of my courses, especially like, say, organic chemistry, I don't like it at all because the instructor seems...I find it hard to like the instructor. But then the other day we had another teacher come in to teach, and it was actually...he just taught it totally different, and he was funny, and I understood every single thing he said. And it was fun, and my hand didn't fall off from writing so much, and it was such a different experience. So they [teachers] do play a lot in whether you like a course or not.*

Another participant explained how her experience of studying chemistry in university was completely different than her experience in high school. It was her chemistry professor in college that facilitated her love for organic chemistry. Corrie explains:

> *Even though I'm in (pre-)pharmacy now, I didn't do great in chemistry in my high school, because we didn't have the best teacher. But I love organic chemistry right now. It's really weird, but I really like my instructor. I find him really funny. I guess it's just that I really enjoy it. It's a lot of fun, and I think it's so interesting, especially the way he jumps around the [black]board and he just loves what he's doing, so it makes you really interested to know what you're learning... The way he teaches is totally different. He doesn't have*

notes or anything. What you have to do is use your brain for a second. It was a really different learning experience. I found him really good.

Many of the participants indicated that the professors who really make an impact on students' learning and appreciation of a subject, are those that make the subject material interesting and fun.

I had fabulous teachers when I was in college [prior to studying at a small university that she currently attends]. I had a few wonderful, wonderful science profs that made it fun. It wasn't serious. You learned a ton, but if we were learning something about the electron transport chain, we had balls chucking around the room as electrons. It became an entertaining thing. It became alive. It wasn't simply a book-learned subject. It became a lot more alive than the original things I had started out with. So those kind of people [instructors] really, really helped.

(Sara, biology)

There've been a couple of lab courses I've taken -- and in the lab courses where the coordinator makes a real effort to make the experiments relevant and interesting and meaningful, and not just following a bunch of stupid instructions, those were really interesting, and it sparked an interest in me, and it made the whole thing easier.

(Lisanne, biochemistry)

Another important issue raised by participants regarding professors is that the approachability of and familiarity with professors played a significant role in their appreciation of their academic program. Participants from smaller postsecondary institutions in particular were vocal about their appreciation for the connection they have been able to maintain with their professors. For some, it was the connection that they made with an individual professor in an area of study that encouraged them to major in that area. In a focus group conducted at a college in a rural setting, participants in an engineering program discussed the large influence of a particularly helpful instructor:

Carla [engineering]: I found I really connected with my chemistry teacher, and enjoyed the class more and more, and for that reason, I'm going to go into chemical engineering, whereas the physics -- I just couldn't get far with it. I felt stuck.
Christy [engineering]: It's the same sort of thing. The chem. teacher ... he's a great guy. I was considering going into chemical. I don't know yet what I'm going to go into. But it definitely influenced me. I don't really want to go into the civil or mechanical, because all this chemical stuff sounds really cool.

Students in focus groups at a small university also emphasized the helpfulness of having professors who make an effort to get to know their students on a personal basis:

In terms of things helping this year, I think that absolutely the contact with professors [was helpful]. Students at this university will say that absolutely the contact with professors is invaluable. I have a really close relationship with the master's student that's working in the lab that I worked in, and the prof. But I've been on a first-name basis with all the profs in Biology since my first year.
(Sabine, biology student)

My very first science teacher who made me fall in love with science in college took all our pictures on the first day of school on Polaroids, and we each wrote our name on a card. Our name, what we were in, what our interests are, what we wanted to do, and he pasted each of our pictures on our page, and I saw him the next day in the hall, and he said, "Hi Sara, how are your Education classes going?" And I was on Cloud 9. I loved it. He knew who I was. I didn't even know his name. I had no idea what his name was. I was so happy, I went right home and phoned my mom. I was ecstatic.
(Sara, biology)

Other participants emphasized their appreciation of the knowledge their instructors shared with them about their future potential career options:

The reason I picked forestry, is because one of my forestry professors was the best professor I've ever had. I sat down with her and talked to her about what I could get into, and she knows a lot about the forestry industry, about *what jobs were going with what, so she helped me out a lot. She's just a wonderful lady. She totally set me in the right direction.*

(Cherie, forestry)

[Technology students]: I think the instructors help a lot, because they're all pretty professional and they make it very obvious that they're trying to help you ... ... They're on a personal level, not just going into classes and teaching.
Facilitator: So they're easy to relate to, very knowledgeable, and they really are concerned about how well you're doing as an individual.
[Technology student]: They're concerned about where you go beyond this, too. It's not just about educating you for this year. It's about making sure that you get a job afterwards.

(various technology students from a technical institute)

Leslie found from her experience in her university biochemistry program that the right professor (and teaching assistants) can make a student feel important and confident about their ability to do work:

Well my organic chemistry professor last year, I found he was very encouraging and so he was very useful. He made me more confident with organic chemistry and he was very approachable. I could always ask questions. I think I might have gotten overwhelmed on that course otherwise. I've had really good T.A.'s too in my labs.

Unfortunately, she also noticed a significant decrease in the amount of attention that students can get from their instructors once they reach university. She implied that some are neglecting their teaching duties in favor of putting their attention towards their research pursuits.

Another thing I noticed about the university in general is, some of the professors and the T.A.s, they were there to do their work [research] and it didn't seem like they were there to teach, so I found that was discouraging too. If they came in and didn't care about your learning, they just cared about the information on the board and then moved on, it was like, I can't learn. I don't know if I'm expecting too much out of the people at the university, the teaching staff, I guess. But I think I almost feel gypped. I feel like they're not putting enough in to help us learn. So it was quite a difference from high school, 'cause

> *you'd have your teacher come over to your desk if you waved your hand, and they'd help you out a bit. So maybe that's just the change that I'm feeling...*

Other participants from university programs indicated that "There's a lot of university professors who don't know how to teach" (Loretta, engineering) and "They're brilliant in their information and stuff, but they just don't know how to present it to us in a way that we can understand." (Lucia, microbiology). Professors were sometimes described as teaching at a level that was too high for the participants. They described the professors' expectations as going beyond students' capabilities for their level, and that there needs to be a gap filled between learning the information and being able to effectively apply it. Lucia (a 2nd year microbiology student) said:

> *[When professors are] expecting you to apply the information, and apply it from an area that people are just researching now and that we've never been exposed to before -- that's just a little beyond what we're able to do right now. Give me the paper, give me the information, and then expect me to do it, maybe. But just right off the top of my head come up with that hypothesis -- I don't think so.*

Unfortunately, science and engineering students' encountering of ineffective teaching by professors and instructors is a common experience (Astin & Sax, 1996; Morse, 1995).

Participants from a technology program commented that their professors were "patronizing", "basically saying 'You're stupid' all the time", and that the majority of professors "still treat you like you know nothing" and "treated like children". Many of the participants from technology programs were returning to student life after working for several years as a professional, and had a difficult time re-adjusting to being in an environment where they are not treated as an equal. Various participants indicated that they "feel like I'm being treated like I was in high school", and that "it's very hard to come back and be treated like that".

When Loretta (a chemical engineering student) was asked about the potential of professors to influence a student's likes and dislikes in their field or area of specialization, she said:

> *I don't think you should let them too much, especially if they're negatively affecting you. If you have a bad prof who purveys a very negative attitude especially to your sex or to your cultural origin, then you might...I have some male classmates who go to an engineering computer class taught by a female professor, and she knocks down males. Maybe she's had some bad experiences, I don't know, but in turn, it's affected my friend who does not like the programming course. But he's actually very good at computers. You see? He doesn't like it; he has a mind block, and I was just helping him study for his midterm, which is today. It's affected him that way. A prof can affect you negatively, but I try very hard not to let them ... My physical chemistry professor hates life, and if you go to him with a question, he makes you feel so stupid for not understanding this. So my friend and I , before the midterm on Friday, we had a question. We sent someone who wasn't even in the class to go up there, because if he finds out who we are -- we had to ask a question, we'll fail for sure.*

In general, these findings reflect previous research findings that in many ways, professors may have a significant influence on women's career development in science (e. g., Astin & Sax, 1996).

<u>Teaching Assistants (T.A.s)</u>

Teaching assistants were also mentioned as educational influences on participants' experiences in their science programs. Some participants have indicated that their T.A.s were very helpful, while others experienced frustrations with their T.A.s and how the labs are being taught. One participant stressed the problem of lab evaluations and how the T.A.s sometimes are reluctant to assist students because of evaluations.

> *One thing I've seen in the biology department -- I'm taking a biology course and a chemistry course -- is the attitude towards labs. It's not so much what you do, but the whole attitude of the department and the T.A.s is different. In biology, they teach you what to do. If you have a question, they ask. In chemistry, if I ask my T.A. questions, she'll say, 'No, I can't answer that*

> *because we have to mark you on something'. So if you ask questions on some piece of equipment, how to hook it together, a lot of times, she'll just tell you, 'Figure it out'. I don't think this is a good way of teaching.*
>
> (Lorelei, engineering)

Lisanne described one of her T.A.s as using gender-biased (male-biased) examples to explain concepts in the labs. She indicated that such an experience in a physics lab discouraged her from pursuing the field.

> *I was actually thinking about doing physics myself, but after one year of the physics labs and the complacency on the part of all the professors and coordinators and T.A.s just turned me off. I had T.A.s that would say to me, 'Well, you know what it was like when you played with rockets as a kid'; well, I never played with rockets, and that doesn't make me stupid or mean that I shouldn't be interested in physics, but it sure turned me off.*

It is important to recognize the degree of influence that T.A.s have on undergraduate students, particularly in the early years of their program. In the first two years of their program, students are likely to have much more direct contact with a (male) T.A. than with a professor (Seymour, 1995).

<u>Guidance Counsellors/Academic Advisors</u>

For many of the participants in the study, an interaction with a guidance counsellor or academic advisor left a lasting impact on their attitudes towards science and whether it would be something they would pursue. Some participants indicated that they were required to discuss program requirements with an academic advisor. Others said that they approached guidance counsellors or academic advisors and described their experiences in the focus group. A third group of participants reported having no contact with a guidance counsellor.

High school guidance counsellors were credited with helping some participants make decisions about what postsecondary program to enter and with assisting them in planning their program. Some of these participants pointed out that their high school guidance counsellor presented a realistic picture of what they should expect in postsecondary study, and gave them practical advice about program requirements and timetable planning.

> *I had a really good high school counsellor. She sat down with all of us and we did those tests that you write out, and then she looked at what we were good at in school -- I came from a really small school, so they know all of us really good. It helped me a lot.*
>
> (unidentifiable college student)

> *It was like that for me too [interaction with guidance counsellor]. She didn't sugar-coat anything. She said, 'You're going to need this course, this course, this course, and a minimum of this, this and this to go into there, and here it is, and if we can help you in any way, go for it.*
>
> (unidentifiable college student)

> *Well, I didn't exactly use my high school counsellor to make a decision, but she was always positive and there if you wanted to ask a question. She'd say, 'Well, you can't go to school with those grades, and you can do this and that.'*
>
> (Corrie, prepharmacy)

Others indicated that they received helpful advising at the postsecondary level:

> *Counsellors made it a lot easier. I came in thinking I was going to go into business administration, because I wanted a quick course, something to do, some sort of education to get a better job, and they told me to sit down and think about what I really wanted to do. They told me not to do something you don't want to do if it's not going to make you happy.*

When a focus group of technology students was asked if they had sought out guidance counsellors, several of the participants indicated that their guidance came from their instructors, rather than from guidance counsellors or academic advisors. Students made comments that the instructors "are on a personal level with us", "none of them talk to us like we're below them; they treat us like pretty much equals and they understand that we just don't know as much as they do"..."They always relate their personal experiences, so we have an idea of what's going on out there, what are the options."

Some participants expressed that guidance counsellors seemed to pressure students into choosing a career that the counsellor believed was appropriate. In some cases, the pressure was to pursue a science field, and in others it was to pursue a field outside of science. In many of these cases, the participants felt that they were guided into an inappropriate career choice by a counsellor or advisor. Celine expressed her frustration with the pressure exerted on high school students to choose attending postsecondary education, particularly felt by students in small towns:

> *I know from being in high school -- I didn't end up going to college right away but being from a small town, there's a lot of pressure, and my high school counsellor, I just hated even talking to her, because there was so much pressure to go to school... When you're 17 or 18, you don't know what you want to do. And they don't really give you another option. It's just, 'Where are you going and what are you going to take?'. That's how mine was, so I didn't even like talking to her at all. That's one of the reasons I didn't go to school right away. My school counsellor told me to be a teacher when I was in high school, and I said no because all my friends went into teaching, and I wanted to be different! When I came here, they looked at my chem mark and said, 'Your math mark isn't that great. You should do chemistry. Your chem mark is really good.' I did that, and then I failed. It was, I just kind of did what they said would be good for me, and it wasn't.*
>
> (Noreen, biochemistry)

Several comments were made across focus groups that indicated that guidance counsellors did not play a helpful role in encouraging science as a career field. In many cases, students describe being discouraged by their guidance counsellor. Leslie explained how she ignored her guidance counsellor's discouragement and majored in biochemistry:

> *...He'd say things that were really discouraging, like, 'You're gonna get stuck in something and your marks will be really low and then you'll be stuck there and you won't be able to transfer to something you like. I found every time I'd go to see him, it'd be more discouraging than ever, so I just kind of ignored him*

because I didn't really believe him anyway. My high school...they weren't actually all that encouraging about even going into science...

Sabine described a similar experience of feeling discouraged by guidance counsellors because of her grades. Despite her lack of support, she chose to upgrade and is now pursuing biology.

I wanted to go into medicine since I was quite young -- since I was probably about 10 years old. I never graduated from high school. I quit or whatever, and I came here and upgraded. I found the counsellors, at least at the high school I went to, very discouraging. Because I was kind of a poor student, they told me I shouldn't even bother with things like physics and basically, don't ever bother trying medicine, because they felt that I wasn't able to even have a shot at it. So I got a bit discouraged, but I came here and upgraded, and I really enjoy biology, biological sciences, and stuff like that. A lot of the teachers and counsellors here, I found them much more encouraging than at the high school that I went to. I wanted to do it for years.

