AN EVALUATION OF THE WOMEN IN SCIENCE AND ENGINEERING SUMMER EMPLOYMENT PROGRAM

KAREN MARGARET ANTHONY SHEPPARD

AN EVALUATION OF THE WOMEN IN SCIENCE AND ENGINEERING SUMMER EMPLOYMENT PROGRAM

BY

KAREN MARGARET ANTHONY SHEPPARD

A thesis submitted to the School of Graduate Studies in partial fulfillment of the requirements for the Degree of Master of Education

Faculty of Education
Memorial University of Newfoundland
St. John's, Newfoundland
September 17, 1998

Abstract

There are many factors influencing the career choices of young women. At present the combination of personal and societal issues leads both men and women into largely gender-stereotypical occupations. The WISE Summer Employment Program is one initiative designed to encourage girls to consider careers in the fields of science and engineering. Those accepted to the Program are offered positions as research assistants to work side by side with scientists and engineers for eight weeks at Memorial University of Newfoundland. Positive results from a formal evaluation could be beneficial to the WISE Program in determining the strengths of the Program and finding reliable sources of future funding.

Since the Women In Science and Engineering Student Employment Program is designed to encourage young women to consider careers in science, engineering and related disciplines, the research questions to be addressed by this project were as follows:

(1) to determine whether the program affected the career choices of young women,

(2) to determine whether the program influenced the students' selection of courses in high school, and

(3) to determine whether there had been a change in students' attitudes regarding careers in science, engineering and related fields and various issues related to the subject of women in science.

The method of research planned for this study involved the interpretation of data obtained from questionnaires. In order to assess the short-term effects of the WISE Program a questionnaire was administered in person to all participants of the 1997 WISE Program on the first day of the program. A post-WISE questionnaire of the same format was administered on the final day of the program to assess any changes in educational and career plans, as well as the development of enhanced, positive attitudes towards careers in science. The same questionnaire was administered to a comparison group of girls chosen by the program coordinator as alternates for the WISE Program. These students are selected each year to replace anyone who declines the offer of a WISE position and, as such, are very similar in terms of the characteristics that the program looks for in its research assistants.

The long-term effects of the program were evaluated by administering a questionnaire to students of the 1994 WISE Program. This probed the educational and career choices followed by these young women and looked for the presence of continued positive attitudes toward careers in science, engineering and related areas.

The results of the analysis revealed the many strengths and positive attitudes of the young women who participated in the WISE Summer Employment Program in 1997 and 1994. The experiences and information gained from the Program appear to have given some of the participants more to consider as they attempt to choose a future career.

All groups involved in this study showed very positive attitudes towards careers in science and engineering. Several of these attitudes were significantly

enhanced after participation in the WISE Program, suggesting the value of the Program to the young women of our province.

Acknowledgements

Many thanks go to my supervisor, Dr. Glenn Clark, for his continuous suggestions and guidance and to Gerry White who was instrumental in the analysis of the data.

Thanks also to my family who always provide tremendous support, help and encouragement.

Finally, thanks to the coordinators of the WISE Program whose support and cooperation made this study possible.

Table of Contents

List of Tables

Chapter 1

Introduction to the Problem

In an era of high technology fuelled and driven by science, our nation is necessarily science dependent. The subsequent demand for scientists and engineers is high and can only be expected to grow. We can little afford the loss of talented young women from the sciences, yet the trend of women's under-representation in science and engineering continues. While today's young women aspire to successful career and lifestyle choices, they continue to need support and encouragement as they make one of the most important decisions of their lives - the choice of career. We must ensure that science and engineering is seen as a viable option for all of our young people and support must be provided to enable them to persist along their chosen career paths.

A Cappella is a study completed by the Canadian Teachers' Federation that reported on the lives of adolescent women in Canada. In discussion groups it became clear that teenage girls, who are in transition from childhood to adulthood, must make a significant number of important decisions about their future during their high school years (Canadian Teachers' Federation, 1990, p.12) not the least of which is the choice of a career. Careers ranked 5th out of 34 concerns listed in the participant questionnaire. This research suggests that girls are fully aware of the need to be goal-directed and economically self-sufficient, and that there is now a need to move on to the stage of helping them attain these goals (Canadian Teachers' Federation, 1990, p.20).

Meeting career goals is inextricably tied to educational attainment. There have been substantial increases in the educational attainment of women during the last two decades when the proportion of women aged 15 and over with a university degree rose

from 3% to 10%. This, however, is still lower than that of the male population., although the gap is likely to close further in the future since women currently make up the majority (52%) of full-time students in Canadian universities (Statistics Canada, 1995, p.54).

While women make up the majority of full-time students in most university faculties, women still account for much smaller shares of enrolment in mathematics and science faculties. In 1992-93, only 28% of all university students in mathematics and physical sciences were women (Statistics Canada, 1995, p.54). The proportion of engineering and applied science students has increased but is still just 18% of the total in these areas (Statistics Canada, 1995, p.54).

Education levels for Newfoundland women have also increased. Females consistently graduate from high school at a higher rate than males and there is little difference in achievement levels (Women's Policy Office, 1996, p.4.1). University enrolment is higher for females than males; but males are more often found in science, business, engineering and physical education, while females dominate arts, education, nursing and social work (Women's Policy Office, 1996, p.4.1).

For those young women choosing science, performance also has an influence on career choice, but perhaps not in the expected manner. Female science students perform at least as well as, if not better than, their male counterparts (Nevitte et al., 1988, p.42). The very best female students are an important resource since the will be tomorrow's scientists and will lead the way for future women in science. Data from Nevitte et al., however, show that these very talented young women are much more likely than their average peers to defect from science (Nevitte et al., 1988, p.44). The best female science

students are about five times more likely than average performers to seek nurturing careers. Academic ability alone is clearly not sufficient for propelling talented women towards science careers. Many of the most able female science students, who have overcome the many real or imagined obstacles to entering science, still do not see science careers as attractive options. Support and encouragement must continue throughout post-secondary institutions and into the workplace if these talented young women are to persevere in the sciences.

These statistics translate into similar trends for women in the labour force. Although decreasing since 1982, the majority of employed women continue to work in occupations where women have traditionally been concentrated. In 1994, 70% of all employed women were working in either teaching, nursing or health-related occupations, clerical positions or sales and service jobs. Women remain very much a minority among professionals in the natural sciences, engineering and mathematics. Just 19% of professionals in these areas in 1994 were women, a figure which has changed little since 1982 (Statistics Canada, 1995, p.67). Newfoundland women have experienced growth in participation rates in the labour force over the last two decades, but the majority of this growth has been in clerical and service industries with some increase in teaching and health as well (Women's Policy Office, 1996, p.3.2). No gains are reported for women in science, engineering and related fields.

Women in Science and Engineering (WISE) is a Canadian network of individuals working together to promote and support women in science, engineering and related careers and to act as an information resource to educators, employers and government.

The goals of WISE are

- to encourage women to seek higher education and achievement in science, engineering and related fields,
- to provide a support network for women in these fields,
- to inform Canadians about opportunities for and contributions by women in these fields, and
- to provide a unified, representative voice for members on issues relating to women in science, engineering and related fields (Women In Science and Engineering, 1994).

WISE Newfoundland and Labrador was formed in 1988 and has been very active in promoting wider curriculum and career choices for women throughout the province. The activities of WISE in this province include a Career-a-Month poster series, a WISE Choices video and teachers' guide, career talks, science fair awards and judging, provision of resources and presentations for the general public and special interest groups. Perhaps their largest undertaking, however, has been the WISE Student Summer Employment Program.

In the summer of 1990 the Newfoundland Chapter of Women In Science and Engineering designed an innovative program to address the problem of the small number of women entering the fields of science and engineering. Funded by Canada Employment's Summer Employment/Experience Development (SEED) Program, thirty-three female high school students from the Avalon Region were offered positions as

research assistants in the laboratories of various science and engineering disciplines. Tours, presentations and many group activities were planned to help make the summer a rich experience for these young women.

The program has received support from many groups and individuals. Funding comes from a variety of sources. Memorial University of Newfoundland provides administrative support since the program operates on campus each summer. University faculty, staff and graduate students are involved as supervisors for the students and in many cases have gone beyond the program's expectations in designing projects for the girls and in rehiring many of their WISE students in following summers. They have shown enormous confidence in the potential of these young women.

More than 200 young women applied for the 33 positions available in 1990 (Women In Science and Engineering, 1991, p.1) and the WISE Program has grown steadily ever since. The number of positions available fluctuates from year to year due to funding uncertainties but generally stays between 40-50 student positions. One indicator of the program's growing interest is the enormous number of student applications which has reached more than 500 in a single year from around the province. This is a clear indication of the acute need for the kind of encouragement and experience the program aims to provide.

Encouraging young women to consider and pursue careers in mathematics, science and engineering is necessary if we wish to have an equal representation of women in these fields. The WISE Program was designed in an attempt to address this need. The WISE Student Employment Program has been running for seven summers since its inception in

1990. Preliminary and informal results appear promising. Many WISE students continue to pursue science-related careers, some continue to work in the laboratories of their WISE supervisors and many receive awards and scholarships for their studies.

The WISE program clearly indicates young women's interest in science-related careers as evidenced by the large number of applicants each year. The program aims to support the growth of this interest into career goals. After seven years, however, it is time for a more formal evaluation, which may help to identify the strengths and weaknesses of the currently operating program.

Initiatives concerned with the promotion of science and related fields have become fairly common. In Newfoundland and Labrador, there are several such programs in addition to that run by WISE. The Faculty of Medicine offers one week MedQuest programs throughout the summer which aim to introduce students to careers in health and life sciences. The Newfoundland Science Center offered science camps for young children during the summer of 1995 which were enthusiastically received. The Association of Professional Engineers and Geoscientists of Newfoundland offers Future Set which involves children up to age 14 in various science and engineering projects throughout the summer.

While the WISE Summer Employment Program appears to be the only intervention program designed specifically for young women in Newfoundland, other Canadian provinces offer several initiatives aimed at girls. In British Columbia Women Do Math is a one-day conference on scientific careers held annually at Simon Fraser University. The emphasis is on mathematics as enjoyable, accessible and necessary. This

program has developed into a version called Ms Infinity which serves smaller and more isolated communities in British Columbia and the Yukon. The Society for Canadian Women In Science and Technology sponsors a series of half-day summer workshops for girls with female instructors (Ackler & Oatley, 1993, p.263). Ontario offers workshops and conferences in several parts of the province to encourage women's participation in mathematics and science. York University has set up Careerscope and Science Odyssey programs which feature speakers and visits to the campus for grade nine and ten girls. The Toronto Board of Education has a women's study coordinator and individual schools appoint a women's study representative. At Charleston Southern University the Summer Science Enrichment program offers young women a chance to learn about science and engineering and careers in related fields. The schedule balances classes, laboratories, field trips and motivational seminars by local engineers and researchers (Karges-Bone, 1992, p.11).

The under-representation of women in science and engineering is clearly seen as an important issue and one worth addressing. The efforts of programs such as the WISE Program are directed at encouraging young women to consider courses and careers in science and technology as appropriate choices. Many intervention programs designed to encourage young women to consider non-traditional careers have been tried and some have been quite successful. Yet many have been discontinued because funding did not continue after a trial period. Some sponsors like to provide seed money for an experimental project, take credit for the successes but fail to provide funding on a permanent basis. If we think that intervention programs can be discontinued because they

have done their job, we ought to consider the case of the Association to Aid Scientific Research by Women. Started in 1898, it was dissolved in 1932 because the objectives for which this association had worked were seen as being achieved, since women were given opportunities to engage in scientific research on an equality with men, and to gain recognition for their achievements (Brush, 1991, p.414).

An evaluation of the extent to which the goals of the WISE Program are being met now seems desirable. Such an evaluation can improve the program for the young women it serves and may result in a more reliable source of extended funding if it is shown to be effective in encouraging the participation of young women in science, engineering and related fields.

Chapter 2

Related Research

Ideally, the decision to pursue a career in science or engineering would be driven by interest and aptitude alone. Approximately equal numbers of men and women would train for and be employed in these disciplines. However, we do not live in such a society. Complex social factors also strongly influence career choices and these factors provide some possible explanations for women's under-representation in these fields. The image of science and scientists, as well as the competitive nature of science, combine with young women's socialization and classroom experiences to create powerful negative influences on young women studying and working in science. The seepage from science and related careers has prompted some to call for a more female-friendly science, a feminist science. Others argue that we should instead work to improve the processes and characteristics of today's science in order to make it more inclusionsary for both women and men.

The process of selecting a major is greatly influenced by matters of image (Barber, 1995, p.230). Students are guided by the image and expectations of a discipline that they have formed as outsiders. The insider's reality is often quite different. Students' experiences as insiders in science and engineering accumulate and this reality strongly affects the decision to stay or switch to a non-science major. As women move toward the world of professional science they encounter a truth very different from their expectations: that science still functions largely as a "boys only" world (Barber, 1995, p.231).

While women may have become more comfortable with the image of themselves as scientists, they have become no more comfortable with the reality of working day to day in

such disciplines. In Western culture, boys are socialized to develop the qualities valued by scientists while girls are not. Entering and adapting to the prevailing culture of science challenges the identity of women in a way not experienced by men. Faced with assimilation into such a culture, many women who had planned to work in science and engineering change their minds and instead choose a career that allows them to preserve their identity (Barber, 1995, p.232).

The ordinary processes of science often act to discourage women. The most pronounced factor is that of students' difficulty in tolerating the high degree of competitiveness. The failure of students to draw faculty into more personal pedagogical relationships is another factor contributing to the decision of many women to leave science and engineering majors. Since women are traditionally raised to work more for the approval of others than for intrinsic goals, this lack of personal attention can be extremely disorienting (Seymour, 1995, p.465).

An apparent difficulty in seeing physical attractiveness and intellectual capacity as other than mutually exclusive qualities of women in science was also observed by Seymour (1995) to be a marked feature of women's male peers. While not directly linked to decisions to switch majors, the rude behaviour, inappropriate remarks and jokes as well as apparent resentment (Morgan, 1992, p.230) of their male peers are constant sources of stress for women socialized to value attractiveness.

Another argument presented in the field is that the pattern of socialization that young women bring to science and engineering is entirely different from that of young men. Many aspects of science and engineering and their training programs force young

women into conflict with their own socialization experience (Seymour, 1995, p.463). Transforming the culture of these disciplines is seen as the key to real progress toward equity. Rather than assimilate women to existing standards, a broadening of professional norms is needed in order to narrow the gender gap that exists (Barber, 1995, p.232).

Classroom disparities in attention, feedback, praise and support for assertiveness often favour boys and are suggested as another factor influencing career choice. A common assumption about group instruction is that all students in the class are involved in the same experiences. However, analysis of the National Assessment of Educational Progress indicated that boys had far more personally involved experiences in science than girls (Otto, 1991, p.368) and girls also had fewer out of class science experiences. Differential expectations for boys and girls add to the overall effect of lowering girls' self-esteem and confidence in their mathematics and science abilities (Seymour, 1995, p.438).

Burkam, Lee and Smerdon (1997) report that gender differences in science class activities were larger than all other measures carried out in their study, except for achievement. Girls spent more time on passive activities (homework, listening, taking notes) than they spent in active classrooms involving hands-on activity such as laboratory work. Although teachers' reports of classroom activity were gender-neutral, girls still claimed to spend less time on labwork than boys. This may be due to the girls' passive involvement while the boys manipulated the apparatus, thus controlling the activity.

Results of this study provide support for the importance of hand-on labwork. Hands-on experiences where students do experiments themselves are linked with increased learning in both physical and life sciences (Burkham, Lee & Smerdon, 1997, p.320). Such

activity has particular importance for girls undertaking physical science where laboratory activity is linked to reducing the gender gap in physical science learning (Burkham et al., 1997, p.320). Along with presenting science content in relevant contexts, laboratory activities are a major part of instruction which stimulates female interest in science (Otto, 1991, p.370). If the theory that girls do not engage in informal science experiences outside of school holds true, activities such as labwork are critical for girls' understanding and appreciation of science.

Women may also differ in what they see as the primary goals of their education. Seymour (1995) claims that while many young men are willing to place career goals above personal satisfaction, young women show a greater concern for making their career goals, education and personal priorities fit together. Switching majors for the reason of greater personal satisfaction is also supported more in daughters than in sons (Seymour, 1995, p.446). It is clear how such dissatisfaction can develop in science and engineering disciplines. This provides a clue as to why so few women persist in these disciplines.

Nevitte, Gibbins and Codding (1988) suggest that the substantial seepage of women from science also contributes to the shortage of women in science professions. Results from their study of final year undergraduates in science at nine Canadian universities provide evidence of significant gender differences in the recruitment of such students to the science community. They also identified a trend showing that women are consistently more likely than men to leave science for nurturing careers (Nevitte et al., 1988, p.40).

Many factors affect young women's decisions to either persist in or defect from

science. The principal finding of Nevitte et al. is that female science undergraduates are significantly more likely than their male peers, and females in other disciplines, to have fathers in scientific and technological occupations (Nevitte, Gibbins & Codding, 1988, p.41). The influence of mothers in science careers could not be determined since too few such parents could be identified. Fathers who work in science appear to demystify science for their children, especially their daughters. Such reasoning borrows from socialization theories and suggests that family and role models are important at career decision point as well as during earlier decision points relating to course and major selection.

Although women have increased their participation in science, mathematics and technology careers in the years since educational equity legislation was passed in the United States, that participation is still well below parity (Farmer, 1995, p.155). A priority for many government agencies is to increase women's participation in these fields. A longitudinal study by Farmer, Wardrop, Anderson and Risinger (1995) aimed to identify factors related to persistence in science, mathematics and technology careers for a group of students who aspired to such careers when they were initially studied as ninth or twelfth graders in high school. A focus of the study was the identification of factors related to women's persistence in these fields. The research was guided by social cognitive theory. This theoretical model assumes that over time interacting factors in the self and in the environment influence the strength of interest in careers and the selection and persistence or nonpersistence in a science, mathematics or technology career (Farmer et al., 1995, p.155).

It was hypothesized that there would be gender differences in persistence and that

more high-middle socio-economic status students would persist in science related careers. The researchers also expected that more younger women would persist in science and that students with higher grade point averages in high school would be more likely to persist. Cognitive sets such as aspiration levels, role perceptions, self concept and mathematics and science self efficacy were also considered. Studies have shown that homemaking commitment negatively affected career commitment for high school women (Farmer et al., 1995, p.157). Farmer likewise expected to find home commitment to be lower for women who persisted in science than for those who did not.

The study also included environmental sets such as parent, school and society support as well as available financial support for college. The behaviour set included the number of elective mathematics and science courses taken in high school, since some studies have found a positive relationship between taking science and mathematics courses in high school and the choice of a science major (Farmer et al., 1995, p.158).

Contrary to expectations, however, socio-economic status did not have a significant effect on persistence for men or women. The expectation that younger women would be more likely to persist was also not supported by the data. Science GPA had a moderate effect on persistence for men but not for women (Farmer, 1995, p.163). It is interesting that these men and women had, on average, identical GPAs in science in high school but this GPA was not a critical factor for women's persistence in science as an adult.

The findings related to aspirations showed a strong relationship between aspirations and persistence for men, but this relationship was not found for women. In

fact, career commitment scores for women were negatively related to later persistence, and women who had switched from science to another career were now more career committed. For male and female participants the importance of career was greater than that which they had held in high school. For women it appears that increased career commitment is also related to a shift away from their adolescent interest in a science related career (Farmer, 1995, p.164). The negative relationship was also found between women's home commitment and career commitment as perceived life roles became more salient. Not surprisingly, men did not display a similar trend.

The most important factor upon women's persistence was found to be elective science taking in high school. This was not, however, a significant predictor for men (Farmer et al., 1995, p.165). It may be that men take these courses more routinely, whereas women take these elective courses as a result of an aspiration to a science related career. Clearly not everyone is potentially suited for a career in science, mathematics or technology. However it is reasonable to suggest that adolescents be exposed to a wide variety of courses and career fields, including the sciences, at an early age so that they can make choices consistent with their own interests, values and abilities.

Performance also has an influence on career choice, but perhaps not in the expected manner. Female science students perform at least as well as, if not better than, their male counterparts (Nevitte et al., 1988, p.42). The very best female students are an important resource since they will be tomorrow's scientists and will lead the way for future women in science. Data from Nevitte et al., however, show that these very talented young women are much more likely than their average peers to defect from

science (Nevitte et al., 1988, p.44). The best female science students are about five times more likely than average performers to seek nurturing careers. Academic ability alone is clearly not sufficient for propelling talented women towards science careers. Many of the most able female science students, who have overcome the many real or imagined obstacles to entering science, still do not see science careers as attractive options.

The fact that young women with exceptional high school mathematical and science preparation have very different career plans from similarly prepared men (Dick & Rallis, 1991, p.291) suggests the impact of socializers. In 1986, Dick and Rallis (1991) found that both men and women who choose science or engineering careers have had some specific encouragement to do so by parents or a teacher. In fact the influence of a teacher was the only significant difference between women who had chosen a science career and those who had not (Dick & Rallis, 1991, p.289). A study by Rayman and Brett supports this finding. According to their results, the odds of a female science major staying in science after graduation were 3.6 times greater if she received career advice from an advisor and 6.7 times greater if she had the parental support and encouragement of both parents (Didion, 1996, p.439). Encouragement from teachers and parents is clearly important in the choice of a career in science.

Almost all who comment on gender and mathematics, science and technology note the lack of female role models in these areas at the senior levels. To conclude that only female teachers can positively influence young women would be unfair, but female teachers can be important role models in showing their students that women can do it. Female students must then also conclude that "I can do it, too" (Canadian Teachers

Federation, 1992, p.55). Female role models are likely insufficient in overcoming all the influences against the choice of mathematics, science and technology careers. Female students, however, especially high achievers, are more likely to name teachers as playing an important role in their decision making (Canadian Teachers' Federation, 1992, p.56).

Throughout their schooling girls encounter more obstacles- some quite subtle- than do their male peers. By the time they get to university or college the cumulation of these experiences can largely influence their choice of major and career. It is proposed that women professors are especially important for women in higher education because "...identification with an authority figure of one's own gender may counteract the deleterious effects of past and present sexism" (Crosby & Reinardy, 1993, p.477). This assumes that women identify with their female professors more than they do with their male professors.

While there are anecdotal accounts of this relationship, Crosby and Reinardy (1993) present some empirical data to support their assertions. A nonverbal technique for gauging affiliations that has been used mostly for cross-cultural studies was used and most students out of the 140 females who participated in the study agreed they had little difficulty expressing how close they felt to their professors with this technique and that it diminished the tendency to give socially acceptable responses.

In analyzing their data, Crosby and Reinardy (1993) found that female college students felt closer to their female professors than to their male professors (Crosby & Reinardy, 1993, p.481). Generalizations cannot be made from this study since most participants attended a women's college and had been enrolled in a course on women's

psychology which may differentiate these women from other college women. As well, men may also feel closer to their female professors. It may be some characteristic of females that allows students to feel closer to them. Either way, female role models can have a positive impact on their students.

Rienzi, Allen, Sarmiento and McMillin (1993) obtained data from 2148 questionnaires (50.4% female) completed by university alumni in an effort to identify the nature of interactions between students and faculty. Among men, 90% reported no differential treatment, 7% reported favourable treatment from at least one source and only 2% reported negative treatment. Among women, however, 78% reported no differential treatment while 11% reported favourable and 10% reported negative treatment. The favourable treatment was most frequently from faculty in the students' majors, but faculty in their area are also the most frequent source of unfavourable treatment reported by women (Rienzi, et al., 1993, p.154).

These results may be because women are more likely to report favourable and unfavourable treatment. Men may be less sensitive to negative treatment and less likely to report it since it goes against the idea of being powerful, aggressive and independent (Rienzi et al., 1993, p.156). The data do not attempt to provide for such explanations but they do demonstrate the need for better understanding of the role faculty plays in supporting women in the sciences.

Students reporting negative treatment by faculty also tended to rate the quality of their programs and their own satisfaction lower than other students (Rienzi et al., 1993, p.157). Since 10% of the women surveyed reported these negative experiences with no

offsetting positive treatment it is likely that these experiences are a factor in deciding to persist or not in their chosen field. Institutions need to respond and work with faculty, staff and students to eliminate the occurrence of such treatment and to counteract its effects.

Another factor put forward as an influence on young women's educational and career choices is the way in which textbooks have portrayed scientists and engineers. Those mentioned were largely male. In popular culture as well the scientist is often portrayed as a nerd and is understood to be male (Brush, 1991, p.406). Even popular magazines portray women scientists as atypical (Brush, 1991, p.405). It is difficult to demonstrate how the pairing of "scientist" and "man" affects young women, yet it is hard to imagine that it has no effect at all. One indirect indication is provided by a survey of 509 women asked to name the people they most admired. Only three named a scientist and these scientists were male (Brush, 1991, p.406).

There is also a growing body of evidence that women make decisions about their lives differently from men (Baker & Leary, 1995, p.4). Their decisions are based on such things as their expectations about multiple life roles, self identity and ways of interacting with people and the world. Women and young girls describe their world in terms of relationships and a need for a sense of connection with others. In Baker and Leary's (1995) study of young women, the girls liked science and planned to study more science in the future. However ,the positive statements they made about science were made because it met their need for connection and relationships and it allowed them to work with others (Baker & Leary, 1995, p.14).

These girls also gave affective and altruistic reasons for their choices in science. They stated their desire to help people, animals, plants or the earth (Baker & Leary, 1995, p.16). Judgements and decisions about science are made in this way. For example, biology is seen as helping people and this potential to be helpful draws girls to biology related careers, while physical science careers are avoided because they appear unrelated to the girls' concerns. Values such as co-operation, working with people and helping others are thought to be characteristic of women in general. The undervaluing of these concerns in science tends to turn young women away from these sciences.

Eccles (1994) has developed a theoretical framework to guide her research into women's educational and career choices. This model relates such choices to two sets of beliefs: the individual's expectations for success and the importance or value the individual places on the options perceived to be available to them. She also relates these beliefs to cultural norms, experiences and aptitudes. The model predicts that people will most likely enroll in courses that they feel they can master and that have a high task value for them. In most studies evidence supports the finding that girls and boys differ in their expectations for success at various academic subjects and careers. Females were found to be less confident of success than males in science-related professions. This difference in occupational efficacy is a significant predictor of occupational choice (Eccles, 1994, p.593). Substantial evidence of gender differences in the valuing of educational and occupational options also exists. Benbow and Stanley (cited in Eccles, 1994, p.596) found positive relations between liking biology, chemistry and physics and plans to major in one of these areas. They also found that valuing helping others was a predictor of not

aspiring to physical science related professions (Eccles, 1994, p.599). Work by Gati, Givon and Osipow (1995) also suggests the impact of the importance assigned to various work aspects. They found that income was significantly more important for men, while relationships with people were more important to women. As in Eccles' (1994) model, men valued aspects of traditional male roles while women valued aspects of careers that included the traditional female social and humanistic orientation (Gati, Givon & Osipow, 1995, p.213) and these values can lead women and men to choose very different careers. Clearly, believing one can succeed at an occupation is critical to one's decision to enter that occupation. However, this selection also depends on the value attached to characteristics of the occupation itself.

Socialization plays a role in these educational and career choices as well. First, gender role socialization leads women and men to have different personal values. It follows, then, that tasks involving various characteristics will have different value for women and men. Gender roles also suggest different primary activities for women and men. If a woman has internalized her culture's definition of the female role as that of wife and mother, she will likely rate parenting and family as more important than career roles and will be more likely to make decisions in favour of these roles. The women in Eccles' (1994) study indicated they would be more likely to make sacrifices in their professional life for the needs of the family than would men. Since providing for the family financially can be done by having a successful career, men see these roles as compatible and aspiring to a career poses less conflict for them.

Some evidence suggests that men are more likely than women to exhibit a single-minded devotion to one goal, especially an occupation. Women, in contrast, appear to value competence in several activities simultaneously (Eccles, 1994, p.601). The perceived difficulty of managing demanding professional work with home and child care responsibilities is cited as a reason for the low representation of women in science and engineering (Morgan, 1992, p.230). Many women are largely responsible for raising their children at an age when scientists are establishing their careers. The perceived conflict between traditional female roles and values and the demands of male-typed education and careers in very salient for women (Eccles, 1994, p.602). If institutions provided home making support for women, comparable to the technical and secretarial support provided to men, this conflict could be greatly reduced (Mason, 1991, p.206).