Noreen [biochemistry]: He [high school guidance counsellor] kind of turned me off. He said I shouldn't take bio, but I didn't listen to him.
Facilitator: Why did he say that?
Noreen: We had all these aptitude tests that we had to take, and mine were really high in sciences, and he told me that basically my personality didn't match with what my tests matched with. I don't know why...

Many participants indicated that guidance counsellors played no role in their career planning. In many cases, a guidance counsellor's help was not sought out, but in other cases participants sought out help and did not receive it. Sara described how she felt that the guidance counsellor in her high school didn't care enough to be of assistance to students:

I have very, very little respect for guidance counsellors, not that they're not trained, but they don't seem to really care. They don't really seem to put the effort into it that it requires, and I've heard that from a lot of people: 'My guidance counsellor isn't helping'. ... My guidance counsellor steered me in the wrong direction, and I've heard that from other people: either not telling them where they could go, or not pointing out the wonderful things that are

> *out there. I come from a small town, and a lot of the boys would have done phenomenally in construction, which is booming. That was never perceived, it was never investigated, it was never encouraged. So now, they're at home on the farm, which is, honestly, a dead end thing right now, the way everything is. So I have lost a ton of respect.*

Students from a small university described the centralized academic advising they received as "abysmal", "horrible", and being "less than none". Many described the guidance counsellors they have dealt with as being unknowledgeable. Sabine said that she found that the academic advisors

> *..don't know the requirements and the advice they give is bad ...To me, they shouldn't be trying to do what they're doing. They shouldn't be trying to give people advice about every single program at the University. How can you possibly give that kind of advice?*

In summary, participants' interactions with guidance counsellors were more often described as discouraging rather than helpful. Researchers have found that guidance counsellors can be less helpful to females with nontraditional career interests (e. g., Tomini & Page, 1992) and may encourage them towards traditionally "female" careers (e. g., Betz, 1997). A lack of contact with guidance counsellors has also been noted in previous research (e. g., Farmer, 1997).

3. Family and Community Influences

Participants frequently mentioned the important influence of family members and others in their personal life, on their decision to pursue a science field. Parents seemed to have the largest influence on participants, whereas siblings, peers, extended family, and community members seemed to influence them to lesser degrees. These various family and community influences are described in detail below.

Immediate family: Parents and siblings

Many participants indicated that their parents encouraged them to pursue a science career, and many of these parents were working in the same field. Those who indicated that a parent was particularly influential to them in making their career decision seemed to mention their father as the main career influence for them in their family. Leslie indicated that having a father who was a professor at the university made the transition to university a comfortable experience:

> *My dad's a professor here, and he's in engineering, so that made me feel a lot more comfortable. I don't know why I tried out science. Maybe because I felt more comfortable with the university 'cause I was only a block away, too, and lived there my whole life and it didn't feel that far, so I was feeling kind of brave when I came in.*

Lynette said that for as long as she can remember, she has always been interested in becoming a doctor like her father:

> *Well, my dad's a doctor, so that helped a lot. I've always been interested in what he does. We'd sit on the subway and he'd teach me the four chambers of the heart. I knew the circulatory system when I was 6, I've always been the studious one in the family. I'm the oldest child, so I've always been...like a chip off the old block sort of thing. I've always leaned toward medicine. It's never been a conscious decision like, okay, today I'm going into medicine...it's just always been there.*

The significant influence of fathers' encouragement of their non-traditional daughters' career development has been well documented in the literature (e. g., Berkowitz, 1993; Betz & Fitzgerald, 1987).

Some parents weren't so encouraging. Samantha, an agricultural biotechnology major, described her parents as not taking her career goal of being a veterinarian very seriously:

> *Samantha: My parents giggle at me when I tell them what I want to do.*
> *Facilitator: Oh, really?*
> *Samantha: They're not discouraging, but they nod and smile.*
> *Facilitator: That you want to be a veterinarian?*
> *Samantha: Yeah. My parents spent a year telling me I should go into something easier. 'You work too hard, you don't have enough fun. Do good in French or something!'*

For other participants, their parents' influence on their career decisions was so strong that their parent made the decision for them, even if they didn't know anything about the career choice. Nduka, an international student majoring in chemistry in a university college, described her commitment to a field she knows little of, as it was chosen by her father:

> *Nduka: I think it was because of my dad, because my dad is a petroleum engineer... I'm not sure if that's the main reason why I chose to be a chemical engineer, but it had a part in it. The word "engineer" was so...what we've just been calling an engineer is something I want to be able to do...*
> *Facilitator: It was something you wanted to aspire to, was it?*
> *Nduka: Ever since I was in high school, I've said I wanted to be a chemical engineer and I've never changed [my mind] once.*
> *Facilitator: How did you know what chemical engineering was then?*
> *Nduka: I don't, I still don't right now!*

Another participant studying neuroscience at a large university indicated that her parents were pressuring her into pursuing a medical degree. Louella indicated that her parents played "...a pressure role --- you're going to be a doctor, whether you like it or not." Lucia explained that her mother also pressured her to pursue medicine, as her mother was unable to pursue that career herself.

> *It's just stifling. I don't like being around my family. My brother has a learning disability. He's 21. He hasn't finished high school. He has the ability to do it, but everyone has told him for years and years that he can't. He doesn't care anymore. My mother is a teacher. So it's always been expected of me that I'm going to do something. My mother's look on life is, 'I had you, I couldn't be a doctor, I have to be a teacher; therefore, you are going to be a doctor.' My grandparents look at it that way, too. I'm only the second person to get a degree [in my family] ... I would love to teach, honestly. That's my calling in life, I think. But my mom's against it, because she said she sold out to become a teacher and she doesn't want me to do that.*

Other family members also influenced participants in their career decision making. Siblings were mentioned as having a large influence on a few participants' career choice. Linda, an engineering student at a large university, followed in her older siblings' footsteps:

> *My brother, when I was in Grade 6, chose to go into engineering, so that was my first visualization, understanding of what engineering was all about. Also, my other sister chose to go into engineering. So I saw a theme there. I thought, well they're related to me. I could do it if they could do it.*

Linda's ability to observe her brother and sister's success in engineering is an example of Bandura's (1977) concepts of vicarious learning and modeling. This experience subsequently increased her self-efficacy and influenced her to pursue engineering as her brother and sister did.

Peers

Some participants indicated that their decision to go into science was influenced by a friend. Some indicated that they initially chose science courses to be with a friend who was taking them, and ended up liking the courses and majoring in the area. A participant (Leanne) who was studying biochemistry indicated that she had an older friend who had taken courses in the department and recommended them. Another participant, Stella, described how a casual decision to take a math course with a friend turned into a career decision to pursue math as a major.

> *It was this one particular friend who said, 'Hey, take this math class with me' that changed everything forever. That class was my favourite class that first year. Of course, that had to do with having my friend there. It also had to do with the professor.*

In every case, the influential friend was female. In his self-efficacy theory, Bandura (1977) discussed the importance of same-sex modeling, because the more similar an individual is to their model, the more likely the individual is to emulate the model.

Extended Family and Community

Some participants expressed that they were encouraged by not only their family, but also by their community. Laura said that the people in her small town were encouraging her to pursue sciences, and combined with the many people in her family who were in the sciences, it felt like a safe bet:

> *For me, I guess it was mainly my family, and the people I grew up with in town that kind of pushed me toward the sciences. I was never any good at English in high school, but when I came here, it was kind of funny -- that was my best class in first year. I guess my sister, she was in the sciences, and my uncle just finished a Ph.D., and I felt like sciences ... they just seem safer, I guess, for some reason.*

Corrie cited several influences on her decision to pursue pharmacy, including her cousin, pharmacists, and other professionals:

> *Well, I made my decision because I have a cousin who's almost finished pharmacy. I got a job at her pharmacy, too, and that helped me make my decision. I know a lot of pharmacists, too. I know a lot of people in the health food industry, too. Basically, they helped me to make my decision.*

4. Academic Issues

Academic factors, both at the high school and postsecondary levels, were important to participants in helping them to make career decisions. Participants talked at length about the reasons they chose their area of specialization; how course scheduling and program requirements have influenced their career development; and the impact of coursework continuity and transferability on subsequent career options. They also discussed their dislike of program competitiveness and its negative impact; how tuition costs are affecting their ability to persist in their programs; the importance of applicability of what is learned in school to the world of work; and the outlook for their success in finding desired employment once they graduate.

Choice of Specialization

Many participants indicated that they made their choice of major based on their academic interests in science, their academic strengths in science, and the challenge and variety it can offer in a profession. Carmel, a general science student, indicated that her high school fondness for science influenced her to pursue science in college, although she had not yet determined what area of science she wanted to major in.:

> *I chose science because that's what I like. It's just -- I don't want to go in to the arts program because that's not really what I like. I'm a science person, so that's why I'm here. I'm not sure what kind of science person, yet, but I'm going to be a science person.*

A technology student also chose to pursue a science program because of her interests in high school. Theresa indicated that these interests focused her to the point that she "couldn't see herself doing anything else". Linda described that while her interest in science started in high school, her cumulative experience with chemistry in university has shaped her career path towards either chemical or materials engineering:

> *I was thinking of going into chemical engineering because of my love for chemistry. After taking a second qualifying year, I still took some general courses, and I took a materials course, and I really loved that -- the study of how they're hot-worked and cold-worked and improving them -- after doing that, I decided, that's what I really wanted to do.*

When a focus group with technology students was asked what appealed to them about science, several answers were offered, including that "every day, going to work, it's going to make me think, so I'm not going to get bored"; "it's a knowledge thing, it's learning something"; "I want to know how things work. I want to know what's inside"; "I'm a visual person, so I don't believe it until I see it"; "I like the really abstract things, I like that you can just make a picture in your brain of the whole puzzle, and pick your way through it." Lisanne, a biochemistry student, shared many of the same attitudes about science. She returned to school after having obtained a business degree and having worked for several years. She said that for her to decide to return to university, "it had to be something like science, something that would always be changing and never boring."

Many participants found that their academic strengths in high school and postsecondary education also were important in their choice of specialization in science. In many cases, the participants' interests and strengths in science overlapped. It is likely that as a result of their success in math and science in high school, they developed high science-related self-efficacy expectations that encouraged them to pursue postsecondary studies in these areas (Hackett & Betz, 1981).

Course Scheduling and Requirements

Many participants indicated that difficulties in course scheduling had an impact on their program and subsequent career decision-making. Difficulties included the limitations encountered with prerequisites; courses and labs scheduled at late hours which were inconvenient and prevented students from maintaining a part-time job; and an imbalance of course offerings across the two terms. Linda described how difficulties scheduling one course affected her whole timetable in engineering and her preparedness for the term.

> *I had my schedule all set up, and I registered in all of them, but then I found out I couldn't take one course which also limited another one, so I had to do a whole rearranging of my courseload. I don't think I was quite prepared for my courseload yet, but I'm easing into it now and I'm hoping things will smooth out now. It's after the mid-terms. I did okay, but I didn't do as well as I'd hoped. Hopefully when the time comes for finals, I'll be better prepared.*

One participant who was a biology major described how the required courses in her area of study seem to be offered all in the same term, creating unbalanced terms. Another biology major in her final year of study, Sabine, indicated that long school days and biology courses always offered at the same time at her university were frustrating.

This semester's a little different for me, because for the first time ever, I don't have any labs. But it's the same thing. My Tuesday, I start at 1:40 and I go till 9:00pm straight, without any breaks. And yeah - there's courses offered on campus and I find it very annoying that are every year, offered some time in the afternoon. Basically, my afternoons have been full [with prerequisites], so there are definitely courses on campus that I cannot take and can never take [that I want to take].

Stella is a student at the same university and expressed the same sort of difficulties with scheduling conflicts in her computer science classes and labs. Now in her fourth year, she indicated that she has been able to negotiate different times for some labs and tutorials. Also, her part-time work schedule has had to change (and be reduced) due to the inflexibility of course offerings.

There are three Computer Science classes that I want to take. One of them has a lab and a tutorial and both of the labs and tutorial -- all four -- both sets of labs and tutorials that they scheduled conflict with the two other classes that I want to take, so I just went to the Chair and said, 'Look, this is the problem. I've talked to the lab instructor. She says she'd be willing to meet me some other time.' He said, 'Fine, here's a waiver form'. And it was easy. So far, the only thing that has made me have to miss classes is my part-time job. There are often classes that are only offered at the same time in every semester, and I always work at the same time every day, and I just can't take those classes. So this semester, I had to cut down on my hours of work.

Participants in various majors attending the same university college were almost unanimous in describing difficulties with getting the core classes that are required for completion of their respective programs.

Facilitator: Does it have to be as packed and as crammed and as stressful, to graduate and get all the courses you need?
[Student]: I think so... and all the core requirements that we need. Especially here, where if you fail something and they don't offer it next year...
Facilitator: So you have to have that course. So there's some...you're finding that the courses are not consistently offered?
[Student]: All the bios are once every second year.

Facilitator: It's a real problem with prerequisites.
[Student]: You can't take it in the next semester.
Facilitator: So it kind of puts your whole program back two years. So that adds to the stress, too, I guess.
[Various students]: I have that problem...I have that problem.