Researchers have identified many educational and social factors thought to be responsible for the discrepancy between the numbers of men and women in the sciences. While the argument that women have different cognitive abilities than men has lost support in recent years, it is generally accepted in the field that women may have a different way of learning and operating in science due to their differing roles on society. These differences have given rise to a call for a more female-friendly science, a feminist science.

One such framework for the development of a feminist science is that of feminist standpoint theory. This theory is based on the premise that the differing social experiences of men and women give them different ways of looking at life and interpreting events and thus different standpoints (Roychoudhury, Tippins and Nichols, 1995, p.898). This

different standpoint can engender a pattern of thought or understanding that is currently absent from science. Indeed, women's experiences have historically been neglected as starting points for scientific research and as generators of knowledge (Roychoudhury et al., 1995, p. 898). In supporting the need for a feminist science, Ruth Ginzberg (1987) suggests that gynocentric science has existed all along but has not been recognized because it was not called science.

Another supporter of a feminist science is Hilary Rose. Using an example of the writing of Marge Piercy she says that when writing or talking about science, feminists always return to alternative visions offering what she calls the "possibility of a new, utopian society" (Rose, 1986, p.59).

> Our technology did not develop in a straight line from yours... We have limited resources. We plan co-operatively. We can afford to waste...nothing. You might say our-you'd say religion? - ideas make us see ourselves as partners with water, air, birds, fish, trees (Rose, 1986, p.59).

Feminists do not return to these ideas by chance. Rose claims that, because scientific knowledge comes from practice within the world, a feminist view, rooted in the caring nature of much of women's work, will be qualitatively different from masculinist science (Rose, 1986, p.60). Much of women's labour has been in the home, as well as in jobs involving patience and repetitive tasks. The combination of menial labour and "people work" with children, husbands and the elderly (Rose, 1986, p.70) has involved both labour and love. Women have gained from this much experiential knowledge, knowledge gained individually from the practice of caring. This will be a characteristic of feminist science.

Feminist standpoint theorists are not surprised at the underrepresentation of women in science because the logic and processes dominated and developed by men can never be totally compatible with women's standpoints and so there is a need to include women's views and ways of knowing in science. It may be that the inherent masculinity of science is the prime reason girls avoid science (Roychoudhury et al., 1995, p.899). Men comprise the majority of science teachers, students and scientists, applications used in teaching are often masculine in nature and male dominance in the classroom is often the norm.

Although philosophers and sociologists have questioned the objective, unemotional and value-free view of science, this view dominates academia (Roychoudhury et al., 1995, p.899). Feeling a personal bonding with the subject is unacceptable in science. In a study by Wolffensperger (1993), female university students reported that science and distance were expected to accompany each other. One young woman wrote, ...the teacher's criticism was that I hadn't distanced myself enough from the topic; it was not scientific (Wolffensperger, 1993, p.43). The work of Barbara McClintock, Rachel Carson and Anna Brito was often seen as "odd" or "incomprehensible" (Ginzberg, 1987, p.70). Carson, who introduced ecology to Americans, urged people to try to learn to live with insects rather than try to control nature with pesticides. McClintock dealt with her subjects very personally and with much care, treating them as individuals. She said,

> ...when I was really working with them, I wasn't outside, I was down there. I was part of the system. I was right down there with them, and everything got big. I was even able to see the internal parts of chromosomes - actually everything was there. It surprised me because I actually felt

> as if I were right down there and these were my friends (Martin, 1988, p.129).

Brito says of her studies that,

> ...you must identify with what you're doing. You must totally identify. If you really want to understand about a tumour, you've got to be a tumour...you fall in love with a thing (Martin, p.130).

It is likely that women would feel like outsiders when their emotional and connected ways of knowing are not sanctioned or are marginalized. Scientific endeavours, therefore, need to be based in both men's and women's experiences so that people are not forced to assume a viewpoint incompatible with their own (Roychoudhury et al., 1995, p.899). In telling students to distance themselves from their subject, it must be made clear that this means that science requires them to consider all of the relevant data before drawing conclusions.

The intimacy with which these scientists relate to their objects of inquiry is common in feminist conceptions of knowledge. It is the "oddity" of these approaches, claims Ginzberg, that should tell us that there is an alternative scientific paradigm (Ginzberg, 1987, p.70). Scientists usually deny, or at least do not acknowledge, their relationship to the objects they study in the way that McClintock does. Keller (1989) speaks of McClintock's "feeling for the organism" which McClintock openly expresses. This, some say, is characteristic of feminist science.

Objectivity can also be used to isolate the production of pure scientific knowledge from the uses of that knowledge (Fee, 1981, p.384). Thus scientists funded by the military

are free to insist that the use of their research is not their responsibility. Here objectivity is used to cover up passivity on the part of the scientists who have agreed to accept the position and laboratory freedom in return for their silence. Women, who have been traditionally viewed as passive, have special reason to question the power of others to require such silence (Fee, 1981, p.386). Feminist science would not create distinctions between the production and uses of knowledge, between thought and feeling, subject and object. It would not divorce objectivity and subjectivity but would rather try to integrate all of these aspects for a more complete understanding of our world (Fee, 1981, p.389). A feminist epistemology based on women's labour in the world must insist on the validation of subjectivity in science. It will emphasize the holism and harmony she sees in McClintock's work. This will necessarily be a distinctive feminist science.

There is, however, more to the doing of science than method alone. Style and approach are what some say distinguish women scientists and should characterize a feminist science. Feminist paradigms in many areas enable scholars to understand previous anomalies, reinterpret traditional texts and expand the canons of their fields (Hardy, 1988, p.134). The different style is not part of our present metatheories of science. Philosophers of science focus on rationality and logic, not the friendship and love characteristic of McClintock's work. The important elements are theoretical understanding, not intuition. Personal feeling and relationships are seen as impediments to objectivity, not ingredients of discovery. But science is a human activity joining thought and action, reason and emotion, subject and object, fact and value (Martin, 1988, p.133). Definitions which portray science as only the first side of these dichotomies will certainly

be inaccurate. Feminist science would supposedly address this concern. Carol Gilligan's work on moral development discovered a pattern of response. She called it a different voice, one that had been overlooked or misrepresented by the dominant theory of the field (Martin, 1988, p.130). In studying the thought and work of women scientists, both Evelyn Fox Keller and June Goodfield (Fox Keller, 1989, p.33) have uncovered attitudes, assumptions and experiences that our metatheories of science do not capture. This is what Martin calls a "different style" (Martin, p.130, 1988).

The case studies by Keller and Goodfield suggest that the intuition and love in this different style function heuristically in science in that they are prominent in the discovery of hypotheses and the decisions as to which hypotheses warrant further study. McClintock's intimate knowledge of her corn allowed her to grasp what was going on and which aspects of their behaviour needed to be researched further (Martin, p.131, 1988). Karen Messing sees some more aspects of the different approach and style. She, too, feels certain that a feminist science would ask and address different questions (Messing, p.65, 1986). Women scientists have been responsible for most of the understanding we have of the effects of the workplace on women's health, for instance.

In Wolffensperger's (1993) study, the freedom to choose what components to study as part of their degree program was a positive factor for female students. It allowed them to find relevance in the work and this renewed their motivation. One student wrote, "I recognized aspects of myself in the subjects I was studying, so that my studies became closer to me" (Wolffensperger, 1993, p.42). Science and technology need to incorporate the feminist ideas of context and connection (Messing, p.66, 1986).

Despite differences between men and women's approach to learning, many propose that we do not need to call for a totally new and separate conception of science in order to appreciate the differences between male and female scientists. An important component of many feminine critiques of science is the rejection of the idea that a single method can include all the varieties and types of knowledge and experience. Therefore, how can we justify that one distinct feminist method will account for all these varieties of knowledge and experience? Between men and women, even among these groups, there may be differences in their science; but this does not mean we need a totally different science.

Harding (1987) defines a research method as "a technique for gathering evidence" (Harding, 1987, p.21). If we look at some of the most widely accepted examples of feminist research, it becomes clear that their methods of evidence gathering are not unique. Carol Gilligan listens to what women say when presented with familiar moral dilemmas. This is one traditional method in social science. Joan Kelly-Gadol, using another traditional method, examines ancient property and marriage records to show that women did not have a renaissance, at least not during the Renaissance(Harding, 1987, p.21). Clearly some of the most influential feminist scientists have not employed a distinct feminist method, but rather have used some very traditional methods of inquiry. We can now ask, what is the point of developing a theory of distinct feminist inquiry when some of the best research will not satisfy its criteria (Harding, 1987, p.21)?

With this question in mind, it seems more sensible to try to determine what factors make these examples of feminist research distinctive. While these features may have

consequences for the choice of research methods, there is no reason to label them methods themselves. One distinguishing characteristic of feminist research is that it generates questions for exploration from the perspective of women's experiences. It is science for women, it answers their questions and allows women to have their interests addressed. Harding maintains that there is "no good reason to appropriate under the label of method every important feature of the scientific process" (Harding, 1987, p.28). How problems are selected is part of the process and does turn out to make a difference to the results of inquiry, but it is not usefully considered a distinctive research method.

Another feature of feminist research is placing the researcher in the same "critical plane" as the subject matter to be studied. Then the researcher is not an invisible, omnipotent voice of authority but rather is real and subject to scrutiny along with the subject matter and data. The desires, attitudes and interest of the observer are part of the evidence needed to evaluate results and thus should be presented with those results (Harding, 1987, p.29). Like other features of feminist inquiry, this subjectivity is not within the method category and it must not be allowed to interfere with the scientific development from ideas to observations to theory.

Finally, Harding identified another problem in the tendency of social scientists to seek a unique method as the explanation for what is unusual in feminist research or feminist science (Harding, 1987, p.25). The term method itself is vague, for how could one define a "scientific method" so that it referred to practices common in every scientific discipline. Similarly, a single feminist science cannot be expected to include all the possible practices in scientific areas.

There also seems to be agreement that feminist values should not produce a science which could be labelled as "soft" or "bad" science (Damarin, 1991, p.111). By feminist we are referring to the advocation of the granting of social, political and economic rights to women equal to those granted to men. Feminist theory attempts to describe women's oppression, to explain its causes and consequences and to attempt to achieve liberation for women (Tong, p.1, 1989). Feminist science thus emphasizes the desire for equality in the sciences as opposed to highlighting the dichotomies between men and women. It emphasizes unity instead of separation, not requiring a separate science but rather a broadening of what we already have. "The badly needed reunions of thought and action, reason and emotion, subject and object, fact and value, and the enrichment of our theories of science, these promises depend on the very expansion of the boundaries of philosophy of science..."(Martin, p.138, 1988).

The proponents of a different science needed some legitimization or better yet an exemplar. This was found when Barbara McClintock was awarded the Nobel Prize for Medicine in Physiology in 1983. At the same time, however, that some feminists were claiming McClintock as a prime example of their feminist science, mainstream scientists claimed her as one of their own, stating there is only one science. Stephen Jay Gould stated that her "feeling for the organism," a term coined by Keller, is in no way distinctive (Keller, 1987, p.37). McClintock herself is not a feminist. She has resisted all classification and remains committed to science as a place where all "matter of gender drops away" (Keller, 1987, p.37). Thus, there are problems with considering McClintock as the cornerstone of a distinct feminist science.

It seems that women scientists inside the circle of power have everything to lose by demarcation along the lines of gender. Such limits have, historically, only excluded them. It is hardly surprising that these women strongly resist the concept of a feminist science. Also, because our understanding of science and femininity are so opposed in society, it is hard to justify a satisfying definition of feminist science when these two terms have historically been constructed in opposition to each other.

The McClintock study is, however, valuable. Evelyn Fox Keller's biography of McClintock is the second part of the biographical research which goes beyond mapping the exclusion and compromise between private and public life required of women and instead explores the specific contribution of a woman scientist whose life and work have been characterized by a high degree of personal autonomy and recognition. For many women working in science it validates the possibility of difference within science as we know it. It makes room within the existing "canon" for many of the questions and interpretations that the earlier one rejected. It presents a larger, richer science rather than a different, separate one (Keller, 1987, p.41).

Regardless of the debate over the need for a feminist science, the differences between men's and women's experiences and ways of knowing indicate several implications for instruction. Science teaching usually invokes the values of patriarchal science (Damarin, 1991, p.113). For example, biology students are required to deaden their empathy as they dissect frogs; mathematics and physics students must suspend beliefs when faced with an unrealistic problem situation. Such situations can begin the initiation of some students into science, but they can also separate others, often women, from

science. A major goal of female-friendly science must be the provision of opportunities for students to connect what they learn with their real-life experiences (Roychoudhury et al., 1995, p.899). This approach can benefit both male and female students. Giving students the option to pursue their interests can make room for experiential differences. It can also provide them with a sense of ownership for their learning (Roychoudhury et al., 1995, p.917).

Another inclusionary technique suggested is the use of projects of extended length. Roychoudhury et al. (1995) found that many female students appreciated such projects. According to the students, the longer time period allowed for a cyclical process of observation and discussion which led to a better understanding of the project. Women in the field support this contention saying that the extended time for data collection fosters women's need for connection with their study (Roychoudhury et al., 1995, p.914). Added benefits appear to be that science-apprehensive students had time to feel more comfortable and successful in science and the feeling of ownership created was especially important for emale students since it legitimized their vantage point (Roychoudhury et al., 1995, p.911).

Teachers can have an even more direct influence on their students. In Wolffensperger's (1993) study, female university students described their teachers as "...unapproachable beings, as self centered personalities who work in blinkers...and are not interested in students" (Wolffensperger, 1993, p.43). This feeling was compounded by the fact that most of the academic staff they encountered were male. Clearly, more personal attention is required on the part of teachers if we are committed to increasing women's participation in science.

Wolffensperger (1993) also found that the competitive atmosphere of science and science education is disconcerting for female students. This is supported by the findings of Roychoudhury et al. (1995) whose subjects responded that working in groups was a positive experience. This female propensity for collaborative work is often mentioned by researchers studying the learning styles of women. Such co-operative pedagogic methods are suggested for female-friendly science (Roychoudhury et al., 1995, p.912).

Damarin (1991) suggests that the computer could be useful in the creation of materials for feminist instruction in science for several reasons. First of all, the use of the computer requires the instructional designer to take a fresh look at the subject matter (Damarin, 1991, p.114). By moving away from traditional modes of instruction, a designer working with feminist values could incorporate these values into the software.