Participants also commented on the amount of arts electives that they are expected to take in their science programs, despite a small amount of introductory or junior arts courses. Many indicated that they wished they would have been able to choose electives from other faculties as well:

> *I find it frustrating that you have to take all your required courses, then you have to take an arts option. Why can't you take a phys.ed. option, or a business option, or something else? Why does it have to be arts? That annoys me quite a bit...And the amount of junior courses is...I don't know...it seems like it's too small, when you [non-arts students] also have to take an arts option.*
>
> (Lauren, neuroscience)

<u>Coursework Continuity & Transferability</u>

Some participants shared their frustration regarding changes made to their programs and courses, which they feared may reduce the credibility of the older program from which they are to graduate. Problems mentioned included being caught in the middle between the old program and the new program, and having course requirements change mid-program, sometimes forcing a student to register for a course almost identical to one that had been offered in the older version of the program. Sabine described how the changes in her department had put her in this situation:

> *...Biology last year went through a huge change in terms of requirements, course offerings, and it's awful that there's courses that I have to take in my degree that I can't because they don't exist anymore. I have to take replacement ones that are half things I've taken before, and half new, and it's -- The thing is, they make the change as of right now, so that the course, if they*

> *would go for one more semester, all of us would get cleaned up. But they don't go for one more semester, they say, 'Yeah, that was the last time that course was offered. Sorry.'*

Carla described how she felt caught between the two versions of her engineering program:

> *It would have been nice if they'd explained that my environmental course wasn't really an environmental course...it is, but they changed, they switched the whole course around that year, so I had to make the decision, if I'm going to go to University, I have to finish it the way I have it now, because everything was changing. I couldn't wait a year. They were changing the whole program, and I asked them, and they were making it a bit more applied. So it looked really bad for me, because there were two years of us [students] that were going to go through it and have this degree that they had totally changed -- must have been for pretty good reasons.*

Another issue that was raised by participants was the lack of transferability of courses from college to university in some areas of study. A forestry student in a university-transfer program at a college expressed her frustrations with the incompatibility of her program's courses with the university degree program. Despite the specialization and relevance of the forestry courses offered at the college, the same courses are not acceptable at most universities. Colleen explained:

> *I'm in forestry, and I'm in university transfer. I can't take any specific forestry courses, like dendrology, because they're not recognized by any university. It's really frustrating. So I'm doing chem, bio, and I'm getting my economics, getting computer sciences -- maybe I'll go into that facet of forestry business...I'm kind of more in general sciences than in forestry. It can be very, very frustrating, especially with the transferability. That word has been haunting me ever since I came here.*

Another participant, Cherie, pointed out the differences between the forestry programs in college and university, describing the university program as "completely different" than the "hands-on" approach to learning at the college. She indicated that the hands-on approach would be preferred to what she was anticipating for when she would be transferring to university.

Camellia has encountered some of the same difficulties in her engineering transfer program. Despite the relevance of some of her coursework to future job opportunities, the university where she will be transferring will not accept the courses. She indicated that the university doesn't seem to be providing students with the skills that are currently relevant for working in the field.

> *Something that's interesting is that I'm going to be studying in chemical engineering, and I took a class in AutoCAD, called Engineering Drawing. This will not transfer for me at all. I will get no credit for it when I transfer to a university. But the thing is, if I go out to get a job, they're going to go, 'Oh, you have AutoCAD experience; we're going to hire you'. Because when you go out into the job market, the first thing they look for is AutoCAD experience, and it's not even something that's required.*

<u>Program Competitiveness</u>

Many participants in different science areas of study expressed how the competitiveness of their program has made their postsecondary experience difficult. Pre-medicine students were mentioned by participants as being particularly competitive. Leslie explained her frustration of having classes with competitive pre-med students:

> *I'm finding this year frustrating in biochemistry because there's a lot of pre-med students in it. It's pretty competitive, and I'm finding that it's beginning to get to me. It seems to me like there are a lot of people who are there for the wrong reasons, like trying to [get into something else], so it's....I'm finding it kind of a frustrating program .... in a lot of my other science courses that are pre-requisites for medicine, everybody ... people aren't as helpful. They're more...driven for themselves, which is fine, but I find it a bit less pleasant...*

Lucia also found that students in the first two years of her microbiology program at university were very competitive because so many students were trying to get into medicine. She explained that it was hard to obtain cooperative studying relationships with other students because of the grading curve.

> *Lucia: I try to have at least one person in each class, but I find it's so competitive. People are, like, "No, you can't see"...yeah, because you're 'riding the curve'. Especially in labs.*
> *Facilitator: what's the competition for?*
> *Lucia: To get a 9 so you can get into med school.*
> *Facilitator: It's the pre-med group, is it? Or going to grad programs?*
> *Lucia: No, nobody really cares, not until your 4th year. It's like, do I apply to grad school or not. By that point, you've probably forged a relationship with a prof who'll accept you no matter what. And if you're in science in 4th year, you've pretty much been weeded out.*

She also indicated that "it's a lot more cooperative in the final year. The first two -- you're lucky if someone doesn't slit your throat just to get your paper".

Celine found that competitiveness in her forestry program was increasing as she neared the end of her program, as students are trying to obtain as much experience as possible to make themselves employable.

> *Celine: It's more difficult this year. It's not -- there's no chemistry or math or that sort of thing -- it's probably competitive this year, too, so they like to pretend like they don't study, or something. I don't know -- it's really competitive this year. There's three or four of us who are sort of competing for the top, so we don't get together much.*
> *Facilitator: Do you think it gets more competitive as you go on in the field you're in?*
> *Celine: Most definitely. The jobs, especially; experience, because that's what makes or breaks you in forestry, is your experience...*

Researchers have found that science faculty are more likely than other professors to use pedagogical techniques such as grading on a curve, which tends to promote competition among students (Astin & Sax, 1996; Morse, 1995). Astin & Sax (1996) found that women instead prefer active learning methods in the classroom such as discussions and cooperative learning techniques.

Tuition Costs

Participants cited different ways of paying for their education. Some indicated that they had scholarships; others indicated that their part-time jobs were getting them through school; some said that their parents were assisting them to pay; and others required a student loan to help them pay for tuition and other expenses. Participants who received full or partial scholarships expressed feeling fortunate at receiving the funding, as it is difficult to obtain.

> *I had a scholarship from Petro-Canada.. that's where my dad works... for a little less than half this year, and the rest I came up with from the summer job. I was really lucky to get it .... They do that for their employees' kids, so it was just really lucky.*
>
> (Laura, biology)

Sabine is another biology student who earned a 4-year science and technology scholarship, which is no longer being offered. She described it as playing a major role in her choosing to major in science rather than arts, and expressed regret that future potential students in science, particularly females, have lost out on the opportunity:

> *...I wasn't sure what to go into. I went into university right out of Grade 12, and I was sort of toying with, I was very interested in, political science areas as well as biology, and I had to choose between the two and I wanted to do both. This college was actually good for that. It's a liberal arts institution, and every year, I've taken six or seven of my ten courses in science, but then I would take Poli Sci, English, that kind of thing. I was just talking to the recruitment officer at my high school, and we were talking about different scholarship programs, and she mentioned the Canada Scholarship in Science and Technology, and said, 'You have a chance of getting that one. Just say Biology, and do the other stuff on the side, and have that be what you do.' And I said, 'whatever'. And I ended up getting it and maintaining it through my four years, so I have to take six courses in sciences as part of that and it's been excellent for me. I'm not saying good money was the reason, but that was the reason for my decision at the time. That was what pushed me towards the Bio as the declared major instead of Poli Sci .... It was an incredible scholarship program offered by the federal government that was -- for me, it*

> *was $10,000 over 4 years -- they ended it. My year was the last year to have gotten it, and the government cut it. That was a wonderful thing for women in science, and for bringing women into science, because we give the same number of scholarships to men and to women, there was way fewer women applying, so it was a really big incentive. But it's gone.*

Most participants who had received scholarships indicated that they were small entrance scholarships (provided by the province, secondary school, or postsecondary program), with no funding after the first year of postsecondary study. Scholarships for second year and beyond were described as harder to obtain, as the qualifications are typically more specific and often provide less money. While the availability of scholarship money decreased for participants, they stressed that the cost of tuition is very expensive and requiring a larger percentage of the student budget each year. Sabine commented on the price of tuition at her university: "I've been here four years, and it's twice what it was when I came. $2000 to $4000. I'm not earning twice as much in my job." Students at a small university were aware that their tuition was more costly than at larger universities in and outside of the province.

School-to-Job Relevance

A theme that was prevalent across focus groups was that of the importance of learning skills that would be applicable to the world of work. For many of the participants, having "hands-on", practical experience was a crucial part of their postsecondary studies. Many participants indicated that they knew they wanted to do something in the sciences, and that they favoured pursuing a program which was applicable to the "real world". Carla explained how engineering fit what she was looking for:

> *I've always known that I would do something with sciences...I would have gone into something like medicine, but I didn't like the biology. Looking at the other sciences, it didn't seem like it was applied, and engineering, I noticed, was applied sciences, and that's what I really liked about it.*

Others like Taylor chose their current program of study to attain the "hands-on" skills that were not provided by a previous university degree:

> *I got a degree in Biology and sciences, and I had a minor in Chemistry, and I couldn't get a job. I decided I loved Chemistry better than the Biology part, and I've already been at this technical institution once, and I got a good job from that, and -- that's a different story! I knew how this institution worked, 'cause I've been here and I thought that it would be better, and I like chemistry better, too.*

Many participants commented that as they progressed in their program, they noticed that their courses were becoming more practical. They consequently felt appreciative of this increasing relevance to their future employment. Tamara credited the increased applicability of what they are learning in her second year technology program as playing a major role in keeping students in the program until graduation.

> *I think most people, once they make it to second year -- first year, it's so general that you kind of almost feel you're doing it but you're not getting anywhere, because you're not into your specialized portion yet. Then once you hit second year, it's, 'Oh, I'm finally doing stuff that I'm going to be able to use on the job', and you start getting more excited about it. So I think once you're in second year, it's not as likely for people to leave...*

Celine had a similar experience in her forestry program. She noticed a progression from having a general science courseload with no apparent emphasis on forestry, to being fully immersed in forestry classes. With the increase in coursework relevant to forestry, she found that she appreciated her program to a much greater degree.

> *Last year, the first year of the forestry program, when I started, was strictly general science. And I remember thinking, 'I'm not in forestry'. And my first year, I hated it so much. I didn't even know what kind of job I could get and I didn't like it. And then, this year, it's all forestry classes. It makes a world of difference when you're learning stuff that applies to what you're doing.*

Leslie explained that the hands-on experience she has gained from some applied courses has been valuable for many reasons. She said that these courses provide an opportunity for social networking, and a way to get a better sense of what to expect once she is in the workforce:

> *I found that one of the really appealing things about the geology course I took was that they had this field trip, and it does feel more like a program where you're going somewhere...hands on... that was really neat, too, because you got to know a bunch of people, and then when you got back to the lab with those people, it was more of a ... you felt more like a networking thing. That was really useful, and I wish they had that in more of my other courses that I'm taking, and also it gives you more of a feeling of where things might lead. So I found that really useful.*

Some participants did comment that they were frustrated that some of their coursework did not seem relevant to their future career. Chera is a premed student in college who feels that her prerequisite calculus course is irrelevant. She commented that

> *I struggle very badly with Calculus. I'm not doing well, and it says it is a prerequisite to be accepted to medical school, and I really don't see how it applies. I'll never use it...*

Various students in a technology program were expressive when they discussed the irrelevance of some of the course requirements and how their program emphasized skills that they knew wouldn't be put to use when hired for a job:

> *They put too much emphasis on things that don't seem to be as important as others... Especially since every company has a service rep to do all this stuff. In the lab, you're a chemist. You're not an electronics whiz... But if in the electronics course, we would have gotten a little bit more theory, and he would have said, if somebody would have said, 'You are taking electronics because...', instead of 'You're taking electronics'. Well, why do I need to know how to solder? Why do I need to know how to build a circuit? What relevance does this have to my life? You're never going to go into a lab and set up a circuit...you're never going to solder...*

Some of the participants have had a job working in a lab and have noticed a large gap between what is learned in postsecondary studies, and what was required when working in the field. They indicated that theory was emphasized in the classroom, but it was not being used when working in a lab. Tasmin shared her frustrations about having struggled in her program with what seemed to be irrelevant on the job.

> *When I worked at my chemical lab over the summer, everything that we learned and crammed in is not really relevant. Like, all of our lab work is all hands-on. We're very adequate in the lab. But the theory part? There would be certain things, and it doesn't matter. When I was working, if there was something you didn't understand, you'd ask, they'd explain it to you...*

A lot of the participants' frustration about the lack of applicability to a job situation in their coursework was that these non-applicable courses were consuming precious money and time. They believed that these resources could have been applied more efficiently towards more relevant coursework. Cherie explained how she viewed the situation:

> *Part of this is, we have to pay for this. It's taking our money, and it's taking our time. And if we can't use it -- it's wonderful to learn, and it's wonderful to have lots of background about many things, but quite frankly, I can't afford to pay for something I can't use.*

Success in Viable Post-Graduate Employment

Many participants indicated that the job outlook in the careers they were considering was a major factor in the decision to pursue their area of science. They reported having researched their career and having talked to people in the field to find out about the employment outlook before applying to their major. Many of the students who discussed employability as having influenced their career decisions indicated that they saw their education as being a 'means to an end'. They saw their degree or diploma as directly linked to a job, and wanted their student experience to be as brief as possible. Others expressed that it was reassuring to think that their program would lead to a specific job, or envied students in programs with a more direct link to professional employment. Laura discussed her feelings about her field, biology:

> *Well, I know that I want to be in biology -- in that sort of area, but I'm still finding it hard to... I want a direct route. I don't want to get a degree in biological sciences and then maybe get a job here and get a job there. For example, the pharmacy program, when you get out you can be a pharmacist... it's so cut and dried. I don't know if that's kind of boring, but I just prefer that. So I'm finding this year it's a little ... stressful not knowing where exactly I'm going, but I know it's biology somehow. I guess that's what's making it harder because I don't like spending so much time and energy on things I might not need. I still have that feeling. At the same time, I'm enjoying some of the classes that I might not need...*

Carmel, a participant who identified her major as "general sciences", also expressed uneasiness about her career indecision. What she does know is that she wants to find a career which would not require several years of study:

> *For me, I just want to figure out what I want to do as soon as possible, because I want to get this schooling over with and I want to get out there and work and do something that I like. I don't want to be a doctor because it takes so long. I just want to be able to figure it out, and not take a long time and get a degree and be able to work.*

Other participants in her focus group concurred with these feelings. Liz, a physics student who was torn between a science degree and an engineering degree when she started university, expressed how she felt she made the wrong choice based on her perception that graduates of a general science degree would not find viable employment:

> *...So I'm thinking to myself, I have to figure out what I'm going to do, because even coming to university, it was between engineering and science -- and I chose science. But then I'm always thinking, 'Well, should I have gone into engineering', because with this degree, I personally think it's very worthless... unless you go into teaching or something or research. Otherwise, I don't see how you could get a real job with it.*

Some participants described themselves as choosing fields other than what they would prefer to study, as they believed (or were influenced by others' beliefs) that these other fields held more promise of finding employment. Tatiana discussed her decision between two technology fields:

> *I find biology more interesting than chemistry, but I'm better at chemistry and there's more work...Right now, out there, they say there's biology, but not a lot of work, but chemistry, there's a lot. So chemistry was my first choice.*

Parents also influenced their daughters' choices of major with their own beliefs about which career choices will have a healthy outlook. Noreen said that her mother had a science degree and encouraged her to also pursue science, as "..She wanted me to get a career, 'cause if you don't go into arts, unless it's psychology, or a music degree, you can't really do anything." Nadia described growing up on a farm, and that she

> *...didn't want to do farming! But in farming, there's a lot of biology going on, too, so that would be good. And my parents always got the impression across to me that -- I'm also into music, too -- but they always told me there's not really a career in that. There's a better career in biology.*

5. Coursework Management

Participants indicated that they had very heavy courseloads in their programs. The skills learned in facilitating the management of their coursework had a major influence on the kind of experience they had as a female student in science. The main subthemes in this area included: learning efficient time management; developing academic coping skills (e.g., group work); meeting academic work requirements; and study skills development.

Learning Efficient Time Management

Time management was an important skill that had to be learned early on in the participants' academic program. This was especially true for technology students, who are in a particularly concentrated and demanding program. They suggested that the nature of their program "makes you a better person in organizing your time"... "definitely, you *have* to learn how to do it"..."time management skills are definitely better than they were before". Participants felt that despite the heavy workload, they appreciated having the opportunity to really learn how to manage their time efficiently. Sara indicated that for her, part of making her time more efficient included learning how to better organize her schedule:

> *I find it really depends on the classes, on the load -- not necessarily the class load, but the -- what you feel is the load. So the load is as heavy as it was last semester, but it doesn't feel as bad, because I purposely partitioned it a certain way. I said, this is what I'm taking, these are the days, this way I have a 4-day week. It feels like less, even though it's the same.*

Developing Academic Coping Skills

Many participants stressed the importance of developing a network of peers from which study groups can be formed. Some participants, such as Linda (engineering), explained how they did not have good study skills in their first year and that they did not seek help from other students, and that they have since learned that making connections with other students is very important:

> *I wish I had known how to study instead of studying the night before...I did get a little bit of insight from my sister. She did help me out, remembering what the course loads were like. What I did wrong the first year was working by myself. I hardly made any friends and it made it tough. But this year, my second year, I found a friend that I completely click with, and we work together at the same pace and we help each other out and my marks have increased a lot through that.*

Group work seemed to be especially important to engineering students. Loretta described how studying in a group helps with not only learning the material, but with staying motivated as well.

> *I don't know about sciences, but if they're in engineering, definitely group work helps a lot. You have many assignments. One course I'm taking has an assignment every class, and requires, if you're lucky, an hour; if you're not lucky, five hours, depending on the level of difficulty. So you can get stuck on something and you'll want to give up. It's very easy to want to give up. So*

having a group or even another buddy to ask questions...The very first few weeks of school this year, all I did was network: "Hi, can I have your number? I'll give you mine"... and I do call.

Participants from a large university explained that working with other students was important, as it made them feel like they were not alone and that they belonged in the program. Laura and Leslie indicated that this was especially important their first year of classes.

Leslie: I do like to work on my own, too, but I do like the feeling of a program with a network of people --
Facilitator: You're not cut off from everybody.
Laura: It's like you belong, or something?
Leslie: And everybody's got their common goal.
Facilitator: Teamwork?
Louise: Yeah, and it's helpful, especially as that was my first year. It was really helpful. I felt a lot more part of something instead of just taking a bunch of courses and running around to offices.

In contrast, some participants have learned from their first year that group work isn't effective for them, and they have figured out the best ways for themselves to learn. Leanne finds that working sometimes with one other student, or studying alone, works best for her own style of learning.

In terms of group work, I find I'm not a group work kind of person. I do the stuff and then I cross-reference with people. I do that with Carrie [focus group participant] for chemistry; we meet the morning before class, we check out, try to get the right answers. I find that for most of my classes. I like to go home. I like to sit at my kitchen table. I like to study by myself. If not that, I have my friend there who's nice and quiet and we study together just to keep one another awake.

Another important academic coping skill that was mentioned was the ability to approach professors and instructors for help. Many of the participants felt too intimidated to approach professors when they first started university, but they have since learned the importance of asking questions. They indicated that it is not difficult once you get used to approaching the professor:

> *First year, I hardly talked to my professors at all, even though I had questions. I just asked my friends, or just left them. But this year, I've been asking my professor more. And it is pretty easy.*
> (Carrie, biochemistry)

The problem of unapproachable science professors has been discussed previously in the literature (Astin & Sax, 1996; Morse, 1995). In order to avoid further attrition of female and male students who feel too intimidated to seek the help they need to pass the introductory level coursework necessary to major in the field, this issue needs to be addressed.

Meeting Academic Work Requirements

Many participants commented that their academic workload was very heavy. Technology students appear to be particularly burdened with a heavy courseload. One student described her experience in the program as "just 'skimmin' the surface' to get by". Another student shared her frustrations with the vast amount of work technology students were expected to learn within two years.

> *Actually, we were talking to one of the professors today, and he was saying -- he's working at a chemical company right now -- and he was talking to one of the old students from here. She didn't know how to do a certain thing, and they asked 'How come? Don't you teach that?' And he says, 'Yeah, but they don't have time to absorb it'. And that's exactly the truth. If you asked us some of the stuff from first year, just off the top of your head: This! We'd be like, 'Oh, no, no, no'... Give me an hour to go back and find it....And we're all pretty decent students; we're not failing or anything. It's just, you knew it at the time 'cause you needed it for that exam, and then, carry on, 'cause there's so much more that you have to make room for.*

Some technology students indicated that they were familiar with university programs, and that their experience in technology has been very time-intensive in comparison.

> *Twila: I took it [university program] for a year and a half, and there was very, very few assignments, no quizzes. You had mid-terms and finals. But here, we have an assignment every class, or a quiz in each class, at least once a week, plus all the different labs, plus mid-terms and finals. So it's a different kind of work.*
> *Taylor: And also, when you're in university, if you took lab courses, you could make your schedule -- like, you could take two this semester instead of five like we're taking. The labs, it says 3 extra hours 'cause you have 3 hours of lecture, 3 hours of lab, but the lab is actually 10 extra hours a week, not 3. So you could decide how many labs you were going to take. If you had an easy class, you could take three labs, if you had harder, you could take two. Here, you don't have a choice; this is what you're taking. And at times, we could go home from university. Some days, I was off at 11:00. Work here: 8:00 to 4:00.*

Study Skills Development

Many participants indicated that they entered university or college with poor study skills, and that through experience, they have learned the skills necessary for postsecondary academic success. Participants indicated that they learned to prepare properly for exams and not cram; to study in groups to help with motivation; and that they discovered a way to study that is most effective for them.

> *One of the things I did last year, I wasn't quite out of the "cram, cram, cram" mode of studying. It worked okay for me last year, but I did orientation this year, and I met some older students, and they actually study, read the text before they go into class, make notes, and they can get a 9. So it's proof positive that studying before actually does work. That's the attitude I've applied for this year and that's what I'm trying to do.*
> (Leanne, biochemistry)

> *I had no study skills when I left high school. I had zero. I remember studying for departmentals suntanning on the patio with the radio blaring. I*

> *had fun, but I didn't learn anything. By this year, I make sure I study every night. And I have my group, in case I'm not ready to study, I know people who will make me. I have friends who will say, 'Let's study tonight. This time is when we're studying.' Having somebody that I have to meet to study means I'll show up.*
>
> (Sara, biology)

> *I did change my habits from last semester to this semester, because it's a huge wake-up call. I didn't do any work at all the first semester, I found. I thought I could just deal with the same amount of workload my first year, and you can't. I had four labs a week, I think, and three bios and a chem, and I just had to change it, because I did so poorly. So this semester, it's going a lot better...This semester, I finally figured out I had to come to school, stay in school all day and work in the library, and go home for supper, and come back and work.*
>
> (Nicole, chemistry)

6. Gender Issues

Participants demonstrated a variety of opinions about how gender has influenced their studies and career decision-making in the sciences. A large number indicated that they felt that they were not treated differently by professors and instructors in their area of study or in their work terms because of their gender. For many of these participants, their field of study has a large percentage, if not a majority of women. Some of the women discussed their thoughts that their gender may even be advantageous to them because of employment equity programs in the workforce. Unfortunately, many more comments were made regarding some of the difficulties they had encountered in their programs because they were female. Some women described situations of gender discrimination, having been socialized to believe that women aren't as capable in science as men, and how they have observed how some women "masculinize" themselves to fit into a male-dominated field.

Equality of Gender

One of the most popular opinions stated on the theme of gender was that women, including themselves, were not treated differently in their postsecondary programs or in their co-op work term placements. Many of the women stated that in their particular program (e. g., biology, computer science, prepharmacy, technology), women represent at least approximately half of the students in their classes. Students in a technology program indicated that the 1997/98 postsecondary year was the first time that the number of females exceeded the number of males in the program. A particularly interesting comment was made by Christy, an engineering student who expressed resentment at being singled out as a female student:

> *Even if there was just one [female in engineering], it wouldn't make a difference, because you're not treated differently. And this whole entire idea [research on women in science] really bothers me. I hate being singled out because I'm a girl, and say, 'Oh, you're special because you're here'. Because I don't feel special. I feel, anybody could come and do this, too. And it really bothers me when people put the emphasis on, 'Oh, there's girls here'. This is so weird ..... This is what we want to do. We picked this not because we're a girl and we want to show everybody up. This is what we want to do.*

Other participants saw their gender as being either an advantage, and many more saw their gender as being a distinct disadvantage, particularly in future employment opportunities.

Advantages of being Female in Science

A few participants indicated that they believed that their gender has been, and/or will be, distinctly advantageous in their career development. They feel they have a good chance at attaining scholarships and jobs with programs like affirmative action and employment equity. Corrie, a prepharmacy student, said that ".. being a minority and also being a woman, it's a good choice going into science, because I think a lot of employers are looking for women in sciences, especially minorities..."

While some women had emphasized the lack of role that gender played in their career decision-making, others felt that a perceived lack of women in their field encouraged them to pursue such a career. Linda, an engineering student, explains her motivations to pursue the field:

> *I have a goddaughter, and she's a little wee baby right now, but when she gets older, I want her to look up to me and consider doing this field as well, because I think one of the main reasons for taking engineering as well, yes, there are not a lot of females in engineering and also, I thought at the beginning it would be quite interesting to become a female prof, because there are not very many in engineering, and it would be very interesting to teach here. It would be nice to lure in more females to come into the study, but it's hard to -- when they see the math, they say, that's not what I want to do.*

Linda hopes that her participation in a non-traditional field will be encouraging to other young women who may be considering following in her footsteps.

Disadvantages of being Female in Science

Participants were quite vocal at identifying the difficulties they had experienced as a female studying in the sciences. Issues that were discussed included gender discrimination in the work force (both experienced and perceived for the future), sex role socialization (including beliefs of both sexes that women aren't as capable in the sciences as men), and "masculinization" and overcompensation of female students and professors to achieve acceptance and success among their male peers.

Most women who commented on their perception of gender discrimination in the work force indicated that they have not observed problems with gender discrimination in their programs of study. Many of these women, however, expressed that they have experienced or anticipate experiencing some form of "sexism", "sexist people" and discrimination in hiring practices. There is evidence that their concerns about encountering sex discrimination when applying for jobs are valid, as one researcher found women to have higher unemployment rates at all levels of employment in science and engineering (Vetter, 1996). Some of the students in the technology field indicated that while in their program, it was much more difficult for women to find jobs, whereas men had no problems finding employment, despite there being less males in the program. These students also were quite vocal about how they have experienced being "passed over" for positions because of the physical work involved, and the underlying assumption that women wouldn't be able to do as good a job as men with physical work. Tamara, a technology student, said that

> *... one of the companies last year, they were asking some of the female interviewees what they could lift, like canisters and that kind of thing -- John* got that job -- and one of the things he'd have to do every day, is basically, he'd have to take a gas cylinder and lift it up two steps, because there was this little two-step thing to get the canisters down and back up, and they gave him the job because they didn't think women could lift them...(*name changed)*

Because of this sexist attitude demonstrated by such companies, the women stated that in some cases, they weren't even considered for an interview. Another technology student, Tatiana, alluded to an "big boy's club" as being present in many companies ,"because whether you like it or not, men always want to hang out with, hire, work with other men...".

Some women expressed their concerns of being discriminated against because of their (current or future) marital status, as they believe that women who may become pregnant and require maternity leave will not be considered for positions. This echoes the research finding that there is a sexist perception in industry that women are not 'permanent' employees (e. g., Vetter, 1996). Celine, a forestry student, commented:

> *One of the things that worries me is that when you go in to get a job, they're going to look at you and say, 'Mid-20s, married, she's going to have kids pretty soon', and that might stand in the way of you being hired over a man. I don't know if that's true, but that's one thing I worry about.*

Taylor, a technology student, shared the advice that she has received about the reality of hiring practices, and how to approach a job interview:

> *I was told black and white, when an industry hires you, they make an investment in you. And it's a dollar value, say, $100,000 per employee. Now when they hire a woman, she's going to get married. Like, I'm engaged, but if I have an interview -- I was told, you never say that... Tell them you're never having kids... Because the reality is, this guy was saying from the company, is if they're going to invest $100,000 in you and you're going to get married in a year, and have kids, they just lost $100,000. If they hire a guy, he might be there for a long time. He might be a lifer.*

Interestingly, some of the women who already have had their children believe that they are in an advantageous position, as they've "done the marriage thing, so maybe we're leaning more toward the male thing, the $100,000 investment", as commented on by a technology student.