The computer also allows for alternate representations of scientific truth. The interconnectedness of verbal, visual and aural information could highlight the inter-relatedness of perspectives. Hypermedia, in particular, could allow students to explore information in multiple, non-linear paths (Damarin, 1991, p.114). The computer, with its access to large databases, has the potential to include large quantities of information in instructional materials. This invites students to find and explore the experiences of women and of gender in their study of science (Damarin, 1991, p.114).

Finally, computer simulations are not destructive of the objects under study. As such, women need not suspend feelings of empathy or concern for life, nature or the environment as they study science (Damarin, 1991, p.114). Within science instruction, computers may be more flexible and less full of traditional biases than other media and

modes of instruction. Computers, in and of themselves, will not present alternative viewpoints. However, if used to create opportunities to move away from just the facts, computers may be a key to opening science to more women and to more ideas (Damarin, 1991, p.120).

An attempt to completely redefine the process of knowledge generation and activity in science would be an enormous task and one which seems to be unnecessary. Any framework labelled as feminist science faces the danger of being perceived as soft science and as such will certainly be met with disapproval by members of the scientific community and perhaps the community at large. A suggestion in 1991, by Chris Decker, health minister at the time, that midwives should be part of our health care system (Evening Telegram, 1991, p.11) met with very little support. If the public can not support such traditional women's methods in such a clearly female issue, how can we expect a feminist view of science to fare any better?

The demand for the development of a feminist science must not be interpreted or presented as a separatist goal of generating distinct versions of science, but rather it should be seen as an attempt to connect two different perspective and make science more inclusionary. The task falls to those who are within the scientific community who have the opportunity to prevent a waste of future potential.

Society pays a high price for its inadequate support of women's dual roles, as well as its failure to successfully encourage and support women in non-traditional fields such as science and engineering. At present, both men and women largely tend to go into gender-stereotypical occupations. It is the acknowledgement that such discrepancies engage

broad issues of gender equity and the potential loss of scientific talent that must drive the effort to seek explanations for the low numbers of women in the sciences and to find successful solutions.

Chapter 3

Method

There are many factors influencing the career choice of young women. At present the combination of personal and societal issues leads both men and women into largely gender-stereotypical occupations. The WISE Summer Employment Program is one initiative designed to encourage girls to consider careers in the fields of science and engineering. Those accepted to the Program are offered positions as research assistants in laboratories at Memorial University of Newfoundland. These girls work side by side with scientists and engineers for eight weeks. They are also involved in tours and outings and participate in events with guests from the scientific community. After eight summers of operation, the WISE Program could benefit from a formal evaluation. Positive results from such an evaluation could demonstrate the value of the Program and possibly lead to more reliable sources of future funding.

Since the Women In Science and Engineering Student Employment Program is designed to encourage young women to consider careers in science, engineering and related disciplines, the research questions to be addressed by this project were as follows:

(1) to determine whether the program affected the career choices of young women,

(2) to determine whether the program influenced the students' selection of courses in high school, and

(3) to determine whether there had been a change in students' attitudes regarding careers in science, engineering and related fields and various

issues related to the subject of women in science.

The method of research planned for this study involved the interpretation of data obtained from questionnaires. In order to assess the short term effects of the WISE Program a questionnaire was administered in person to all participants of the 1997 WISE Program on the first day of the program. This questionnaire gathered information about the students' science courses taken to date, planned courses for the following school year, their career plans and attitudes toward science, engineering and related careers. This initial questionnaire asked the students to provide their name, age and school grade as well as the science courses they had completed to date. They were then asked which science courses they had chosen for the 1997-1998 school year. Finally, students were asked if they had made any career plans and if so to provide details of any such future educational and career goals. Their attitudes towards science, engineering and related careers and these careers as options for women were assessed by means of a series of statements to which students were asked to indicate their agreement or disagreement. A Likert scale was devised where students were asked to indicate how strongly they agreed or disagreed with statements using a scale consisting of strongly agree, agree, disagree, strongly disagree and don't know. For the purposes of statistical calculations these statement were assigned a code from 1 – 4, one representing "strongly agree" and four representing "strongly disagree." The response of "don't know" was not included in statistical calculations A post-WISE questionnaire of the same format was administered on the final day of the program to assess any changes in future educational and career plans as well as the development of enhanced, positive attitudes about careers in science. Students were

also asked to indicate any aspects of the program that they had found to be particularly influential on their views of science as a possible career path for themselves and for women in general.

The same questionnaire was administered to a comparison group of girls chosen by the program coordinator as alternates for the WISE Program. These students are selected each year to replace anyone who declines the offer of a WISE position and, as such, are very similar in terms of the characteristics that the program looks for in its research assistants.

The long term effects of the program were evaluated by administering a questionnaire to students of the 1994 WISE Program. This probed the educational and career choices followed by these young women and looked for the presence of continued positive attitudes toward careers in science, engineering and related areas. This questionnaire asked for the students' name, age and current status with regard to what and where they were studying and/or working. They were asked to provide information on their future educational and career plans. The statements to be rated for agreement or disagreement on the Likert scale were also administered to ascertain their attitudes towards science, engineering and such careers as possibilities for themselves and women in general. They were also asked if participation in the WISE Program influenced their educational and career decisions. If so, they were asked to provide any details they could as to what they found worthwhile in the Program.

Since the questionnaires could not be administered in person to either the 1997 alternates or the 1994 participants, these groups of girls received their questionnaires in

the mail. A cover letter explained the purpose of the study and the extent of the students' involvement, stating that participation was voluntary and could be withdrawn at any time. The latter also provided information allowing the students to contact the researcher if necessary. There was also a consent form which the students signed and returned with their completed questionnaire in the accompanying stamped, return-addressed envelope.

A telephone reminder was made to girls who had not returned their questionnaires one month, and two months, after the initial mailings. Several students were sent a second questionnaire package, since they had discarded or mislaid the original copy. Sixteen of the twenty-six alternates returned completed consent forms and questionnaires, as did twelve of the twenty-six participants from 1994. In telephone conversations with some of the 1997 alternates, it was found that many thought they did not need to complete the questionnaire since they had not been involved in the WISE Program. This problem was created because they had not read the cover letter and they agreed to participate after speaking with the researcher. Other limitations are presented below.

(1) Limiting the evaluation to an examination of the extent to which objectives have been met may miss other unintended effects that could be important in the success of the WISE Program.

(2) The evaluation assumes that the goals of the WISE Program are attainable.

(3) We cannot know what educational or career goals participants of the WISE Program would have pursued had they not participated in the program. For comparison we are restricted to looking at the choices of similar non-participants.

(4) A selection bias may mean that those chosen for the WISE positions are particularly inclined to careers in science or engineering, thus creating nonequivalent groups for comparison.

Chapter 4

Data Analysis and Discussion

The first group studied in this evaluation were the participants in the 1997 Women In Science and Engineering (WISE) Summer Employment Program. Thirty-six girls were employed as part of the program during that summer and all completed a questionnaire during the first and last day of the program. Descriptive statistics were generated to provide some insight into the group under study including the science and mathematics courses they had completed and the science and mathematics courses they planned to take the following school year, as well as their future academic and career goals. Parametric statistics, including t-tests for paired samples and t-tests for independent samples, were generated to determine if the program may have been responsible for any significant changes in attitudes towards careers in science and engineering.

As can be seen from Table 1, the participants in the 1997 WISE Program had successfully completed many of the academic high school science courses, with Biology 2201, Chemistry 2202 and Physics 2204 completed by 75, 97.2 and 86.1% respectively. As well, 69.4% of these girls had completed Advanced Mathematics 1201. All of the students had been successful with the mathematics and science courses to date and the average mark of all these courses was 89%. These girls have been quite successful academically and as Table 2 shows they intended to continue with science in their final year of high school. It is apparent that, after participating in the WISE Program, there was an increase in the number of girls who reported that they planned to take science in school the following year. The largest increase is in those planning to do Physics 3204,

where the percentage rose from 69.4 to 77.8. Their WISE experience appears to have encouraged these students to continue studying science as they complete their high school program.

Table 1

Science and Mathematics Courses Completed
WISE 1997 Participants

Course	Count	Percent
Biology 2201	27	75.0
Biology 3201	13	36.1
Chemistry 2202	35	97.2
Chemistry 3202	16	44.4
Environmental Science 3205	1	2.8
General Science 1200	1	2.8
Geology 3203	1	2.8
Physics 2204	31	86.1
Physics 3204	5	13.9
Honours Physics	1	2.8
Academic Mathematics 1300	10	27.8

continued...

Course	Count	Percent
Academic Mathematics	61	16.7
Advanced Mathematics 1201	25	69.4
Advanced Mathematics 2201	31	86.1
Advanced Mathematics 3201	7	19.4
Calculus Readiness 3105	3	8.3
Statistics 3104	1	2.8

Note. N=36.

Table 2

Science Courses Chosen for the Following School Year
1997 Participants, Pre-WISE and Post-WISE

Course	% of Pre-WISE participants	% of Post-WISE participants
Biology 2201	2.8	5.6
Biology 3201	41.7	44.4
Advanced Placement Biology	0.0	2.8
Chemistry 2202	2.8	2.8
Chemistry 3202	2.8	2.8
Environmental Science 3205	44.4	44.4
General Science 1200	2.8	2.8
Geology 3203	2.8	2.8
Physics 2204	8.3	2.8
Physics 3204	69.4	77.8
Honours Physics	2.8	2.8

Note. N=36.

Table 3 indicates the occupations of the parents of the students who participated in the WISE 1997 Program. Both the mothers of this group of students and the girls

themselves reflect the statistics reported earlier. Statistics Canada reported in 1994 that 70% of all employed women were working in either teaching, health related jobs or sales and service jobs. Table 3 shows that the mothers of these girls were very typical in their career choices with 62.8% of them working in the fields just listed. It has been shown that these students are academically capable, having successfully completed many of the high school mathematics and science courses. However, their career goals, as those of their mothers, clearly indicate a preference for the health profession. As Nevitte et al. (1988) reported, the best female science students are about five times more likely than average to seek "nurturing" careers.

Table 3

Parental Occupations
WISE 1997 Participants

Occupational Classification	% of Mothers	% of Fathers
Business, Finance and Administrative Occupations	13.4	9.4
Natural and Applied Sciences and Related Occupations	0.0	6.3

Occupational Classification	% of Mothers	% of Fathers
Health Occupations	23.3	9.3
Occupations in Social Science, Education, Government Service and Religion	23.3	5.6
Sales and Service Occupations	16.5	6.2
Trades, Transport and Equipment Operators and Related Occupations	0.0	18.7
Occupations Unique to Primary Industry	3.3	9.4
Occupations Unique to Processing, Manufacturing and Utilities	0.0	6.3
Other	20.0	6.2

After graduating from high school all of these girls planned to attend a post-secondary institution, both before and after the WISE Program. Table 4 describes the post-secondary major aspired to by this group of girls both before and after the 1997

WISE Program. While there is only a small increase in the percentage of girls aspiring to the sciences and related fields (91.7% before and 91.9% after), there are some interesting results. Following the WISE Program there were girls (5.6%) who aspired to study engineering whereas none of the girls had this goal initially. There was also an increase in those who were undecided about a future course of study. This suggests that the Program motivated some students to reconsider their future aspirations in light of the experiences and information that the WISE Program had provided them.

Table 4

Intended Post-Secondary Major
1997 Participants, Pre-WISE and Post-WISE

Major	% of Pre-WISE Participants	% of Post-WISE Participants
Arts	5.6	5.6
Astronomy	0.0	2.8
Behavioural Neurology	2.8	5.6
Biology	16.7	19.4
Biochemistry	11.1	16.7
Chemistry	8.3	8.3
Criminolgy	2.8	0.0
Education	0.0	2.8
Engineering	0.0	5.6

Major	% of Pre-WISE Participants	% of Post-WISE Participants
English	2.8	5.6
French	0.0	2.8
Geology	0.0	2.8
Literature	2.8	0.0
Marine Biology	2.8	0.0
Mathematics	8.3	2.8
Medicine	8.3	2.8
Nursing	2.8	2.8
Nutrition	0.0	2.8
Physics	8.3	8.3
Physiotherapy	2.8	0.0
Psychology	5.6	2.8
Public Relations	5.6	2.8
Science	11.1	5.6
Zoology	2.8	2.8
Undecided	22.2	25

Note. Some students provided more than one response.

Table 5 reflects the changes in the students' choice of post-secondary major as

well. The increase in those aspiring to a career in natural and applied sciences can be seen more clearly in their career goals. There was also a dramatic drop in the percentage of girls aspiring to careers in health occupations, social sciences, sales and service and the arts. The increase in those who reported being undecided about their career goals suggests that participation in the WISE Program gave them more information and options to consider before making such an important decision.

Table 5

Career Goals
1997 Participants, Pre-WISE and Post-WISE

Occupational Classification	% of Pre-WISE participants	% of Post-WISE participants
Business, Finance and Administrative Occupations	5.6	2.8
Natural and Applied Sciences and Related Occupations	41.9	47.5
Health Occupations	86.4	69.6

Occupational Classification	% of Pre-WISE participants	% of Post-WISE participants
Occupations in Social Science, Education, Government Service and Religion	44.5	8.4
Occupations in Art, Culture, Recreation and Sport	19.5	0.0
Sales and Service Occupations	11.2	0.0
Other	5.6	5.6
Undecided	25	27.8

Note. Students provided more than one response.

The questionnaires completed by the girls included a selection of statements to which they were to indicate the strength of their agreement of disagreement. Before comparing the responses gathered before and after the program, several statements were paired to determine whether their attitude on one item was related to their attitude on a similar item. These statements are presented in Table 6. As the results show, the girls'

belief that it is possible to have a career in science or engineering and a family is not based on gender either before or after the Program.

The correlation between the next two statements is not as strong. Before participating in the WISE Program the girls did not associate their belief in the accessibility of science to women to the same accessibility for themselves. However, after the program the correlation between the two statements concerning this issue rose from .3443 to .5268. This suggests that the hands-on personal experience and interaction with role models, many of whom are female, had helped the girls to make the connection and see science and engineering as options for themselves.

Finally, the correlation greater than .7 on the third statement concerning the need for women to work harder than men to succeed in science and engineering suggests that the girls agree with neither of the statements on this issue. This disagreement was strengthened by their participation in the WISE Program, presumably because they did not encounter such difficulties.

Table 6

Attitudinal Correlations
1997 Participants, Pre-WISE and Post-WISE

Statement	Mean (Pre-WISE)	Correlation (Pre-WISE)	Mean (Post-WISE)	Correlation (Post-WISE)
-Women can have a career in science or engineering as well as a family.	1.4706	.6385	1.2353	.6138
-Men can have a career in science or engineering as well as a family.	1.4000		1.3429	

Statement	Mean (Pre-WISE)	Correlation (Pre-WISE)	Mean (Post-WISE)	Correlation (Post-WISE)
-Women can succeed in science and engineering.	1.0000	-	1.0000	-
-I feel confident that I can reach my career goals.	1.2571		1.2000	
-Careers in science and engineering are accessible to women.	1.3056	.3443	1.2500	.5268
-Science and engineering fields of study are accessible to me.	1.2647		1.1765	

Statement	Mean (Pre-WISE)	Correlation (Pre-WISE)	Mean (Post-WISE)	Correlation (Post-WISE)
-Female scientists and engineers must work harder than males to succeed in their field.	3.1563	.7117	3.0938	.7547
-I would have to work harder than my male peers in order to succeed in science or engineering.	3.1563		3.4063	

Note. – = Cannot be computed.

The attitudes of the WISE participants in 1997 were very positive, as can be seen in Table 7. They agreed that science and engineering are accessible and attainable career options for women and for themselves personally and they feel confident in their ability to

achieve their goals. Many responded that they have chosen a career in science or engineering. The WISE Program did, however, have some positive effects on this group of girls. Their agreement with the statement that women can have a career in science or engineering as well as a family showed a dramatic increase after their WISE experience, as shown by their responses on that item.

A significant change was seen in their responses to the statement that they would have to work harder than their male peers to succeed in science or engineering. The level of disagreement on this item increased significantly, $t(31)=-2.10$. $p<.05$. Working side by side with both male and female scientists and engineers demonstrated to these girls that they are as capable as anyone else. It is also clear that the WISE Program provides much information to the participant about careers in science and engineering. Their agreement with this statement increased significantly by the end of the Program, $t(35)=3.99$, $p<.05$. The Program also encouraged the participants to consider careers in science and engineering. The level of agreement with this statement increased significantly by the conclusion of the Program, $t(35)=3.62$, $p<.05$.

Table 7

T-tests for Paired Samples
1997 Participants, Pre-WISE and Post-WISE

Statement	Pre-WISE Mean	Post-WISE Mean	t-value	df	2-tailed Significance
Careers in science and engineering are accessible to women.	1.3056	1.2500	0.63	35	.535
Science and engineering studies are more difficult for women than for men.	3.4375	3.4688	-0.23	31	.823
There are more barriers for women pursuing science and engineering careers than there are for men in these fields.	2.5357	2.7143	-0.96	27	.345
Science and engineering fields do not welcome women.	3.4194	3.5484	-1.28	30	.211
Science and engineering are attainable options for men and women.	1.2286	1.1714	0.70	34	.487

Statement	Pre-WISE Mean	Post-WISE Mean	t-value	df	2-tailed Significance
Women can succeed in science and engineering.	1.0000	1.0000	-	-	-
Female scientists and engineers must work harder than males to succeed in their field.	3.1563	3.0938	0.42	31	.677
Women can have a career in science or engineering as well as a family.	1.4706	1.2353	1.96	33	.058
Men can have a career in science or engineering as well as a family.	1.4000	1.3429	0.47	34	.644
Science and engineering fields of study are accessible to me.	1.2647	1.1765	1.00	33	.325
I feel confident that I can reach my career goals.	1.2571	1.2000	0.81	34	.422

Statement	Pre-WISE Mean	Post-WISE Mean	t-value	df	2-tailed Significance
I would have to work harder than my male peers in order to succeed in science or engineering.	3.1563	3.4063	-2.10	31	.044*
I have considered pursuing a career in science and/or engineering.	1.2800	1.3130	-.442	31	.662
I feel confident about attending a post-secondary institution.	1.2059	1.2941	-1.00	33	.325
I have access to information about careers in science and engineering.	1.8889	1.2500	3.99	35	.000*
I feel confident about my future.	1.5294	1.3529	1.44	33	.160
I see the importance of science in everyday life.	1.3429	1.3714	-0.44	34	.661
I have chosen a career in science and/or engineering.	1.6250	1.8750	-1.81	23	.083

Statement	Pre-WISE Mean	Post-WISE Mean	t-value	df	2-tailed Significance
I have been encouraged to consider careers in science and engineering.	1.5556	1.1667	3.62	35	.001*

Note. df=degrees of freedom

- = Standard error is 0. Analysis cannot be computed.

Means calculated based the following Likert scale:

1=strongly agree, 2=agree, 3=disagree, 4-strongly disagree

*p<.05

Each year the WISE coordinators choose alternates for the WISE Program. If a selected WISE participant declines a position or has to leave the Program for some reason an alternate will be offered that available position. Since these girls are chosen by the same people, based on the same selection criteria, they provide a reasonable group for comparison with the WISE participants of the same year.

As Table 8 shows, the alternates from the 1997 group had completed many of the academic high school science courses with Chemistry 2202 and Physics 2204 successfully completed by 94% and 81% respectively. These students have a very comparable academic background to the girls who were participants in the 1997 WISE Program. It is also true that both groups planned to continue with the sciences in their last year of high

school in the fall of 1997, as can be seen in Table 9.

Table 8

Science and Mathematics Courses Completed
WISE 1997 Participants and Alternates

Course	1997 Participants	1997 Alternates
Biology 2201	75.0	69.0
Biology 3201	36.1	50.0
AP Biology	0.0	6.3
Chemistry 2202	97.2	94.0
Chemistry 3202	44.4	31.0
AP Chemistry	0.0	6.3
Environmental Science 3205	2.8	0.0
General Science 1200	2.8	0.0
Geology 3203	2.8	0.0
Physics 2204	86.1	81.0
Physics 3204	13.9	19.0
Honours Physics	2.8	0.0
Academic Mathematics 1300	27.8	6.3

Course	1997 Participants	1997 Alternates
Academic Mathematics 2200	16.7	56.0
Advanced Mathematics 1201	69.4	75.0
Advanced Mathematics 2201	86.1	31.0
Advanced Mathematics 3201	19.4	31.0
AP Mathematics	0.0	6.3
Calculus Readiness 3105	8.3	0.0
Statistics 3104	2.8	0.0

Note. N=36.

Table 9

Science and Mathematics Courses Chosen for following School Year
WISE 1997 Participants and Alternates

Course	% of 1997 Participants[a]	% of 1997 Alternates[b]
Biology 2201	5.6	0.0
Biology 3201	44.4	25.0
Advanced Placement Biology	2.8	6.3
Chemistry 2202	2.8	12.5
Chemistry 3202	2.8	31.3
Advanced Placement Chemistry	0.0	18.8
Environmental Science 3205	44.4	18.8
General Science 1200	2.8	12.5
Geology 3203	2.8	0.0
Physics 2204	2.8	6.3
Physics 3204	77.8	50.0
Honours Physics	2.8	0.0
Advanced Placement Physics	0.0	6.3

Course	% of 1997 Participants	% of 1997 Alternates
Academic Mathematics 1300	2.8	0.0
Academic Mathematics 2200	8.3	0.0
Academic Mathematics 3200	2.8	3.3
Advanced Mathematics 1201	58.3	25.0
Advanced Mathematics 3201	13.9	43.8
Calculus Readiness 3105	0.0	25.0
Statistics 3104	47.2	18.8
Advanced Placement Mathematics	0.0	6.3

[a]N=36.

[b]N=16

As was the case for the 1997 participants, the mothers of the alternates also work largely in areas other than the sciences. Table 10 shows the percentage of parents employed in each occupational group. It appears that having a parent working in science

was not a large motivating factor in the girls' selection of career goals.

Table 10

Parental Occupations
WISE 1997 Alternates

Occupational Classification	% of Mothers	% of Fathers
Business, Finance and Administrative Occupations	14.2	26.7
Natural and Applied Sciences and Related Occupations	7.1	33.4
Health Occupations	7.1	0.0
Occupations in Social Science, Education, Government Service and Religion	28.6	20.0
Occupations in Art, Culture, Recreation and Sport	7.1	0.0

Occupational Classification	% of Mothers	% of Fathers
Sales and Service Occupations	7.1	13.4
Trades, Transport and Equipment Operators and Related Occupations	0.0	6.7
Other	28.6	6.2

As seen in Table 11, a large majority of both the participants and the alternates in 1997 said that a science major was a possibility for them. However, the 1997 participants were considering several fields not present in the responses from the alternates. WISE participants provided such majors as Astronomy, Behavioural Neurology, Geology, Medicine, Physics, Psychology and Geology. These choices correspond to the positions available in the 1997 Program. It appears that their placements had a strong positive effect on these students, such that it encouraged them to list their summer discipline as at least one of their possible majors for the future. It is also evident from Table 12 that the health related occupations are attractive to many of the 1997 alternates as they were for the 1997 WISE participants.

Table 11

Intended Post-Secondary Major
WISE 1997 Participants and Alternates

Major	% of 1997 Post-WISE Participants	% of 1997 WISE Alternates
Arts	5.6	0.0
Astronomy	2.8	0.0
Behavioural Neurology	5.6	0.0
Biology	19.4	37.5
Biochemistry	16.7	6.3
Chemistry	8.3	12.5
Computer Science	0.0	12.5
Education	2.8	0.0
Engineering	5.6	6.3
English	5.6	0.0
French	2.8	0.0
Geology	2.8	0.0
Mathematics	2.8	12.5
Medicine	2.8	0.0
Nursing	2.8	6.3

Major	% of 1997 Post-WISE Participants	% of 1997 WISE Alternates
Nutrition	2.8	6.3
Physics	8.3	0.0
Psychology	2.8	0.0
Public Relations	2.8	0.0
Science	5.6	12.5
Zoology	2.8	0.0
Undecided	25.0	12.5

Note. Some students provided more than one response.

Table 12

Career Goals
WISE 1997 Participants and Alternates

Occupational Classification	% of 1997 Post-WISE participants	% of 1997 WISE Alternates
Business, Finance and Administrative Occupations	2.8	12.5
Natural and Applied Sciences and Related Occupations	47.5	62.7

Occupational Classification	% of 1997 Post-WISE Participants	% of 1997 WISE Alternates
Health Occupations	69.6	112.8
Occupations in Social Science, Education, Government Service and Religion	8.4	12.6
Occupations in Art, Culture, Recreation and Sport	0.0	12.6
Other	5.6	6.3
Undecided	27.8	0.0

Note. Students provided more than one response.

Data were also collected on the attitudes of this group of alternates and the results are presented in Table 13. The alternates' agreed with the idea that both men and women can have both a career in science and a family. Their agreement with this statement for men and for women has a correlation of .8485. The WISE participants, although agreeing with both statements, appear to show some consideration of gender. The correlation for their attitudes on this issue for men and women fell from .6385 at the onset of the

Program to .6138 when the Program was completed. The experience gained from their summer as a research assistants appears to have made them somewhat more realistic about the challenges of raising a family and having a successful career in science or engineering. Both the participants and alternates made the connection between the accessibility of science to women in general and to themselves personally and do not perceive women generally or themselves as having to work harder than male peers in order to succeed.

Table 13

Attitudinal Correlations
WISE 1997 Participants and Alternates

Statement	Mean (1997 Participants)	Correlation (1997 Participants)	Mean (1997 Alternates)	Correlation (1997 Alternate
-Women can have a career in science or engineering as well as a family.	1.2571	.6138	1.3571	.8485
-Men can have a career in science or engineering as well as a family.	1.3611		1.3333	

Statement	Mean (1997 Participants)	Correlation (1997 Participants)	Mean (1997 Alternates)	Correlation (1997 Alternates)
-Careers in science and engineering are accessible to women.	1.2500	.5268	1.5000	.5222
-Science and engineering fields of study are accessible to me.	1.1765		1.2667	
-Female scientists and engineers must work harder than males to succeed in their field.	3.0938	.7547	2.6923	.6613
-I would have to work harder than my male peers in order to succeed in science or engineering.	3.4063		2.8462	

Statement	Mean (1997 Participants)	Correlation (1997 Participants)	Mean (1997 Alternates)	Correlation (1997 Alternates)
-Women can succeed in science and engineering.	1.0000	-	1.1333	.6504
-I feel confident that I can reach my career goals.	1.2000		1.2667	

- Cannot be computed

Once again the attitudes of the two groups of girls, as seen by their responses to statements presented to them in the questionnaire, were studied. Table 14 shows that both groups possess the attitude that science and engineering are accessible and attainable options and they feel confident in their ability to achieve their goals. Many responded that they have chosen a career related to the sciences. There are, however, some significant differences between the group that has been through the WISE Program and the group which has not. First of all, the WISE participants disagree significantly more, $t(47)=2.11$, $p< .05$, than the alternates with the statement that science and engineering do not welcome women. The experience of working in a laboratory doing meaningful work with

respected scientists was a positive one, where the girls were welcomed and made to feel comfortable.

The 1997 participants also disagree significantly more than the alternates with the statement that they would have to work harder than male peers in order to be successful in science, $t(46)=2.11$, $p< .05$. The WISE positions give the girls responsibility for work that is useful and important to their supervisors. Meeting this challenge has demonstrated to them that they are equally as capable as their male peers. These participants also feel significantly more confident about their future, $t(18)= -2.13$, $p< .05$.

As expected, the WISE participants agreed significantly more with the statement that they have access to information about careers in science and engineering, $t(18)= -3.94$, $p< .05$. The exposure to science and engineering provided by the WISE Summer Employment Program is extremely beneficial to the participants. These are positive outcomes of a program designed to encourage girls to consider some non-traditional careers. They will need this information and confidence in order to choose and succeed in science or any other career of their choosing.