Other women shared expectations of encountering sexual harassment which, to their surprise, were unfounded. Candace, an engineering student, stated that "...I had a teacher call me and warn me about not wearing anything tight, or anything like that that accentuated the difference between boys and girls...". Despite this warning, she indicated that she had no difficulties with male students.

A belief that engineering and the sciences were a "guy thing" was evident in the women's perceptions and experiences, and also in comments made to them by males and influential people (e.g., high school teachers), as both males and females, young and old, have been steadily exposed to society's biased expectation that science is a male domain (e. g., Vetter, 1996). These beliefs likely were introduced in grade school, and carried with them into their academics. A biology student named Laura shared her experience:

> *When I'm talking to the people in engineering, I always get the feeling that it's mostly men...or maybe it's just me.... I think, I probably couldn't do that. It seems like it's more of a guy thing almost, which is pretty sexist. I'm limiting*

myself just by saying it. But last year, every engineer I met was a guy. I was like, 'I'm glad I'm not in there.' But now, I'm getting to know more people. First of all, there's a lot more engineering things than I thought. It's not just engineering: there's electrical, and chemical. I wasn't very knowledgeable about the whole subject...

The idea of technology as being a male-dominated field, with males having grown up learning the skills required, was expressed by Tara, a woman studying in the field:

As far as I understand it, chem tech is still a male-dominated field out there... There's also the handyman thing, too, I think. Because most men have tinkered all their lives -- you know, they're raised differently than we are -- they're kind of mechanical. Not that we're not, but they're expected to be, and we're expected not to be...It's the perception that men are better, at tinkering, better at the math...

As a result, many of the women revealed self-discriminating beliefs, such as science-related careers being "for smart people", a category in which Stella, a computer science student, did not place herself. A math professor warned her that "as long as computer science maintains that "macho attitude", there is never going to be an equal number of women as there are men..." A biology student, Sara, shared her experience as a woman that "...you're meant to be less assertive and less intelligent and you don't put forth your ideas as much". Some women mentioned behaving in conjunction with their self-discriminating beliefs, and express not trusting themselves or other females as much as they would other males in a lab setting. A biochemistry student named Lynette described an example of an experience in which she was faced with sexism by males in the lab. This experience also helped remind her of her own internalized sexism:

I think some guys have a preconceived notion that we're not quite as good. I remember my first physics lab this year. I was with these two guys. I basically took over the computer, and they were like, 'wow, some woman knows how to use the computer'. I did all the computer work. The next week -- we take turns on who's going to do the prep work for the next week -- so the next week was my turn, and they both showed up, having done all the prep work, because

> *they did not trust me, that I would have done it. I showed them everything, and they were really impressed. And they've trusted me ever since. Personally, I discriminate against women, too. If I have a female lab partner, I will trust her less than if I had a male partner in math or science. But once they've proven to me that they're good, then...*

This perception that males were more trustworthy than females was shared by other participants, including Sara, who said that ".. I find the guys -- I trust their judgment a little more, because -- I don't know why, but I do."

Many women described situations of female students and/or professors who took on traditionally "male" traits in order to become accepted in their male-dominated fields of study. For some of the women, this meant putting in an extra effort to prove to both themselves and to others that they were capable students. Leanne, a biochemistry student, described female students in calculus classes as 'going out on a limb', using all the resources they can (e. g., workshops, study groups, help from the professor) that males don't typically bother with, to achieve good grades. Sara expressed her lack of confidence in some of her classes and how she "makes up" for it:

> *I know I'm very doubtful of what I know. I know that if I think I know something, I know it inside out, because otherwise, I'm wary of whether or not I'm ready for a test, or whether or not I understand. And guys don't seem to be the same way. They seem to be very confident, very strong in themselves, and they don't seem to need the social interaction that girls do...*

She also discussed how she has tried to become 'one of the boys' by "overcompensating" and being more "outspoken", "rude" and "forward" when she is around male classmates, "in order to feel more comfortable, and in order to be a part of it". She later said that while she likes the attention she receives, she feels guilty when she acts like this, and feels that she is alienating others (particularly other women).

Participants have indicated that the pressures of being in a male-dominated field have also impacted on the female faculty in the sciences.

Tatiana described the situation with female faculty in her technology program:

> *..it seems to be that the females [female professors] have really bad attitudes... bad attitudes... It's not only to the females, they do it to the men, too. They seem to have a chip on their shoulder, basically. If you want information from them, you have to pry it out of them. It's like a big game to them, it feels to me. And the more they can intimidate you and make you feel bad, the better they seem to feel... ...Sometimes, to the men it's even worse with them. I've seen them belittle them to the point where they actually want to cry... It almost seems they've got that attitude because they want the respect, but you're never going to get the respect if you've got the attitude, especially for female students, because another female is going to look at you and say, 'I don't want to be like you!'.*

Sara had a similar experience, indicating that

> *...the female professors here, especially -- there's not very many -- many of them seem like they have something to prove. Their exams seem harder than the male professors' exams. They seem like they have to prove that they are wonderful scientists, which they are. Many of them seem a little unsure of themselves...*

These examples seem to suggest that female professors take on 'male' traits (e. g., toughness, intimidation) to gain the respect that their male peers receive. This fits with previous findings that indicated that females in male-dominated workplaces must "prove themselves" by overexerting themselves and emulating traditional male "toughness" to fit into the male environment (Frehill, 1997). According to the participants, this strategy backfires, with the students having less respect for professors with "bad attitudes".

Gender discrimination in science has on occasion gone beyond the role of a deterrent to women and 'rears its ugly head' in a potentially dangerous fashion. Although only one student shared a story in which she felt personally threatened by a male student, it is a striking example of what some women may encounter in some male-dominated fields.

Stella shared an experience she had while working on a computer science assignment in a lab on campus:

> *In my first year, when I took Computer Science in the summer, I was staying working until 2:00 in the morning, and finished my stuff, getting ready to go, and some guy said, 'Hey, are you done?' I said yeah. He said, 'Give me your code.' I said, 'No, I'm not going to give you my code. I'm going home. That's cheating.' He said 'Give me your code.' He was very threatening. Some other guy said, 'Hey, buddy, leave her alone. Take a pill.' And I just took off. After that, I bought my own computer and I never go to a lab. So I suppose that is something that is a major deterrent for women working in computer science, is the fact that you have to spend long hours in the lab with geeks.*

7. Creating a Successful Student Environment

An important learning experience through the course of their science or science-related program was that it is essential to create a successful student environment which fosters academic excellence. Some students discussed the importance of living arrangements as being a major contributor to creating a good learning environment. Other subthemes in this area included spouses and relatives; financing their studies; personal development; and balancing family and educational responsibilities.

Changing Living Arrangements

Some participants indicated that they changed their living arrangements during their first two years of postsecondary schooling to create a better learning environment. Some indicated that moving out of residence after a year allowed them more time to study, while others explained that they moved into residence to cut down on commuting time and increase the availability of study time. Others stressed that it was important to live away from the college campus, because the students in their program were good friends, making it difficult to get work done.

For some students, the social contact of living in residence eased the transition into university. Carrie, a biochemistry student, said that residence "was good for first year because I met so many people. It's a nice sort of transition, rather than being by yourself, because there's a lot of other first-years there and you can cry together about your exams...".

For some students, being independent of a partner or family helped reduce their stress and increase their ability to pursue their own goals. Lucia commented on her recent broken engagement and how she really appreciates the space she has from her ex-fiancé and her family.

> *I'm on my own. I just got out of a broken engagement so it's really helping not having someone else depending on me. I like living alone. It gives me the space to actually study out loud in my apartment. I haven't been able to do that since high school when I lived with my parents. My parents live in Fort McMurray, so their being far away really helps. Just having the space really helps.*

Loretta favoured moving away from home as a way to alleviate the burden of the expectations her Asian family puts upon her:

> *I think moving here was better for me than worse. I'm the oldest at home, the only female, and in an oriental family, there are a lot of expectations on my part. I'm expected to do a lot of things around the house and financially, if I'm able to. I found that staying at home was a great burden. I had my brothers who haven't quite finished high school, and they're in their late teens, early twenties. They're not young. I'm the only one who's continued on. I don't get along with my father very well. I can't stay at home, because although I get along with my mom, I feel that I have to help her [play the role]. What she can't do, I have to. I mentioned a family business. She works very hard at it. She spends over 10 hours a day, 7 days a week. She's always on her feet. Staying at home, I feel really tied down. If I stayed at school to study, I'd feel maybe I should be at home. So being here is better, although I have the guilt that they feel I'm abandoning them. But I figure if I can't help myself, I can't help you in 10 years. For me, leaving home was probably a good thing... I don't know if it's courage. It's being called stuck in a place that you don't like very much, and thinking to yourself that you can't live like that for the rest of your life, so you have to change something. I don't know if I can, but I'd like to try.*

Support System

Many participants described the importance of having a support system to help them get through their respective postsecondary programs. Important supports included friends outside of science; spouses; and the support of peers in their program. Leslie explained how her friends outside of science have helped her to put her biochemistry coursework in perspective:

> *...[In first year university] I think I forgot how important it is to just take a step back and spend time with my friends...I thought it would be taking time away from my studies and that wouldn't be any good, but it's actually the opposite. When I take a break, I feel better when I go to study. And you need that support. None of my friends are in science; they're all in arts programs.*

Lisanne returned to university to obtain a second degree after a few years in the workforce. She is married and discussed how her husband's support was essential to her success as a student.

> *This has been a huge, huge adjustment, but I have a lot of support from my husband. I couldn't have done it without his support. Financially, it's not so big an issue for us; it's time. I don't have to do... not just the crappy things like do the housework and clean the toilets; we don't have as much fun time and recreation time, and that's been the biggest stress. I say financially, it wasn't a big strain, but of course it did change things quite a bit, cutting your income in half, really. It starts to show.*

Trina, a participant studying in a technology program, stressed the importance of the support that students within her program provide to each other, as they "pretty much have to...we have no choice. It's such a demanding program that sometimes, where you're skimming, somebody might know it better, so you *have* to rely on other people." A student in another technology program appreciated how the program facilitated the establishment of a support network: "...you go to classes with people you knew from your first year and everybody knows everybody else, and it makes it so much easier as far as ... And it helps that we're not a very big group, either, 'cause *our* class, especially, is really tight with each other. We're willing to help each other out, and that helps a lot."

Financial Issues

Having access to financial resources was seen as an integral part of a successful student environment. Participants talked freely and candidly about the financial difficulties they face as a student. The majority of students indicated that they required financial assistance to finance their education. Many required student loans to finance their studies, and had stories to share about the difficulties they have had with the loan system. Some were being financially supported by parents, some had scholarship money to help pay for school expenses, while others financed their studies with summer and/or part-time jobs. Often, a combination of sources of funding were necessary to continue their studies.

Participants who held summer jobs to help pay for tuition indicated that it was very difficult to find a job that made enough to cover tuition costs, let alone other expenses related to their education. These jobs were often not career-related, and participants were not able to utilize the skills they were learning in their degree or diploma programs.

> *...You definitely have to get a job this summer that pays a lot, and that's one major thing: you just can't have a $5 job...$5 an hour job. That doesn't help at all ...That's all I can find... That's where I'm going to be... It isn't fair.*
> (Nicole, chemistry)

> *I hated my job! ... The pharmacist at the drugstore used to let me watch her and help with stuff, but for $5.25 an hour, for 20 hours a week, it was just not worth it at all. I want to do more than just punch numbers into a till. I can handle more than that.*
> (Noreen, biology)

Student loans were held by many of the participants, and many participants indicated that they encountered difficulties with obtaining them, or in working within the regulations surrounding the student loans. Many students expressed a great deal of frustration stemming from their personal experiences with getting a student loan.

> *I have all my own loans...Student loans...I got refused. I wanted to come into NAIT right out of high school. It's been 3 years. But they refused me student loans for 2 years because I had not been out of home for 2 years, and they expected my parents to pay. Isn't that stupid? ... You're 18, you live at home, it's your education, but because you live at home with your mom and dad, they're supposed to pay ... I'm looking forward to when my kids are 18 [sarcasm]. ... When I applied after the 3 years when I wasn't at home, they said, 'Well, you've been working for 3 years. You should have this much money saved'.*
>
> (Tatiana, technology student)

> *It [student loan system] sucks, because -- the government makes it really hard. They want you to go to school, but then they expect you to live off nothing, and it's hard, 'cause just the way they have things set up to apply. For myself, what they did is they don't take into consideration -- during the summer -- they say, 'Okay, how much did you make during the summer?' They don't take into consideration your living expenses, so then they expect you should have saved every little penny that you make during the summer. They deduct that from what they give you, so it's like -- it's kind of twisted.*
>
> (unidentifiable technology student)

When participants did get their student loan money, many found that the amount provided to them was unrealistically and insultingly low, "demeaning", and barely enough to live on. Tasmin, a technology student, explained how she eventually had to live with six males in order to live within the means provided to her by Canada Student Loan:

> *...But there's no option. I was living on my own, but I was paying -- the smallest -- like a had a little tiny -- one -- bedroom/living room/kitchen, and I was paying $325 a month when I was working. They told me, when I applied for the student loan, they said, "No. Unless you find somewhere cheaper to live..." And that's a reality. I gotta have somewhere to live! The food is down*

the line, unfortunately. I lived on microwave popcorn and licorice for a very long time. That's reality. It's 2 years, and you hope that you'll get a good job. The good thing is, I'm not going to have a big debt at the end of the year.

Because of the difficulties surrounding combining part-time job income and student loan expectations, one student decided that it would be easier to not work than to risk having her earnings held against her:

I never tried...I didn't try... My thing was, I didn't want to make too much money, because I wanted to get a good student loan for this year so I wouldn't have to worry about money this year. I'd rather worry about it during the summer than during the year when I have a whole bunch of other things to worry about...

(unidentified voice of technology student)

In summary, participants' financial situation had a major influence on students' ability to persevere in their studies. Many participants indicated that they were having financial difficulties, and many relied on student loans as their full-time summer jobs (and for some, an additional part-time job during the academic year) did not provide them with enough money to cover their tuition and living expenses for the year. Most participants who financed their education with government student loans indicated that the amount of money allotted to them was unrealistically low. Participants with financial difficulties were coping with these stresses on top of their school-related stress.

Personal Resources

Some participants mentioned their personal resources as being important to their persistence in pursuing a career in science. Self-motivation, persistence, self-trust and intuition were themes in some of the women's experiences. Several women discussed that it was important to them to persevere and finish what they started:

I chose engineering first [before psychology], but while I was in engineering, I was thinking still about psychology. But I thought, I started this and I *should finish it, and I'll finish what I have... and if I still don't like it, I'll come back. Education never stops.*

(Linda, engineering)

Leanne [biochemistry]: I know some people get their undergrad degree in science or whatever, and then they totally switch into business, or something. I don't think I'll ever do that. I also want to get my undergrad degree, because if I didn't get into medicine or something, or if I didn't even want to do that, I'd want to do research work one day.
Facilitator: By getting a degree, you're still keeping the doors open?
Leanne: Yeah. I'd like to get 4 years and get my little piece of paper.

Participants also remarked on how their intuition has developed over the course of their studies and how they have learned more about themselves. Consequently, they have commented that they have come to trust their feelings more. This kind of personal agency was seen as being central to their persistence in science programs.

When you find out what you want to do, you'll know it. For me, this year has been a big turning point, and I want to be in forestry. I'm very excited about it. I can't wait to work. It's just sort of dawned on me. I think that if you don't get that kind of excitement, you're in the wrong place. It's very exciting when you know what you want to do, and you can see that your work is for something. I think when you figure it out, you'll recognize it.

(Celine, forestry)

I think that knowledge is good, and somehow -- and I don't know how it happens, but somehow -- things just spread, and you know about jobs, and you know about requirements, you know when you need to talk to your advisor, you know when to register. You just know.

(Sabine, biology)

One participant described how her pro-active approach to career planning has been useful. At her university, she has noticed that not a lot of guidance is provided to students in planning out their coursework. The unidentifiable student said:

I really looked into what I needed to take and what classes I needed before I could go on to other classes, but a lot of people aren't like that, and you're pretty much on your own. If you screw up, you have to go talk to a counsellor, and it's not easy getting it figured out again. I'm glad I'm that way. It's just kind of natural.

Balancing Family & School

Although most of the participants described themselves as being single and without children, there were a few women who indicated that they were in a committed relationship, a few women who indicated that they had children, and some who were in a committed relationship and had children. They described their family situation as having largely impacted the choices they have made about starting a postsecondary program, or returning to school to study for another degree or diploma. A major factor for some women was the timing of when to have a family. Researchers have found that due to messages regarding the hard work required and lack of female role models, women who anticipate having a family find it a challenge to make a science career compatible with family life (e. g., Astin & Sax, 1996). Christy described how she went about deciding to pursue her forestry diploma in spite of family considerations:

I had chosen to go into forestry before I left high school, which is quite some time ago. At that point in time, I also wanted to have a family. We felt that we would have the family first, and when my youngest hit elementary school, then I could pursue an education. We were seeing in other people's situations, that you get your degree, and then you pay forever to pay back student loans, and then you try and start a family, and then once you have that family, you either have to choose to leave your children or wait until you're older, and then you have to upgrade to go back to work. So I thought, well, we'll just do this the other way around. We'll start the family, we'll get them older, and then I'll go back. So, it's my turn, and I get to go.

Christy has reflected on the effectiveness of her decision, and has noticed the pros and cons to raising a family before pursuing a postsecondary education.

> *There are pros and cons. There are some really good aspects of doing it that way, and there's other things that are more difficult. The difficult part is that at my stage in life, I see other friends, people that I know, who are going through a second education, or they're upgrading, or they're changing careers, or that kind of thing, and I'm just starting. I'm in square one. So that's difficult. On the other hand, my kids are grown, and okay, so there's both sides to that, so I guess it depends really where you are at this point.*

Lisanne, 31, explained that her decision to go back to school has put a strain on her family plans and her financial situation. She discussed how it feels like she's going through another stage of life and how it's a constant readjustment.

> *They [financial resources] change every day, every time I get a new bill, they change. The living arrangements, too... like I said earlier, the biggest strain for me is coming back. It's almost like I'm a kid again, going through another stage of life. For my husband, that's pretty hard, because you're at a different stage of life. We just built our house, and we're thinking about having a family, and things like that, so... my plans changed. It's a constant readjustment.*

8. Looking Back, Looking Ahead

One of the questions asked of the focus group participants was, "Would you recommend your program of study to other young women? Why or why not?". Participants' responses to this question clustered into three areas: a discussion of the reasons why they would recommend or not recommend their program to other women; advice for prospective students; and suggestions for change, which are directed at educational policy makers.

Reasons for Recommending/Not Recommending Their Program

The overwhelming majority of women said that yes, they would recommend their program to other women who may be considering a career in science. Their reasons included: there were not enough women in science; there are many career options in science; that science is interesting, challenging and rewarding; that there is always more to learn; that "you get to do what you're actually learning in class".

Some participants, particularly those in technology programs, were hesitant to recommend their area of study to other women. They stressed that any prospective student would have to be ready to make the heavy-duty time commitment that it would require. When a technology student was asked if she would recommend her program to other women, her response was "...depends on how much of their life they feel like giving up." Other women felt that it was important that new students should have an understanding of the stress that came along with being in their program. Many women stressed that anyone considering their field would have to have the drive and discipline required for success. Another condition was that the potential students have a good support system (e. g., friends, spouses, family), as participants indicated that it would be difficult to cope alone. A final concern addressed regarding recommending their program was related to prospective students' financial expectations. Tara indicated that a prospective student cannot be motivated by money to pursue a technology program: "If you're doing it for the money, then you shouldn't be in the program at all."

Advice for Prospective Students

Many participants also had advice for young women who were considering a similar career path. This advice fell into common themes across focus groups and participants. Many participants encouraged potential science students to really consider what they were interested in pursuing, whether it was science or some other field. Lisanne, a biochemistry student returning to university in pursuit of a new career, said that

> *In my situation, I would be really reluctant to recommend anything to another student, other than that they should really consider what they want to do. I don't regret what I've done. I knew when I graduated the first time that I'd come back. I knew it because I love being in school, I love learning, I love being in that environment. But I've seen a number of people when I was working,*

and even nowadays, who are pushing themselves into a keyhole that doesn't fit, maybe for the wrong reasons. I think when you're first in university, it's so different, such a different atmosphere from either living at home or being at high school, that you have this huge array of choices just thrown at you. If you do well in your first year, you get letters from every faculty: major in chemistry, major in physics, come study with us, whatever. So what I would recommend to another young woman is to really, really question what she wants out of life. If it's arts, then go do that. If it's education, then go do that.

With the large increases in tuition over the last few years, a biology student offered a financial reason for knowing what you want to pursue, before starting. Sabine commented that

In my opinion -- decide what you're going to do, do it, and get out, because the amount of time -- like, twice the tuition in 4 years -- I don't think it pays to take less than a full course load. Decide at the beginning, do your work for 4 years, and get out ... In terms of making it, and being finished and minimizing your debt and all the rest of it -- $50,000 hanging over your head -- that's the best way to do it.

In contrast, other students believe that students entering university should be open to career options that they previously may not have considered. Lorelei, an engineering student, commented that

I would say, just try and keep an open mind. For me, I know when I graduated from high school, in terms of what I could have done, I could have done anything. I could have taken a Philosophy degree, an Engineering degree. I just decided to keep as many options open as I can. I like what I'm doing, but I would like taking an English degree just as much.

A prevalent theme of advice among the participants was to be knowledgeable about what you are interested in and the kind of job you are looking for, as well as about the field in which you are contemplating study. Some participants have said that they didn't know what they were doing in their first year of university. Laura discussed how she was also in this position, and that it would have been helpful to have taken a year off to do more research before entering her biology program at university:

> *I wish I had done more research on the whole career thing before I went off into university. I kind of jumped in. A lot of people said, 'Don't take a year off', because you won't go back to school, so you'd better just go. I almost think I would have preferred it, because....like, I'm taking some first year courses this year because I didn't know to take them last year. I didn't do much research on that. I guess I could have. I don't blame anybody for that.. But maybe if there was more emphasis on it...*

Some students stressed the importance of talking to people in the program in order to get the "truth" about the program and what to expect as a student. Tatiana emphasized how helpful and important it would be for a prospective student to come into her chemical technology lab and get different students' perspectives on being in the program:

> *Definitely talk to people who have been in that program and get the truth. We had buddy students come into our classes, and the instructors tell them what it's all about, but they need to choose four people at random in the lab, and come and sit and talk to them, and tell them the truth. I mean, you could be in a bad mood, and that could scare people off, but they need to know the reality ... They have to know that they have to have finances, that they cannot work a part-time job, and that's reality.*

Carolyn, a general sciences student, recommended that if possible, students should take the opportunity to see what professionals actually do in their job. She said that in her high school, she had the opportunity to job shadow and/or get work experience in different science fields, and that more opportunities like this should be available to students before having to choose a major.

> *Carolyn: I'd recommend science to other women. I'd maybe mention that they should try to get more experience in science and see what they'd like doing more.*
> *Facilitator: Before they enter first year of a general science degree?*
> *Carolyn: At our high school, we could take a work experience wherever you wanted, and you could job shadow, and look at different sciences: pharmacy, medical laboratory science...*

A participant from a technology program mentioned that finances are important to consider, and whether or not you will be able to afford studying in your program of choice. Some programs are extremely demanding and allow little time for having even a part-time job. Tasmin stressed the importance of budgeting for students and becoming disciplined with money, given the limited funding provided by a student loan:

> *I think you have to learn how to budget. It comes with the territory. I live on a student loan, too. My apartment is really close, I walk to school, even though I have a car. The car stays parked. I only use it when I want to go home to see my family. You just have to become disciplined...Everything just has to be in balance ...your money, your social life...*

Other students emphasized the importance of researching science fields in terms of their employability. Kristi, a microbiology student, said:

> *I've been encouraging all the teenage girls I know to just go into sciences -- hard core sciences. Forget about the math. Either take the hard-core engineering programs, or dive yourself into chemistries, because that's where you're going to get a job.*

The importance of time management and organizational skills was a prevalent theme among participants. Many of them felt that students have to discover the importance of these skills for themselves, in spite of being told by professors. Participants also conveyed that as important it is to have discipline and work hard in your studies, it is equally as important to attain balance in life by having some recreational time. The importance of a healthy lifestyle in minimizing school-related stress was emphasized by many of the participants. Liz offered this advice: "Don't drive yourself nuts. You can't be too focused, or else you'll just drive yourself up the wall. I know that much". Other students in her focus group echoed this, and stressed the importance of activities outside of school. Some emphasized the importance of having the support of family while pursuing a heavy program. Corrina, a prepharmacy student, recommended her field to other women "..if you've got a good base of support. It's usually a heavy program. My course load's really heavy. My parents support my family. Or it couldn't be done."

Opinions among the participants differed as to the advice they would make to other students regarding their living arrangements. Most students felt strongly that if financially possible, it is preferable to live by yourself rather than with roommates, because differing lifestyles may conflict and cause difficulties that may impact on your studies. Lauren, a neuroscience student, offered a differing opinion as she felt that living with family was beneficial for her and may also be for others. As a forestry student, Celine indicated that the fieldwork kept her in the bush and away from her husband for months at a time. She stressed that students realize the difficult change in lifestyle required for a student considering forestry as a career choice.

> *Celine: It [forestry]'s not for everyone, that's for sure.*
> *Facilitator: What would I have to like, Celine, if I was going into your field?*
> *Celine: I wouldn't say the outdoors, because I hate the outdoors, and believe it or not, I hate bugs - I freak out. If you would have known me before I took forestry, you would have never thought I would take it. You have to want to challenge yourself, basically. Last summer, I saw my husband maybe a week out of four months. I was in the bush for four months. So that's not one of the benefits of forestry. You don't necessarily have to work in that field, but when you're working your way up, you have to work your way up through that. So you're not home very often, and it's hard work. No one can understand unless you do it. It's extremely hard work.*

Suggestions for Change

Participants' experiences in their science, engineering, and technology programs have led them to think of suggestions for improving the experience of other women studying in their area. One main theme that emerged across focus groups was that high school guidance counselling was inadequate, and that there was a need for better career guidance and preparation for postsecondary study. This was also a prominent finding in the literature review (e. g., Tomini & Page, 1992).

Many participants described themselves as having started university or college with a lack of direction that they felt could have been avoided by better high school career counselling.

> *In my situation, I guess it would be more at the high school level. If there had been more career planning, then I wouldn't be in the situation I'm in now. I would have had more of an idea of where I want to be. And I think I would be in the right faculty. I don't know if I'm even in the right faculty. For me, it's more at high school. If I had more direction, I probably would have more commitment to my studies. I'd probably study more and and make more time for it. Right now, it's just, whatever. I do the best in the courses I'm in, but I think to myself, 'Am I ever going to use this course? Am I just taking it and that's going to be the end of it?'*
>
> (Liz, physics)

> *I think in high schools, there needs to be more counselling on what courses you should take. I know with engineering, it's kind of straightforward your first year. But if you're a first year science student, you're like, okay, what do I do with this?*
>
> (Bev, neuroscience)

One participant brought up the issue of accessing decent academic advising once at university. Sabine indicated that her small university requires more specialized academic advising..."not someone who's trying to pretend to fill all these different shoes".

Others offered more specific interventions that would help their career decision-making process. They suggest that students should have the opportunity to observe professionals working and doing their day-to-day responsibilities, and to be able to ask them directly about their work and what they like or dislike about it.

> *Opportunities to shadow somebody in a career in some science fields, and to be able to see what they do, and how they do it, and why they do it, and if they like it -- and just talk to career people.*
>
> (Carmel, general science)

One participant indicated that she was given the opportunity to shadow someone in pharmacy, her area of interest, but she felt that it would be beneficial to expose students to diverse areas in science. Others, like herself, might have been swayed towards considering other options in science if they had been given the exposure:

> *But I still wouldn't have minded some in other careers in science also, because it was just pharmacy that they [industry role models] like. There's only a few of them and maybe pharmacy was one of the sciences, but I wouldn't have minded being able to shadow some other people who had other aspects in science, too. Maybe that would have influenced my decision, too.*
> (Corrie, prepharmacy)

For many of the participants, the transition from high school to first year of their respective programs was a difficult period of adjustment. Many suggestions were offered regarding ways in which postsecondary institutions could help ease the difficult transition from high school that many students encounter. Sara, a fourth year biology student, offered many from her own experience of having a hard time adjusting to college and then university. She felt it was important that postsecondary institutions make an effort at making their students comfortable and to feel like they were important. She described a mentorship program that takes place at her university that was instrumental in providing a support network which included a professor and several students.