Table 14

T-tests for Independent Samples
WISE 1997 Participants and Alternates

Statement	WISE 1997 Participants Mean (post)	WISE 1997 Alternates Mean	t-value	df	2-tail Significance
Careers in science and engineering are accessible to women.	1.2500	1.5000	-1.59	21	.126
Science and engineering studies are more difficult for women than for men.	3.4706	3.3333	0.62	47	.537
There are more barriers for women pursuing science and engineering careers than there are for men in these fields.	2.7097	2.5714	0.46	43	.649
Science and engineering fields do not welcome women.	3.5143	3.21143	2.11	47	.044*

Statement	WISE 1997 Participants Mean (post)	WISE 1997 Alternates Mean	t-value	df	2-tail Significance
Science and engineering are attainable options for men and women.	1.1714	1.4000	-1.57	21	.132
Women can succeed in science and engineering.	1.000	1.1333	-1.47	14	.164
Female scientists and engineers must work harder than males to succeed in their field.	3.0938	2.6923	1.59	43	.120
Women can have a career in science or engineering as well as a family.	1.2371	1.3571	-0.69	47	.494
Men can have a career in science or engineering as well as a family.	1.3611	1.3333	0.15	49	.881
Science and engineering fields of study are accessible to me.	1.1944	1.2667	-0.56	49	.577

Statement	WISE 1997 Participants Mean (post)	WISE 1997 Alternates Mean	t-value	df	2-tailed Significance
I feel confident that I can reach my career goals.	1.2000	1.2667	-0.51	48	.611
I would have to work harder than my male peers in order to succeed in science or engineering.	3.4000	2.8462	2.11	46	.040*
I have considered pursuing a career in science and/or engineering.	1.3529	1.1333	1.53	45	.132
I feel confident about attending a post-secondary institution.	1.9091	1.5714	1.29	45	.203
I have access to information about careers in science and engineering.	1.3143	2.6667	-3.94	18	.001*
I feel confident about my future.	1.2500	1.6429	-2.13	18	.047*

Statement	WISE 1997 Participants Mean (post)	WISE 1997 Alternates Mean	t-value	df	2-tailed Significance
I see the importance of science in everyday life.	1.3714	1.4667	-0.54	48	.594
I have chosen a career in science and/or engineering.	1.3714	1.2308	0.96	24	.349
I have been encouraged to consider careers in science and engineering.	1.9355	1.5000	1.45	43	.132

Note. df=degrees of freedom

Means calculated based the following Likert scale:

1=strongly agree, 2=agree, 3=disagree, 4-strongly disagree, 5=don't know

*p<.05

The final groups to be studied were the participants from 1997 and the participants from 1994. Data were collected from all 36 of the 1997 participants and from 12 of the 26 participants from 1994. The participants from 1994 also showed themselves to be very capable. They also had completed many of the high school science courses as shown in Table 15. The girls from the 1994 WISE Program had completed many of the 3000 level science courses since they have already graduated from high school.

Table 15

Science and Mathematics Courses Completed
WISE 1997 and 1994 Participants

Course	% of WISE 1997 Participants[a]	% of WISE 1994 Participants[b]
Biology 2201	75.0	75.0
Biology 3201	36.1	83.3
AP Biology	0.0	16.7
Chemistry 2202	97.2	83.3
Chemistry 3202	44.4	66.7
Environmental Science3205	2.8	0.0
General Science 1200	2.8	0.0
Geology 3203	2.8	0.0
Physics 2204	86.1	83.3
Physics 3204	13.9	58.3

Course	% of WISE 1997 Participants[a]	% of WISE 1994 Participants[b]
Honours Physics	2.8	0.0
AP Physics	0.0	8.3
Academic Mathematics 1300	27.8	25.0
Academic Mathematics 2200	16.7	0.0
Academic Mathematics 3200	0.0	16.7
Advanced Mathematics 1201	69.4	75.0
Advanced Mathematics 2201	86.1	100.0
Advanced Mathematics 3201	19.4	83.3
Calculus Readiness 3105	8.3	50.0
Statistics 3104	2.8	33.3
AP Mathematics	0.0	8.3

[a] N=36

[b] N=12

As expected, the occupations of the mothers of the 1994 participants were based in the health and service industries. Some fathers worked in science, but parental occupation was not a major factor influencing the career choices of this group of girls. Table 16 summarizes these findings.

Table 16

Parental Occupations
WISE 1994 Participants

Occupational Classification	% of Mothers	% of Fathers
Management Occupations	0.0	11.1
Business, Finance and Administrative Occupations	0.0	22.2
Natural and Applied Sciences and Related Occupations	0.0	11.1
Health Occupations	20.0	0.0
Occupations in Social Science, Education, Government Service and Religion	60.0	11.1

Occupational Classification	% of Mothers	% of Fathers
Trades, Transport and Equipment Operators and Related Occupations	0.0	11.1
Occupation Unique to Primary Industry	0.0	22.2
Other	20.0	11.1

All of the 1994 participants have gone on to attend a post-secondary institution and a majority of them (81.9%) have chosen to study a science related field with biology being the most cited major as seen in Table 17. As Table 3 presented, Biology was also the most common major aspired to by the 1997 participants. The life sciences continue to attract young women to careers in this field. Since these groups were also selected by two out of three of the same people and based on the same criteria, it is reasonable to hope that the intentions expressed by the 1997 participants to attend a post-secondary institution will translate into the attendance seen in the 1994 group. The 1994 group of participants once again reflect the statistics showing a majority of young women choosing "nurturing" careers. Table 18 shows that 63.7% of the 1994 participants are pursuing their goal of working in health related occupations.

Table 17

Post-Secondary Major
WISE 1994 Participants

Major	% of Participants
Biology	27.3
Literature	9.1
Nursing	9.1
Psychology	18.2
French	9.1
Engineering	9.1
Computer Science	9.1
Business	9.1
Pharmacy	9.1
Undecided	9.1

Note. 1 student did not respond to this question.

Table 18

Career Goals
WISE 1997 and 1994 Participants

Occupational Classification	% of 1997 Post-WISE participants	% of 1994 WISE Participants
Business, Finance and Administrative Occupations	2.8	9.1
Natural and Applied Sciences and Related Occupations	47.5	18.2
Health Occupations	69.6	63.7
Occupations in Social Science, Education, Government Service and Religion	8.4	27.3
Sales and Service Occupations	0.0	9.1
Other	5.6	0.0
Undecided	27.8	27.3

Note. Students provided more than one response.

Table 19 shows the correlation between attitudes based on the same statement

presented to the other group in this study. It is encouraging that over the three years since the 1994 participants were involved in the WISE Program they appear to have experienced few negative experiences to turn them away from science. The correlation between their feelings about having a career in science and a family are not gender-related and the correlation between their attitude on this issue for men and for women is even higher than that for the recent 1997 participants. Their experiences since completing the WISE Program have not discouraged their belief that women can have both a career and a family.

The second statement in Table 19 shows that, although both groups agree with the statement that science is accessible to women and to themselves personally, the correlation on these items is lower for girls from the 1994 Program. Perhaps their own experiences have not turned them away from science but have shown them some of the challenges faced by women in science and engineering. They do, however, disagree that they, and women in general, have to work harder. They have not been made to feel any less competent.

Table 19

Attitudinal Correlations
WISE 1997 and 1994 Participants

Statement	Mean (1997 Participants)	Correlation (1997 Participants)	Mean (1994 Participants)	Correlation (1994 Participant:
-Women can have a career in science or engineering as well as a family.	1.2353	.6138	1.2500	.8485
-Men can have a career in science or engineering as well as a family.	1.3429		1.3667	

Statement	Mean (1997 Participants)	Correlation (1997 Participants)	Mean (1994 Participants)	Correlation (1994 Participants
-Careers in science and engineering are accessible to women.	1.2500	.5268	1.2500	.5222
-Science and engineering fields of study are accessible to me.	1.1765		1.6667	
-Female scientists and engineers must work harder than males to succeed in their field.	3.0938	.7547	2.9091	.6613
-I would have to work harder than my male peers in order to succeed in science or engineering.	3.4063		2.9167	

Once again the attitudes of the young women who took part in the WISE Program in 1994 were very positive, especially in light of the fact that it has been three years since their WISE involvement. It appears that their experiences have not had a negative effect on their confidence or their future goals as seen in Table 20. These young women still

agree that careers in science and engineering are accessible and attainable to women and to themselves personally. They remain confident about their future, as do the participants from 1997. Both groups agree that they have considered careers in science or engineering and also agree that the WISE Program encourages young women to consider such careers and, in fact, helped them to choose such careers for themselves. That participants agree with such statements is extremely positive feedback for WISE, since these statements reflect the goals of the WISE Summer Employment Program. The opinion that WISE provided more information on careers in science and engineering than they had previously had access to is just as strong for the girls from the 1994 Program as it is for those who recently finished the Program. This is clearly a strength of the Program.

Finally, the 1994 participants agree significantly more than the 1997 group, $t(43)=2.14$, $p< .05$, that the Program helped them decide what careers they did not want to pursue. Even such an outcome can be positive since it helps these girls to make an informed decision about a future career. However, the Program does not aim to have students dissatisfied in the positions, and, as the program has evolved, the effort to place students in suitable laboratory environments has been successful.

Table 20

T-tests for Independent Samples
WISE 1997 and 1994 Participants

Statement	Post-WISE 1997 Mean	WISE 1994 Mean	t-value	df	2-tail Significance
Careers in science and engineering are accessible to women.	1.2500	1.3333	-0.55	46	.583
Science and engineering studies are more difficult for women than for men.	3.4706	3.5833	-0.50	44	.615
There are more barriers for women pursuing science and engineering careers than there are for men in these fields.	2.7097	2.6364	0.20	40	.841
Science and engineering fields do not welcome women.	3.5143	3.5000	0.08	45	.934

Statement	Post-WISE 1997 Mean	WISE 1994 Mean	t-value	df	2-tailed Significance
Science and engineering are attainable options for men and women.	1.1714	1.0833	0.73	45	.470
Women can succeed in science and engineering.	1.0000	1.0000	-	-	-
Female scientists and engineers must work harder than males to succeed in their field.	3.0938	2.9091	0.62	41	.538
Women can have a career in science or engineering as well as a family.	1.2371	1.2500	0.05	45	.962
Men can have a career in science or engineering as well as a family.	1.3611	1.3667	0.99	46	.327
Science and engineering fields of study are accessible to me.	1.1944	1.667	0.21	46	.835

Statement	Post-WISE 1997 Mean	WISE 1994 Mean	t-value	df	2-tailed Significance
I feel confident that I can reach my career goals.	1.2000	1.1667	0.25	45	.805
I would have to work harder than my male peers in order to succeed in science or engineering.	3.4000	2.9167	1.79	45	.080
I have considered pursuing a career in science and/or engineering.	1.3529	1.1667	0.94	44	.354
The WISE Program helped me decide what careers I do not want to pursue.	1.9091	1.3333	2.14	43	.038*
The WISE Program made me feel more confident about attending a post-secondary institution.	1.3143	1.6667	-1.19	13	.254

Statement	Post-WISE 1997 Mean	WISE 1994 Mean	t-value	df	2-tailed Significance
The WISE Program provided me with more information about careers in science and engineering.	1.2500	1.2500	0.00	46	1.000
The WISE Program has made me feel more confident about my future.	1.3714	1.4167	-0.22	45	.827
The WISE Program has helped me see the importance of science in everyday life.	1.3714	1.4167	-0.27	45	.787
The WISE Program helped me to choose a career in science and/or engineering.	1.9355	2.000	-0.18	40	.350

Statement	Post-WISE 1997 Mean	WISE 1994 Mean	t-value	df	2-tailed Significance
The WISE Program encourages young women to consider careers in science and engineering.	1.1667	1.2500	-0.63	46	.532

Note. df=degrees of freedom

- =cannot be computed

Means calculated based the following Likert scale:

1=strongly agree, 2=agree, 3=disagree, 4-strongly disagree, 5=don't know

*p<.05

Discussion

The results of the analysis revealed the many strengths and positive attitudes of the young women who have participated in the WISE Summer Employment Program in 1997 and 1994. These girls are intelligent, confident students who have successfully completed many of the high school science courses available to them. They intended to continue their studies of science in their last year of high school and then study at a post-secondary institution. Most of these students had considered science as a major. Biology was cited most often as the major of choice. The life sciences and health related careers repeatedly demonstrated their attraction for these young women, but the WISE Program did result in

an increase in the number of girls who aspired to engineering, as well as an increase in the number of girls who were undecided about their future career after participating in the WISE Program. The experiences and information gained from the Program appear to have given some of the participants more to consider as they attempt to choose a future career.

All groups in this study demonstrated a high correlation between their belief in the ability of women to have a career in science or engineering and a family and the ability of men to have the same. It is encouraging that the girls' beliefs on this issue were not based on gender. Although the correlation for the 1997 participants had increased after their participation in the Program, the 1997 alternates and the 1994 participants had a higher correlation than the 1997 participants. This seems to suggest that WISE showed the participants some of the challenges women face as they attempt to balance both a career and a family. Participation in the WISE Program also helped the participants to transfer their belief that science and engineering are accessible to women to a similar belief for themselves personally. The correlation had increased on these statements at the end of the Program. This effect was lower for the 1994 group. Although they still agree with the statements, their optimism seems to have been tempered by their experiences in the three years since they participated in the WISE Program.

All groups involved in this study showed very positive attitudes towards careers in science and engineering. They expressed agreement with the statements that science and engineering are accessible and attainable to women and to themselves personally. They expressed confidence in their futures. Significant differences were found in some areas for

the 1997 participants. Their disagreement with the statement that they would have to work harder than their male peers to succeed in science or engineering increased significantly. They apparently experienced success in their laboratory work and gained confidence in their abilities from their experience. They also agreed significantly more, after the Program, with the statement that they had access to information about careers on science and engineering.

When compared to the alternates from 1997, the WISE participants again showed several significant differences. They disagreed significantly more with the statement that science does not welcome women and that they would have to work harder to be successful in science or engineering. They have gained much confidence from their experience and were made to feel welcome in the positions. They also agreed significantly more with the statement that they had access to information about career in science and engineering. Both the confidence and the information they have gained may enable them to make informed decisions about their future.

Finally, the 1994 participants in the WISE Program expressed agreement with the statement that WISE encourages women to consider careers in science and engineering and provides information about these careers. They also agreed that the Program helped them to choose such a career for themselves. That these attitudes persisted in WISE participants after three years demonstrated a very positive effect of the Program.