> *Make your students feel comfortable. It's a new environment, it's a scary environment, you don't know anybody, you're away from home, you've lost the security of mom and dad, the real world's expensive, it's hell. When I came here my first year, they put us [1st and 2nd year students] in a mentor group with a professor. There were about 20 of us, but by the end of the year, there were only 6 who stuck it out, and you know, every once in a while, the professor would phone and say, 'Let's go to a movie.'. And he'd take us out and we'd all go to a movie and coffee and he'd have us over to his house for supper, and it was fabulous, because I knew a professor. He wasn't a professor in my area. I got to meet those 6 people, I got to know them very well. We're*

> *not in classes together, but I see them in the hall, and I know I had somebody who I had their phone number, I had somebody who I could go to his office, and he also had a Masters student, a fourth-year student with him, so you had somebody who had experience, who could answer your questions, you had a professor who kind of knew the system, who you could go to and ask. He wasn't your professor. He was a peer, he was a mentor, he was somebody you could talk to. Anyhow, these other students, they were in the same boat as you, away from home, and I found that was so wonderful. I loved that. I found that was a great thing all schools should do.*

For Sara, part of making students feel more comfortable in their first year includes having the most approachable professors teach first-year courses. She also feels that it would be nice to be surrounded by more females in science classes to increase women's sense of belonging in the program.

> *...have your most outspoken, most friendly, most approachable teachers out there ...Those are the kind of people that you need to put forth, and not the kind who are a little leery, and you go, 'I don't know if he really cares. I don't know if I want to talk to him.' So those are the kind of people that you need to put forth. And maybe even having more girls in the first year would make girls see that, 'Hey, we can do this'. Because I know that here we have very few.*

She also indicated that the first year of science programs should have more flexibility in terms of what courses you can take, and that hands-on courses should be included to generate interest in students.

> *I think definitely putting forth the "you pick", you have your year, because that's what you leave high school thinking you're going to get to do. And make it very hands on and very experimental. Maybe we don't know all the things behind it, but let's get in the lab right away.*

Some students saw a need to overhaul their programs, as their programs were not meeting their needs and/or were considered out of date. Students at a technical institute were quite vocal about the ineffectiveness of the current structure of the program. Tara talked about how her technology program has not changed in three decades and that it needs to change with the times and with the needs of the workforce.

> *This program really needs to be overhauled. Unfortunately, the program's been in place since the '60's. 'This is the way we've always done it'. Time to change! By the time I've finished this program, I will be writing a letter and submitting it to the Dean right down through -- my viewpoints, and some suggestions on what can be changed.*

A classmate and fellow focus group participant added that the program would be more manageable and more effective as a 3-year program rather than a 2-year program.

> *It would make a lot more sense to make it a full-time 3-year program. Then you could actually learn all the things you're supposed to learn, instead of just cramming it into your head and praying you remember enough when you need to.*

Additionally, some participants complained of the competitive nature of their programs and wished for a reduction of this influence on their education. Some of the students with this complaint suggested that the pre-med students in their program were "upping the ante" and were resented for creating a highly competitive environment. One participant suggested that science programs should separate the students who want to be scientists from the pre-med students.

Many participants had suggestions for increasing the effectiveness of professors' approach to instruction. Lynette noticed that in her first year of her program leading to her biochemistry major, professors assumed that students were familiar with certain resources, such as the Internet, that are commonly used by university students. She felt it would be helpful if professors would be more hands-on by helping their students learn how to use important postsecondary resources.

> *My first term was really hectic during my first year, and it probably would have been better knowing the resources available. Some of the teachers were like, 'Well, such and such is on the website.' I've never used a website before. I*

don't have a computer that's hooked up to the Internet at home; I just have a little laptop with a word processor and a spreadsheet. Maybe they should - at orienteering - they should show how to use certain resources.

Similarly, Leslie indicated that the quality of teaching is an issue at her university with some professors. She indicated that there needed to be more emphasis on professors' teaching capabilities rather than focusing just on their capacity to be a productive researcher.

Maybe if they [professors] learned better how to teach. It's their job. It's cool that they're doing all this research -- it's important -- but if they had more access to learning how to teach or conduct a class or something. On the opposite end, there were some professors and T.A.s that were just amazing and they'd...you'd study Saturday night. I find that the more interactive the teachers are, the more caring they are towards how well you're doing or how well you understand, the more I'm ready to learn.

In addition to the quality of the teaching having an impact on creating a good learning environment, students also felt that their physical surroundings were very influential. Some participants from a large university offered suggestions as to how to improve their physical learning environment.

Maybe in terms of classroom, the environments are kind of dismal. One of the wings is so cramped, and the writing desks aren't very good. You walk down the hallways, it looks like you're in a prison....the morale thing.

(Leanne, biochemistry)

I have to come quite a distance to come to school, and if I have a big break between my labs and classes, I haven't been able to find a quiet place to study on campus. And I get so pissed off going to the library. It's louder there than anywhere else on campus. I just can't find a place where I can access the resources I need, like the books that are only in the library, and that is quiet enough that I can get some studying in. The campus just seems to be really crowded and people seem to be really immature and selfish, and that just pisses me off.

(Lisanne, biochemistry)

Financial issues were of great significance to participants' ability to persist in their science, engineering, or technology programs. Most participants described themselves as relying on student loans to support them through their program, and in many cases indicated that their loans were not sufficient to cover even their basic expenses. Few students were fortunate enough to receive any amount of scholarship funding, and in most cases students were given a large scholarship in their first year, with little or no funding offered in subsequent years of study. Laura, a biology student, called for better and more consistent funding. She suggested that scholarship money be evenly divided across the years of a students' program to alleviate the financial burden throughout the program.

> *I think it might almost be better if the government or whoever is giving these scholarships, if they divide it up for you. When I was first in the city, I was, like 'Yes, I can afford that; I've got a scholarship...also, being 18, I don't know much about responsibility and all that stuff, so maybe if there was more...not restrictions, but control. Like, if the people giving the scholarships had more control over the money...because if it's all in the first year, you can get that first year over with and then you don't have anything left.*

In conclusion, the women who participated in this study encountered influences on their career decision-making that fell under various themes. Based on their experience, participants had many points of advice for other women who were considering pursuing a career in science. Additionally, they offered suggestions for improvement of their programs to make them more appealing to other women in science. In the next chapter, the findings from the focus groups are discussed.

Chapter V: Discussion

The overall research objective of this study was to explore the experiences of women studying in undergraduate science, engineering, and technology programs, with the intention of learning more about women's career development in these areas. In this chapter, a discussion of the research findings is undertaken, including a review of the implications of the findings for career development theory, education, and counselling. The boundaries and limitations of the study are discussed, and directions for further research are explored.

The data analyzed for this study represented not only the words, phrases, and segments of experiences of women studying in science, but also their many positive and negative experiences, hopes, fears, and visions into the future. Some of the findings reinforce the experiences of women that have been previously documented in the literature, while other findings have proposed themes that represent new contributions to our understanding of undergraduate women's experience in science programs. These findings are discussed in relationship to the three initial research questions:

1. What encourages the entry and persistence of women in undergraduate science, engineering, and technology programs?
2. What prevents highly capable women from completing their undergraduate science, engineering, and technology programs?
3. What implications are there for women's career development theory, for vocational guidance, and for decision makers in education and government policy?

Factors Encouraging the Entry and Persistence of Women in Science

Participants described many helpful aspects of their experience that contributed to their persistence in their science program. Several women indicated that they developed time management skills early on in their program which have positively impacted their academic performance. The development of academic coping skills, including the establishment of peer support networks and working groups was considered fundamental to their academic success. Many women indicated that their decision to major in a science field was based on their academic interests and/or strengths in high school and early postsecondary study.

Many non-academic aspects of creating a successful student environment contributed to participants' career decision-making process. Several students altered their living arrangements, either moving into a residence hall or moving into an apartment to create a better learning environment. Having a personal support network consisting of family, spouses and friends both in and outside of their program was important in coping with the stresses of their academic demands, and supports the findings of previous studies (e. g., Berkowitz, 1993). Some of the women had committed relationships and/or children and have indicated that their family situation has largely impacted on the choices they have made about starting a postsecondary program. Participants' own personal resources, including their sense of motivation and self-trust, were seen as important in their persistence of pursuing their postsecondary studies.

Influential individuals in educational and personal networks were prominent in women's decisions to pursue a career in science. Among educational influences at the high school level, teachers and guidance counsellors were described as having the most influence on students to pursue or avoid further study in science, in accordance with previous research (e. g., Morse, 1995; Betz, 1997). Participants indicated that they sought and found approachable, encouraging, knowledgeable, and caring teachers. At the postsecondary level, professors/instructors were seen as very influential, and individuals appreciated professors who again were approachable, helpful, encouraging, and interesting. This was especially true among rural students who are used to one-on-one attention from instructors and feeling connected with them.

Personal influences were also influential in participants' consideration of career choices. Family members were most important, especially parents, on their decision to pursue a science field (see Altman, 1997). Parents were described as encouraging, but some parents insisted that their daughter pursue a certain field that they had chosen for her. Siblings, peers, and community all were influential to a lesser degree.

The significance of gender in the pursuit of a science degree or diploma was varied. Some participants felt that their gender wasn't an issue in their education and current/future employment outlook. Some noticed a difference and felt that as a woman in science, they had an advantage when it came to scholarships and employment opportunities.

Obstacles for Women in Science

Women emphasized the significance of negative experiences in their undergraduate science program and how they have affected their attitudes and their subsequent decisions about pursuing a career in science. Many discussed experiences of what they found to be a difficult transition from high school to postsecondary study, and felt intimidated by the much larger campus and classrooms they expected to encounter. Several students, particularly those from smaller communities, indicated that they chose to attend a smaller and perceivedly friendlier post-secondary institution to ease them into a large 'big-city' university. These women described themselves as happy with their decision and encouraged other women to attend smaller postsecondary institutions prior to attending a large university.

Not surprisingly, participants often spoke of being challenged with a much heavier workload when comparing their postsecondary studies to their high school experience. Many also noticed a subsequent drop in their academic performance. Their response to these lower grades varied greatly: some students chose to switch majors; some switched academic institutions; and others learned to adjust their expectations and to take a more proactive approach by seeking the assistance they needed from professors and instructors. Difficulties in course scheduling, availability of prerequisite courses, and problems with the transferability of courses were seen as potential obstacles for completing an undergraduate education in science. These experiences are not believed to be specific to female undergraduate students and have not been presented as such in the literature. Some individuals expressed their disapproval of the competitive nature of their programs and indicated a desire for more fostering of cooperative relationships with other students, as was previously found in the literature on women in science (Astin & Sax, 1996).

The manner in which individuals were able to pay (or not pay) for their tuition and other educational costs also had a large impact on the quality of their student life and their career development. Few students had scholarships, and many of those who did indicated that they had held small entrance scholarships in only their first year of study. Some subsidized their tuition and other educational costs with the assistance of their parents, or with part-time jobs if they had time to work after studying. Many required student loans to pay for tuition and were barely scraping by to cover their living expenses. Financial difficulties appeared to be an additional source of stress for many participants who were already stressed with their academic requirements.

For these reasons, participants expressed that it was very important that their education be directly relevant to the world of work. Many of them unfortunately did not see the relevance of much of their coursework, and have noticed a large gap between what they are taught in their program and what they were expected to know once they become employed. Women asserted that it was important for them not only to learn relevant work skills in their postsecondary education, but also to be successful in finding a job soon after graduation. This appears to parallel the universal concern of students across gender and field of study.

Many individuals expressed their concern regarding the guidance counselling they received in high school. Guidance counsellors were able to give practical advice about program requirements and timetable planning, but offered little career guidance and often encouraged students towards particular career choices. In many cases, the participants did not agree on the career chosen for them by the guidance counsellor, and some found that their guidance counsellor actually discouraged them from pursuing the science field they chose to pursue. They expressed concerns about the guidance counselling provided to them and to other students, particularly women interested in science.

Some women indicated that their professors were an encouraging influence in their decision to pursue science. Others described professors who did not value teaching as much as their research. According to many individuals, this impacted on the quality of their teaching and on the interest taken in individual students, which supported previous findings (Morse, 1995). Participants also described instructors who patronized students. These individuals expressed their dislike of being treated as if they were unknowledgeable. Such features were noted as being obstacles to encouraging entry and retention of more women in science.

A few individuals indicated that their gender wasn't an issue in their education and employment outlook. Many others, however, indicated that they have experienced gender-related difficulties, including gender discrimination, socialization that women are scientifically less capable than men, and the experience of trying to fit in to a male-dominated field. Some found that gender discrimination was not present in their postsecondary program, yet alive and thriving in the labour force, as observed from their experience with summer and co-op employment. Participants experienced internalized sex-role stereotyping, as some discussed their beliefs that science was a "guy thing" and that male lab partners are more knowledgeable than females. They also discussed how gender issues affect women in academia and how they try and take on undesirable "male" traits (e. g., appearing tough and intimidating) and take on more work to prove they are equal to their male counterparts. Participants shared the view that they did not favour this approach to their education, and indicated that they would like to see changes in industry and academia towards the role of women in science.