The last question on all questionnaires used in this evaluation was a free response question. Students were asked to comment on their attitudes about the issue of women in science and engineering by referring to at least three of the statements presented in the

Likert style question. Where applicable, the students were also asked to comment about their experience with the WISE Program and to provide any information they felt was important to the evaluation of the Program. Prior to participation in the WISE Program, the majority of girls from the 1997 group (69.4%) referred to their belief that careers in science and engineering are accessible to women and that women can succeed in these fields without having to work harder than their male peers. One quarter of the girls (25.0%), however, did state that there are barriers or obstacles facing women in science. At the conclusion of the Program some different responses emerged. Over half of the girls (51.7%) expressed their desire for a nurturing career or role, which was later reflected in their career goals. The same percentage (51.7%) expressed a greater feeling of confidence after participating in the WISE Program.

The responses of the alternates reflected attitudes similar to those of the 1997 participants. These girls (50.0%) also expressed a belief that science and engineering are accessible to women and 31.3% felt women can succeed in these fields without having to work harder than their male peers. Many (31.3%) do not perceive any difficulty for women when balancing a family and a career.

Finally, 41.7% of the 1994 WISE Participants reiterated the statement that careers in science and engineering are accessible to women. One quarter (25%) of them see no more barriers for women in science than there are for men. Several strong points of the Program are apparent in the responses from this group, since four years have passed since their involvement. They (83.3%) still feel more confident because of their participation in the WISE Program and many of them (50.0%) said that they have a better knowledge of

science and engineering and are more familiar with Memorial University of Newfoundland due to the WISE Program.

Chapter 5

Summary, Conclusions and Recommendations

The Women in Science and Engineering (WISE) Program provides female students with an opportunity to work as a research assistant in one of many participating science laboratories associated with Memorial University of Newfoundland. This program was designed to encourage young women to consider careers in science, engineering and related disciplines. The purpose of this research was to provide an evaluation of this program by determining whether participation in the WISE Program affected the course and career choices of the young women. It also aimed to determine whether the Program resulted in changed attitudes regarding careers in science, engineering and various issues related to women working in these fields.

Data were collected from questionnaires administered to the participants in the 1997 WISE Program, the alternates for the 1997 WISE Program, as well as the participants from the WISE Program in 1994. Statistical analyses were then performed on the data including multiple responses, correlation analysis and t-tests for paired and independent samples. The results of this analysis reveal many things about these students and the WISE Program.

The analysis of the 1997 WISE Participants' responses demonstrated that they were a very academically capable group of young women. They had successfully completed many of the high school science courses including Chemistry (97.2%), Physics (86.1%) and Biology (75%). They have parents who are employed largely in traditional areas. The mothers, in particular, reflect the trend for women to aspire to "nurturing"

careers.

These girls planned to continue with their high school science education and all indicated, both before and after the Program, their intention to attend a post-secondary institution. Many of these students originally intended to pursue a science major but an important increase (from 0% to 5.6%) was seen in those aspiring to study engineering at the end of the Program. More girls were also undecided about their career goals after the WISE Program. The career goals of these girls had shown an increase in those choosing science and a decrease in those aspiring to health occupation, sales, service, arts and social science. Again, more of the girls reported being undecided about their career goals than had reported this before the WISE Program.

The attitudinal responses from this group revealed several positive beliefs. The students' belief in the ability to have both a career in science or engineering as well as a family was not gender-based. They saw this as a possibility for women and men before and after their WISE participation. Their WISE experience caused an increase in the correlation (.3343 to .5268) between their agreement that science and engineering are accessible to women and to themselves personally. This ability to transfer their general belief in the accessibility of science, to its accessibility to themselves, can allow them to consider such careers as real possibilities. This group of girls also disagreed with the statement that women would have to work harder in order to be successful in science or engineering. This belief also carried over to themselves as shown by the correlation (.7117 to .7547) between such a statement related to women and then to themselves personally.

There were several significant changes, at the end of the WISE Program, in the girls' attitudes towards various statements presented to them. Their disagreement with the statement that they would have to work harder to succeed in science or engineering increased significantly after participation in the WISE Program. There were also significant increases in their agreement with the statement that WISE provides information on careers in science and engineering and the statement that they have been encouraged to consider careers in science and engineering.

The results from the 1997 alternates for the WISE Program showed many similarities to the girls who had completed the WISE Program. They, too, had completed many of the high school science courses offered to them. Chemistry 2202 was completed by 94% of these girls while 81% had completed Physics 2204 and 69% had completed Biology 2201. The occupations of their parents were not a large factor which in encouraging them to consider careers in science or engineering, since most of their parents did not work in those areas. As was the case for the 1997 WISE participants, the alternates planned to continue with their science studies in their final year of high school and they intended to attend a post-secondary institution after graduation.

Many of the alternates intended to pursue a science major, as did many of the WISE participants. However, the WISE participants' choice of major after their participation included many areas not being considered by the alternates, including astronomy, behavioural neuroscience, geology, medicine, physics and psychology. These choices correspond to some of the jobs held by these girls during the WISE Program. Their career goals, however, were still dominated by health related occupations, as were

the goals of the alternates. The WISE participants, however, reported being undecided more often than did the alternates.

The correlation results showed that the alternates believed that having a career in science and a family was possible for men and for women. The correlation for these statements was higher for the alternates (.8485) than for the participants (.6138) suggesting that the participants had been exposed to some of the challenges faced by women when trying to balance a career in science and a family. As with the WISE 1997 participants, the alternates made the connection between their idea that a career in science and engineering is accessible to women in general and to themselves. They also disagreed that women in general, or themselves, would have to work harder to succeed in science or engineering.

There were several significant differences between the attitudes of the WISE participants and the alternates. The WISE participants disagreed significantly more with the statement that science and engineering fields do not welcome women and the statement that they would have to work harder than their male peers in order to succeed in science or engineering. The WISE participants were also significantly more confident about their future after the Program and agreed significantly more than did the alternates that they had access to information about careers in science and engineering.

The 1994 WISE participants also revealed several points about the long term effect of the WISE Program. This group of students had successfully completed many 300 level science courses since they had already graduated from high school. The occupations of their parents appeared not to be a major factor in encouraging them toward

science since only 11.1% of the fathers worked in science and none of their mothers worked in this discipline. All of these girls were attending a post-secondary institution, and most (81.9%) were pursuing a science major. Most of these majors were in biology, which reflects the responses of the 1997 participants, many of whom intended to major in biology. The career goals of these students also reflected the goals of the 1997 girls, whose career aspirations were largely found in the health related occupations. Many of the WISE 1994 participants (63.7%) had career goals in health related occupations. In 1997, 47.0% of the WISE participants reported that their career goals included careers in the sciences. A difference was found in the results from the girls who had participated in the Program three years earlier. The percentage of the 1994 participants aspiring to careers in the sciences was only 18.2%.

The attitudes of the 1994 participants about having a career in science and a family are not gender-related , and the correlation between their attitude on this issue for men and for women is even higher than that for the recent 1997 participants. Their experiences have not discouraged their belief that women can have both a career and a family. Although both the 1997 and the 1994 participants agree with the statement that science is accessible to women and to themselves personally, the correlation on these items is lower for girls from the 1994 WISE Program. It appears they have encountered some of the challenges faced by women in science and engineering. They do, however, disagree that they, and women in general, have to work harder than their male peers in order to be successful in science and engineering.

The young women who participated in the WISE Program in 1994 remained

confident about their future, as did the participants from 1997. Many girls from both groups have considered careers in science or engineering and also agree that the WISE Program encourages young women to consider such careers. There were, in fact, very few significant differences between the attitudes reported by the 1997 and 1994 WISE participants. The 1994 participants did, however, agree significantly more than the 1997 group that the Program helped them decide what careers they did not want to pursue.

Conclusions

The results of this evaluation provide insight into the WISE Summer Employment Program and its participants. The girls who are chosen to participate in this program have strong academic backgrounds in science at the high school level. This competency enables them to work well in a university science laboratory. The WISE Program effected few changes in the science courses the participants planned to study in the following school year. However, since course selection occurs much earlier in the school year, these students know it is not practical, or perhaps possible, to change their course selection when they return to school in September.

All students involved in this study planned to attend, or did attend, a post-secondary institution after high school graduation. Many aspired to science majors before and after their involvement with WISE, and biology was the most often cited major. However, the 47% of the 1997 participants who intended to major in science was replaced by only 18.2% of the 1994 participants who had the same intention. These are of course two different groups and the original intentions of the 1994 group is unknown. However, if such a drop is characteristic of such well prepared students, there is likely some factor in

the post-secondary institution which needs to be addressed. After participation in the WISE Program, girls report being more undecided about the major they intend to study, and majors appeared in their responses which reflect the positions that were part of the Program during the summer of the involvement. The career goals of the WISE participants also showed they were more undecided than they were before the Program and also more undecided than the alternates who did not go through the Program. The WISE Program clearly provided the students with information and experiences that influenced their choice of post-secondary major and future career aspirations. Health related occupations dominated the aspirations of all groups in this study, reflecting the appeal of 'nurturing' careers for young women. The WISE experience had an effect here as well, since a drop was seen in those aspiring to these health careers after their participation in the Program.

All groups in this study demonstrated a high correlation between their belief in the ability for women to have a career in science or engineering and a family and the ability for men to have the same. Although the correlation for the 1997 participants had increased after participating in the Program, the 1997 alternates and the 1994 had a higher correlation than the 1997 participants. The WISE participants may have encountered some of the challenges women face as they attempt to balance both a career and a family. Participation in the WISE Program also helped the participants to transfer their belief that science and engineering are accessible to women to a similar belief for themselves personally. The correlation had increased on these statements at the end of the Program. This effect was lower for the 1994 group whose optimism seemed to have been tempered

by their experiences in the three years since their WISE experience.

The attitudes of these young women were very encouraging. They were very positive about women's ability to succeed in science and engineering and felt very confident about the future. There were, however, some significant changes in attitudes. After participation in the 1997 WISE Program, the girls disagreed significantly more than they had originally and more than the alternates, with the statement that they would have to work harder than their male peers in order to succeed in science or engineering. These participants also disagreed significantly more than the alternates with the statement that science and engineering do not welcome women. They agreed significantly more with the statements that they had been encouraged to consider careers in science and engineering after the Program and they agreed significantly more than originally, and more than the alternates, that they had access to information about such careers. The participants also reported being significantly more confident about the future than did the alternates.

The WISE Program demonstrated its effect on the attitudes of its participants in the findings reported above. Their experiences have shown them that careers in science and engineering are options for women. They were made to feel welcome and competent in their laboratory environment and this is reflected in their responses. After the Program they saw no reason why they would have to work any harder than anyone else to be successful. They responded that they had been encouraged to consider the fields of science and engineering, which is a major goal of the Program. It is clear that the Program has fulfilled this goal by providing the information, experiences and encouragement to allow the participants to make informed decisions about their future

careers. Participants leave the Program with a positive view of the fields of science and engineering and they feel more confident about the future as a result.

Recommendations for Future Research

1. A longitudinal study of one group of WISE participants and alternates from the same year would provide much insight into the long term effects of the WISE Program. This evaluation dealt only with the intended majors and career choices of WISE participants and alternates. Such a longitudinal study could determine if the changes demonstrated immediately after participation actually translate into post-secondary study choices and career choices. It could also attempt to identify factors which influence choices not to persist in science and discover ways to deal with such issues.
2. It would be useful to determine whether a correlation exists between the position held by a WISE participant and her educational and career goals. If participants choose a major and career to match their WISE experience, perhaps the WISE Program should consider a rotating work schedule which exposes the girls to a wider range of scientific disciplines thus, empowering them to make more informed decisions about their future.
3. This evaluation studied an intervention at the high school level. The effectiveness of interventions at earlier stages in girls' lives should be investigated. Later interventions and means of support should also be investigated in order to provide a full support network for the young women of

our society as they attempt to choose careers which best suit their needs, while maximizing their tremendous potential.

References

Acker, S., & Oatley, K. (1993). Gender issues in education for science and technology: Current situation and prospects for change. Canadian Journal of Education. 18(3), 255-272.

Barber, L.A. (1995). U.S. women in science and engineering, 1960-1990. Journal of Higher Education. 66(2), 213-234.

Brush, S.G. (1991). Women in science and engineering. American Scientist. 79(5), 404-416.

Burkham, D.T., Lee, V.E. & Smerdon, B.A. (1997). Gender and science learning early in high school: Subject matter and laboratory experiences. American Educational Research Journal, 34(2), 297-331.

Canadian Teachers' Federation. (1990). A report on the realities, concerns, expectations and barriers experienced by adolescent women in Canada. Ottawa, ON: Author.

Crosby, F.J. & Reinhardy, L.M. (1993). Closeness between female college students and their professors: A novel assessment technique. Sex Roles, 28, 477-483.

Damarin, S.K. (1991). Rethinking Science and Mathematics Curriculum and Instruction: Feminist Perspectives in the Computer Era. Journal of Education, 173, 107-121.

Dick, T.P. & Rallis, S.F. (1991). Factors and influences on high school students' career choice. Journal for Research in Mathematics Education, 22(4), 281-292.

Didion, C.J. (1996). Motivating women students: The pivotal role of faculty as mentors. Journal of College Science Teaching, 25(6), 439.

Eccles J.S. (1994). Understanding women's educational and career choices. Psychology of Women Quarterly, 18, 585-609.

Farmer, H.S., Wardrop, J.L., Anderson, M.A. & Risinger, R. (1995). Women's career choices:Focus on science, math and technology careers. Journal of Counseling Psychology. 155-170.

Fee, E. (1981). Is feminism a threat to scientific objectivity? International Journal of Women's Studies, 4, 378-391.

Fox Keller, E. (1989). The gender/science system: or, Is sex to gender as nature is to science. Feminism and Science. Bloomington: Indiana University Press, 33-44.

Gati, I., Givon, M. & Osipow, S. (1995). Gender differences in career decision making: The content and structure of preferences. Journal of Counselling Psychology. 42(2), 204-216.

Ginzberg, R. (1989). Uncovering Gynocentric Science. Feminism and Science. Bloomington: Indiana University Press, pp. 69-84.

Harding, S. (1989). Is There a Feminist Method? Feminism and Science. Bloomington: Indiana University Press, pp. 17-32.

Hardy Aiken, S. (Ed). (1988). Changing Our Minds: Feminist Transformations of Knowledge. New York: State University of New York Press.

Karges-Bone. L. (1992, July/August). Southern girls go for science and mathematics in the summertime. Gifted Child Today. pp.10-11.

Mason, J. (1991, September). The invisible obstacle race. Nature. pp.205-206.

Martin, J. R. (1988). Science In a Different Style. American Philosophical Quarterly, 25, pp. 129-139.

Messing, K. (1986) What would a feminist approach to science be? Resources for Feminist Research, 15, pp.65- 66.

Morgan, C.S. (1992). College students perceptions of barriers to women in science and engineering. Youth and Society. 24(2), 228-236.

Nevitte, N., Gibbins, R. & Codding, P.W. (1988). The career goals of female science students in Canada. The Canadian Journal of Higher Education. 18(1), 31-47.

Otto, P.B. (1991). One science, One sex? School Science and Mathematics, 91,(8), 367-371.

Rienzi, B.M., Allen, M.J., Sarmiento, Y.Q. & McMillon, J.D. (1993). Alumni perception of the impact of gender on their university experience. Journal of College Student Development, 154-157.

Rose, H. (1986) Beyond Masculinist Realities: A Feminist Epistemology for the Sciences. Feminist Approaches to Science. New York: Pergamon Press, pp. 57-76.

Roychoudhury, A., Tippins, D.J., & Nichols, S. (1995). Gender inclusive science teaching: A feminist - constructivist approach. Journal of Research In Science Teaching, 32, 897-924.

Ryan, B. "Minister believes midwives could be part of community-based health care," The Evening Telegram, 21 October 1991, p. 1

Seymour, E. (1995). The loss of women from science, mathematics and engineering undergraduate majors: An explanatory account. Science Education. 79(4), 437-473.

Statistics Canada. (1993). Standard Occupational Classification. Ottawa: Minister of Industry, Science and Technology.

Statistics Canada. (1995). Women in Canada: A Statistical Report (3rd ed.). Ottawa: Housing, Statistics and Social Statistics Division.

Tong, R. (1989). Feminist Thought. Colorado: Westview Press, Inc.

Wolffensperger, J. (1993). Science is truly a male world.: The interconnectedness of knowledge, gender and power within university education. Gender and Education, 5, pp.37-52.

Women In Science and Engineering. (1991). Summer employment program student summaries. (Available from WISE Newfoundland and Labrador).

Women In Science and Engineering. (1994). Summer employment program student summaries. (Available from WISE Newfoundland and Labrador).

Women's Policy Office. (1996). Women in Newfoundland and Labrador: A Statistical Compendium. St. John's, NF: Author.

Wolffensperger, J. (1993). Science is truly a male world.: The interconnectedness of knowledge, gender and power within university education. Gender and Education, 5, pp.37-52.

Women In Science and Engineering. (1991). Summer employment program student summaries. (Available from WISE Newfoundland and Labrador).

Women In Science and Engineering. (1994). Summer employment program student summaries. (Available from WISE Newfoundland and Labrador).

Women's Policy Office. (1996). Women in Newfoundland and Labrador: A Statistical Compendium. St. John's, NF: Author.

Appendix A

August 22, 1997

Dear Student,

I am a graduate student in the Faculty of Education at Memorial University. I will be asking students involved with the Women In Science and Engineering (WISE) Summer Employment Program to complete questionnaires as part of an evaluation of the program to be submitted as my thesis for the degree of Master of Education. I am requesting your consent to participate in this study.

The WISE Program is designed to encourage young women to consider careers in science, engineering and related disciplines. This study will endeavour to discover if the program is effective in influencing the course selection and career choices of young women, and to determine if there has been a change in students' perception of careers in science and related disciplines as a result of their participation in the WISE program. This study has received the approval of the Faculty of Education's Ethics Review Committee.

All participants will be asked to complete questionnaires and some may be chosen to participate in group discussions which will be recorded. All information gathered in this study is strictly confidential and at no time will individuals be identified. Any recorded discussions will be erased at the conclusion of the study. Participation is voluntary and students can withdraw their participation at any time. The results of this research will be available to you upon request. If you wish to speak to someone not involved with this study please feel free to contact Dr. Patricia Canning at the Faculty of Education, Memorial University of Newfoundland. Also, feel free to contact my graduate supervisor, Glenn Clark, at 737-7612.

If you agree to participate in this study please sign below and **return the bottom portion to me with your questionnaire by September 30, 1997.** Thank you for your consideration of this request.

Sincerely,

Karen M.A. Sheppard

I _____ (Student's name) agree to take part in a study to evaluate the WISE Summer Employment Program undertaken by Karen M.A. Sheppard. I understand that my participation is voluntary and I can withdraw at any time. All information is strictly confidential and no individual will be identified.

Date Student's Signature

Appendix B

Women In Science and Engineering
Summer Employment Program
[Pre-WISE 1997 & 1997 Alternates]

1. **Name:**_____

2. **Current address**:_____

_____
City Province Postal Code

Telephone: ( )_____

3. **General Information**

Date of birth:_____

Last school grade completed:_____

Mother's occupation:_____

Father's occupation:_____

4. **Science/Mathematics courses completed to date:**

Course Name and Number	Final Mark

Course Name and Number	Final Mark

Science/Mathematics courses selected for 1997-1998 school year

5. **Educational Goals**

Are you planning to attend a post-secondary educational institution?
If so, which institution? (You can list more than one)

What will be your major?

6. **Career Goals**

Future career plans, if known_____

If you are considering more than one option, please provide the careers you are considering

If you have yet to form your career plans, check here_____

7. Please indicate how you feel about each of the following statements by ticking the appropriate box.

	Strongly agree	Agree	Disagree	Strongly disagree	Don't know
Careers in science and engineering are accessible to women.	[ ]	[ ]	[ ]	[ ]	[ ]
Science and engineering studies are more difficult for women than for men.	[ ]	[ ]	[ ]	[ ]	[ ]
There are more barriers for women pursuing science and engineering careers then there are for men in these fields.	[ ]	[ ]	[ ]	[ ]	[ ]
Science and engineering fields do not welcome women.	[ ]	[ ]	[ ]	[ ]	[ ]
Science and engineering are attainable career options for men and women.	[ ]	[ ]	[ ]	[ ]	[ ]
Women can succeed in science and engineering.	[ ]	[ ]	[ ]	[ ]	[ ]
Female scientists and engineers must work harder than males to succeed in their field.	[ ]	[ ]	[ ]	[ ]	[ ]
Women can have a career in science or engineering as well as a family.	[ ]	[ ]	[ ]	[ ]	[ ]
Men can have a career in science or engineering as well as a family.	[ ]	[ ]	[ ]	[ ]	[ ]
Science and engineering fields of study are accessible to me.	[ ]	[ ]	[ ]	[ ]	[ ]
I feel confident that I can reach my career goals.	[ ]	[ ]	[ ]	[ ]	[ ]
I would have to work harder than my male peers in order to succeed in science or engineering.	[ ]	[ ]	[ ]	[ ]	[ ]

	Strongly agree	Agree	Disagree	Strongly disagree	Don't know
I have considered pursuing a career in science and/or engineering.	[ ]	[ ]	[ ]	[ ]	[ ]
I feel confident about attending a post-secondary institution.	[ ]	[ ]	[ ]	[ ]	[ ]
I have access to information about careers in science and engineering.	[ ]	[ ]	[ ]	[ ]	[ ]
I feel confident about my future.	[ ]	[ ]	[ ]	[ ]	[ ]
I see the importance of science in everyday life.	[ ]	[ ]	[ ]	[ ]	[ ]
I have chosen a career in science and/or engineering.	[ ]	[ ]	[ ]	[ ]	[ ]
I have been encouraged to consider careers in science and engineering.	[ ]	[ ]	[ ]	[ ]	[ ]

8. Please comment on your attitudes about the issue of women in science and engineering by referring to at least three of the statements from the previous page.

Appendix C

Women In Science and Engineering
Summer Employment Program
[Post-WISE 1997]

1. **Name**:_____

   Mother's occupation _____

   Father's occupation _____

2. **Science courses** selected for 1997-1998 school year:

   _____

   _____

   _____

3. **Educational Goals**

   Are you planning to attend a post-secondary educational institution?_____

   If so, which institution? (You can list more than one.)_____

   _____

   What will be your major?_____

4. **Career Goals**

   Future career plans, if known_____

   _____

   _____

If you are considering more than one option, please provide the careers you are considering_____

_____

If you have yet to form your career plans, please check here_____

5. Please indicate how you feel about each of the following statements by ticking the appropriate box.

	Strongly agree	Agree	Disagree	Strongly disagree	Don't Know
Careers in science and engineering are accessible to women.	[ ]	[ ]	[ ]	[ ]	[ ]
Science and engineering studies are more difficult for women than for men.	[ ]	[ ]	[ ]	[ ]	[ ]
There are more barriers for women pursuing science and engineering careers then there are for men in these fields.	[ ]	[ ]	[ ]	[ ]	[ ]
Science and engineering fields do not welcome women.	[ ]	[ ]	[ ]	[ ]	[ ]
Science and engineering are attainable career options for men and women.	[ ]	[ ]	[ ]	[ ]	[ ]
Women can succeed in science and engineering.	[ ]	[ ]	[ ]	[ ]	[ ]
Female scientists and engineers must work harder than males to succeed in their field.	[ ]	[ ]	[ ]	[ ]	[ ]
Women can have a career in science or engineering as well as a family.	[ ]	[ ]	[ ]	[ ]	[ ]
Men can have a career in science or engineering as well as a family.	[ ]	[ ]	[ ]	[ ]	[ ]
Science and engineering fields of study are accessible to me.	[ ]	[ ]	[ ]	[ ]	[ ]
I feel confident that I can reach my career goals.	[ ]	[ ]	[ ]	[ ]	[ ]

I would have to work harder than my male peers in order to succeed in science or engineering.	[ ]	[ ]	[ ]	[ ]	[ ]
I have considered pursuing a career in science and/or engineering.	[ ]	[ ]	[ ]	[ ]	[ ]
The WISE Program helped me decide what careers I do not want to pursue.	[ ]	[ ]	[ ]	[ ]	[ ]
The WISE Program made me feel more confident about attending a post-secondary institution.	[ ]	[ ]	[ ]	[ ]	[ ]
The WISE Program provided me with more information about careers in science and engineering.	[ ]	[ ]	[ ]	[ ]	[ ]
The WISE Program has made me feel more confident about my future.	[ ]	[ ]	[ ]	[ ]	[ ]
The WISE Program has helped me see the importance of science in everyday life.	[ ]	[ ]	[ ]	[ ]	[ ]
The WISE program helped me to choose a career in science and/or engineering.	[ ]	[ ]	[ ]	[ ]	[ ]
The WISE program encourages young women to consider careers in science and engineering.	[ ]	[ ]	[ ]	[ ]	[ ]

6. Please provide any information about yourself, the WISE program, your WISE experience or anything else that you feel is important to the assessment of the effectiveness of the WISE program.

Please comment on your attitudes about the issue of women in science and engineering by referring to at least three of the statements from the previous page.

Appendix D

Women In Science and Engineering
Summer Employment Program
[WISE 1994]

1. **Name**:_____

2. **Current address**:_____

City Province Postal Code

Telephone:( )_____

3. **Parents' Permanent Address** (If different from above):_____

_____
City Province Postal Code

Telephone:( )_____

Mother's occupation _____

Father's occupation _____

4. **General Information**

Date of birth:_____

Last school grade completed:_____

5. **High School Science/Mathematics Courses Completed**

Course Name and Number	**Final Mark**

Course Name and Number	**Final Mark**

6. **College or University attended (or planning to attend):**

College/University	Year(s) of Attendance	Major

7. **Employment History:**

Employer	Position	Year(s)

8. **Career/Career Goals**

Career plans, if known_____

_____

_____

If you are considering more than one option, please provide the careers you are considering._____

_____

_____

If you have yet to form your career plans, check here_____

9. Please indicate how you feel about each of the following statements by ticking the appropriate box.

	Strongly agree	Agree	Disagree	Strongly disagree	Don't Know
Careers in science and engineering are accessible to women.	[ ]	[ ]	[ ]	[ ]	[ ]
Science and engineering studies are more difficult for women than for men.	[ ]	[ ]	[ ]	[ ]	[ ]
There are more barriers for women pursuing science and engineering careers then there are for men in these fields.	[ ]	[ ]	[ ]	[ ]	[ ]
Science and engineering fields do not welcome women.	[ ]	[ ]	[ ]	[ ]	[ ]
Science and engineering are attainable career options for men and women.	[ ]	[ ]	[ ]	[ ]	[ ]
Women can succeed in science and engineering.	[ ]	[ ]	[ ]	[ ]	[ ]
Female scientists and engineers must work harder than males to succeed in their field.	[ ]	[ ]	[ ]	[ ]	[ ]
Women can have a career in science or engineering as well as a family.	[ ]	[ ]	[ ]	[ ]	[ ]
Men can have a career in science or engineering as well as a family.	[ ]	[ ]	[ ]	[ ]	[ ]
Science and engineering fields of study are accessible to me.	[ ]	[ ]	[ ]	[ ]	[ ]

	Strongly agree	Agree	Disagree	Strongly disagree	Don't Know
I feel confident that I can reach my career goals.	[ ]	[ ]	[ ]	[ ]	[ ]
I would have to work harder than my male peers in order to succeed in science or engineering.	[ ]	[ ]	[ ]	[ ]	[ ]
I have considered pursuing a career in science and/or engineering.	[ ]	[ ]	[ ]	[ ]	[ ]
The WISE Program helped me decide what careers I do not want to pursue.	[ ]	[ ]	[ ]	[ ]	[ ]
The WISE Program made me feel more confident about attending a post-secondary institution.	[ ]	[ ]	[ ]	[ ]	[ ]
The WISE Program provided me with more information about careers in science and engineering.	[ ]	[ ]	[ ]	[ ]	[ ]
The WISE Program has made me feel more confident about my future.	[ ]	[ ]	[ ]	[ ]	[ ]
The WISE Program has helped me see the importance of science in everyday life.	[ ]	[ ]	[ ]	[ ]	[ ]
The WISE program helped me to choose a career in science and/or engineering.	[ ]	[ ]	[ ]	[ ]	[ ]
The WISE program encourages young women to consider careers in science and engineering.	[ ]	[ ]	[ ]	[ ]	[ ]

10. Please provide any information about yourself, the WISE program, your WISE experience or anything else that you feel is important to the assessment of the effectiveness of the WISE program.

Please comment on your attitudes about the issue of women in science and engineering by referring to at least three of the statements from the previous page.