Implications for Career Development Theory

The findings of this study illuminated additional information about the experience of women in undergraduate programs in science, engineering, and technology programs relevant to understanding the career development of women in science. Socioeconomic status was shown to be very important to women's career development in science. Participants reported having held few scholarships, many of which expired after their first year of postsecondary study. As a consequence, they experienced difficulties in covering mounting tuition costs and living expenses that had previously been paid for, in part or in full, through entrance scholarships. Lack of funding was seen by many participants as a potential obstacle to their retention of a postsecondary program. In examining an individual's career development, it is important to consider socioeconomic status as a variable that can deter potential successful scientists from entering or completing a degree or diploma. Super (1990) stressed the importance of the socioeconomic environment (i. e., one's community, school, family, peers, and the state of the economy/labour market) on career development. Krumboltz (1979) also discussed the impact of environmental conditions and events beyond our control, including the availability, affordability, and salience of higher education; and occupational conditions, such as the number and nature of job opportunities. Findings in the present study highlighted the relevance of factors such as steadily increasing tuition and an unstable labour market on women's career development in science.

This study also demonstrated the nature of Super's (1990) career identity development. Most of the participants in this study were in the *exploration stage*, between the ages of 15 and 25. Many of the participants explained that they did not appreciate being forced into making career choices that they were not ready to make, which concurs with Super's assertion that adolescents and young adults are not often ready to make definite career changes until their mid-twenties.

Krumboltz (1979) indicated that individuals develop more from their learning experiences than anything else. Participants discussed having used their learning experience in combination with their previous abilities to make observations about themselves and their environment. For example, some individuals indicated that they were not good enough at certain activities. Such self-observations can be unfairly biased against one's self and may become perpetuated into their self-schema and incorporated in their career decisions. This appears to have been the case with the participants who indicated that males do not trust them in the labs and that subsequently they do not trust themselves or other females. The women who participated in this study encouraged a greater presence for women faculty in non-traditional fields, which supports Bandura's (1977; 1986) theory of self-efficacy. The greater the exposure to women in nontraditional fields, the greater self-efficacy experienced by women, and the greater the likelihood that they may choose a nontraditional career for themselves.

As has been discussed previously in career development theory, family plays a large role in women's career decision-making. While few participants described struggles as a mother attending university or college, many women anticipated having to balance a nontraditional career with a family life in the future. It is important to be aware of potential career obstacles (i. e., stereotypes that science is not a 'female thing') that may develop early in life and limit one's aspirations, according to Gottfredson (1981).

A relevant issue for women's career development in nontraditional fields is the issue of the role of academics and how they impact on women's choice of and persistence in science. Several themes in the data analysis are related to academic factors (i. e., Transition from High School; Educational Influences; Academic Issues; Coursework Management; Creating a Successful Student Environment), and it is important to gain a better understanding of this aspect of women's career development.

Implications for Education

The findings of this research have numerous implications at all levels of the educational continuum. During elementary school, girls should be given opportunities to learn about a wide range of career opportunities, including careers in science and engineering, through exposure to good female role models, both in the classroom and in textbooks (Blaisdell, 1995). To create a lasting interest in science and math, we need to have more scientists working in the educational system to show teachers how to make science and math exciting (Eccles, 1997). In her research on middle schools, Eccles found that hands-on instruction and the opportunity to work on real problems rather than made-up problems were helpful in encouraging girls' development in these areas. They must come to view math and science as tools to be used interdisciplinarily to recognize the relevance of having this knowledge and why it is important to take these courses in high school.

In the current study, the researcher also found that high school and postsecondary students value hands-on approaches to learning math and science. Many participants described themselves as having wanted more hands-on experience than they were provided with in high school or in their current undergraduate program. Opportunities for job shadowing and interviewing professionals in the field are other means of gaining practical and tangible information about a career choice. They can provide students with a more accurate perspective on the day-to-day responsibilities of the professional and may confirm or disconfirm the students' interest in that particular career field.

The results of the present study indicate that there is more work to be done towards improving teacher education to reflect gender sensitivity and a 'female-friendly' approach to education. It is crucial that these teachers and professors maintain an 'approachable' stance so that students may feel comfortable in asking for the one-on-one assistance that many participants have indicated was a helpful part of their experience. Other aspects of creating a female-friendly educational environment include minimizing the often competitive climate in science undergraduate programs. Participants indicated that they desired less grading on a curve, and more cooperation and teamwork among students which could be fostered by the use of active learning methods in the classroom, such as discussions and group work (Astin & Sax, 1996; Eccles, 1997). Finally, changing science and engineering fields to accommodate more life roles (e. g., family) through greater flexibility of course offerings and timetable scheduling would help eliminate some obstacles for women (Blaisdell, 1995).

The transition between high school and postsecondary education has been a particularly difficult process for many first-year postsecondary students. Several measures can be taken to alleviate the stress of going through such a major transition. Firstly, to ease the career planning needs of high school students, guidance counsellors need to provide information regarding the process of applying to and registering in postsecondary programs. Secondly, the creation of a support network such as a mentorship program for new postsecondary students is an excellent way to make the students feel comfortable and for them to create a social network. This would seem especially helpful for students who are away from their family and other support systems in their community. A third way of easing the transition into postsecondary studies from an academic standpoint is to increase the promotion of developing study skills, including time management skills. Students can be encouraged to take advantage of the academic support services that are usually offered through their student services.

Many suggestions were offered regarding the structure of the undergraduate programs. Measures need to be taken by postsecondary institutions, from small colleges to large universities, to collaborate in discussion regarding the nature of the relationship between the college and university programs. The current lack of continuity and transferability creates problems in the transition process that could be reduced through a closer connection and partnership between a university-transfer college program and a university. Changes may also be helpful in reducing the intensity of some undergraduate programs. Some programs are condensed into intense two-year full-time programs. Participants indicated that such programs are extremely intense and that there is no way that they can expect to do very well due to the sheer volume of material they are expected to know for their exams. Some indicated that stretching their program from two years to three would be helpful in reducing their stress levels, and may open these programs up to more women for whom the fast and intense pace of the program was previously prohibitive, particularly those with families. However, many students indicated that lengthening their undergraduate program may not be financially possible in their circumstances.

Changes need to be made in addressing the difficult financial situation of many Canadian undergraduate students. Many students did not receive any funding for their postsecondary studies, and most students who have received scholarships found that they were lured into their program with a lucrative entrance scholarship but received no funding in subsequent years. Many students had government student loans and often encountered difficulties with the regulations, if they were able to obtain one at all. The allocation of scholarship funding needs to be evaluated. An equal division of scholarship funding across every year of a student's undergraduate program may be considered to alleviate students' educational costs throughout their program.

Implications for Counselling

Closely associated with the implications for women's education in science and engineering are the implications for counselling that arose from this study. Students' interactions with guidance counsellors and academic advisors had a major impact on their attitudes toward science. In many cases, the guidance counselling received was described as inadequate or inappropriately biased towards or away from certain career choices, including science fields.

Guidance counsellors may benefit from an increased occupational knowledge base and a greater knowledge of career development theory, such as that of Super (1990). According to Super, high school and undergraduate education usually takes place during the exploration stage of career development. During this period of time, the student is learning more about their abilities and interests and exploring diverse occupational options. Guidance counsellors may then wish to encourage students to explore various careers rather than attempt to narrow them down into a single career choice. Academic advising was mentioned as problematic in scenarios where the same advisors tried to advise students in every faculty on campus. Academic advisors who can specialize in certain faculties may be more knowledgeable and helpful to students seeking specific questions regarding their program.

Directions for Further Research

The present study has revealed many factors important to women's career decision-making in science that had not previously been discussed in the literature (e. g., the transition from high school to postsecondary studies). These new insights on women's undergraduate experience in science and engineering reinforce other researchers' calls for more qualitative research into the nature of women's experiences in science courses and majors (Astin & Sax, 1996). I concur with Astin and Sax (1996) in that there is a need for specific questions to be addressed in future research with undergraduate women in science, and these are outlined below.

One area of inquiry identified is the further investigation of the role of student-faculty interaction and how it impacts on students' educational development. A second area of interest for future research is an examination of students' financial circumstances and their effects on academic success. For many students, men and women, financial constraints are becoming more of an obstacle to students' academic surviving and thriving. With more and more students needing to find at least a part-time job to supplement their educational and living costs, Astin & Sax (1996) indicated that there is a need to examine how working while in university, career-related or not, affects academic success. There also is a need to take a closer examination of the experience of women of different socioeconomic circumstances, particularly those who rely on government student loans to pay for their undergraduate education - how is their experience different than other students who are not in debt? The present funding situation for many students is inadequate and perhaps a closer look needs to be taken at the means of deciding the sizes of loans for individual students. Another area for future research is that of cross-cultural issues and their affect on women's decisions to pursue science and engineering.

The current study utilized focus groups for collecting data on the career decision-making of undergraduate women in science. Future research may benefit from the use of in-depth, phenomenological individual interviews with a small number of participants in order to gain greater insight on the experience of being an undergraduate woman studying in science. This different qualitative approach may reveal different aspects of their experience which might not be discussed in a focus group setting.

While insight has been gained into the career decision-making of undergraduate women in science, there is more work to be done towards understanding the complexities of how to encourage more women to choose and remain in a science career. Science, engineering, and technology are rewarding and challenging areas of study, and women are still underrepresented in many majors and in the corresponding high-demand, high-pay occupations. In order for research and practice in these fields to be fully informed and progress to their full potential, it is necessary for women to become more involved in science in education and industry. A larger presence of talented women in these areas is needed as we enter into a new millennium, and I hope that further research propels us towards greater understanding and consequently greater presence of women in science.

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Appendix A

THE INFLUENCE OF YOUNG WOMEN'S EXPERIENCES ON CAREER DECISION MAKING IN SCIENCE: WHAT ARE THE POLICY IMPLICATIONS?

Researchers at the University of Alberta are working with WISEST (Women in Scholarship, Engineering, Science and technology) and the Alberta Women's Science Network to complete this three-year SSHRC funded project. Members of the research team will be conducting focus groups with women in science/science related programs on this campus on ________ and are inviting women to participate (particularly those near the end of their degree/diploma).

Each focus group will have approximately 6 to 8 participants and take 45-60 minutes. You will be invited to comment on the experiences that you have had in your chosen field, your expectations, goals, and current situation. Facilitators are particularly interested in what has helped your progress and what has made it difficult. Feel free to bring your lunch in - refreshments will also be provided.

Participants will be selected from this sign-up sheet. We will try to reach you to confirm your attendance, but if you do not hear from us please still come! If you are interested please fill in the information below and return these sheets to the instructor in this class. Thank you! Your participation is very much appreciated.

NAME	PROGRAM	MAJOR AREA	PHONE NUMBER	12:15 or 1:40
eg. Jane Doe	B.Sc.	Chemistry	555-5555	12:15
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Appendix B

Focus Group Protocol

The following is a guide for facilitators when conducting the science career focus groups for young women scientists at 5 Alberta universities, colleges, technical institutes. Facilitators may vary the order and wording according to the needs of the group. It is important to maintain a relaxed, conversational tone throughout the 45-60 minute discussion.

Introduction

We are conducting focus groups with young women science, engineering, and technology students at five Alberta universities, colleges, and technical institutes. You are the _______ group that has met with us. I am ________ and this is _______, and together we would like to explore with you the experiences that you have had in your chosen field, your expectations, goals, and current situation. We are particularly interested in what has helped your progress and what has made it difficult.

Purpose

Through sharing your experience with us, you will be helping us to track the career development, as they are experiencing it, of young women who hope one day to be members of the science and engineering professions.

Recording Sessions

Explain the need to tape the session, transcripts, confidentiality and obtain signed consent forms and demographic information sheets (names should not be signed).

Participant introductions

Have each participant introduce themselves using their first name and state in which area they are studying.

Focus Group Process

Stress the following: 1) everyone's experiences are important, 2) there are no good or bad opinions, 3) we expect that opinions and experiences will differ, 4) we are interested in hearing and understanding each person's perspective, 5) we would like to know of any ideas that people have that might have improved things or made it easier for them to reach their career goals.

Appendix C

Cues and Prompts

A) Relay Experiences

We would like to hear about your educational experience in science, engineering, or technology.

* Are you a full-time student? What is a typical day? Do you have a part-time job? If so, is it career-related?
* What did you do over the past summer (school break)?

B) Identify Critical Elements

* What were your expectations when you started school this year? Have you had to change them at all? In what way? How did that happen?
* Were there things that helped you this year?
  Were there things that made it difficult this year?
* What resources did you use in making a decision to pursue your current field of study? What if anything has changed in your study plans?
* What role, if any, did your high school guidance counselor play in your career decision-making? University academic advisor?
* What role did important people (e.g., family, friends, instructors, mentors) play in choosing your current field of study and career path?
* What has it been like being a woman in the field you have chosen?
* Would you recommend your current field of study to other young women students? Why? Why not? What do you wish you had known before you got here?

C) Strategies and Outcomes

* What plans did you have to put in place so that you could study here this year? [Living arrangements, financial support]
* How have those plans worked out for you? Have you changed them at all? If so, how?

D) Suggestions for Change

* Can you suggest things that would have improved your situation?
* How do you think that these can be implemented so that other students can benefit?

Appendix D

Agreement to Participate (Focus Groups)

THE INFLUENCE OF YOUNG WOMEN'S EXPERIENCES ON CAREER DECISION MAKING IN SCIENCE: WHAT ARE THE POLICY IMPLICATIONS?

Alberta Women's Science Network (AWSN) through it's member organization WISEST is joining researchers at the University of Alberta to complete this three year project. The study is supported by a SSHRC Strategic Research Grant under the "Women and Change" program and AWSN.

We are conducting focus groups with young women science, engineering, and technology students at five Alberta universities, colleges, and technical institutes and would like to invite you to participate in one of those groups. Through discussion in this group we wish to explore with you the experiences that you have had in your chosen field, your expectations, goals, and current situation. We are particularly interested in what has helped your progress and what has made it difficult.

We anticipate that the group will be between 45-60 minutes in length. The entire proceedings will be recorded on audio tape and the contents later transcribed, tapes will then be erased. You will be asked to introduce yourself to the group using only your first name and your area of study.

The information you provide will be kept strictly confidential. You will not be identified, nor will your university or college in any of the reports of the study results. You may withdraw from the study at any time, without consequences. You are asked to sign this consent form and return it to the facilitator in your focus group.

I ______________________ agree to participate in this focus group using
(print full name)
the process described above.

Signature of study participant ______________________
Date ____________1998

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