FACTORS INFLUENCING WOMEN'S PARTICIPATION IN MATHEMATICAL DISCIPLINES

by

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Abstract

Few high-achieving, university-bound, female high school students are choosing to pursue a mathematics degree at university. Researchers have discussed a wide range of factors that may account for this situation. This thesis is a two-stage mixed-methods research investigation of the factors that influence mathematically-able (above 70% in advanced mathematics courses), university-bound women's decision to pursue or not pursue a mathematics degree. Students in two Grade 12 advanced level classes in mathematics were surveyed regarding their post secondary career and schooling intentions. The data were analyzed in three different ways: comparing male to female mathematics students generally, comparing men and women who intend to pursue mathematics after high school versus those who do not, comparing women who intend to pursue mathematics as a major to those who do not. Findings from the first stage survey indicated that women and men had chosen to pursue mathematics at university in equally low numbers. Females' intentions to pursue a particular career were linked to genuine interest whereas males' reasons were linked to pay as well as genuine interest. Women who were intending to pursue a mathematics degree identified teachers as their person of greatest influence.

In the second stage of the study five female students who were intending to pursue mathematics at university and five who were not were selected from the larger group for interviews. Interview data indicated that despite equally strong achievement levels in high school the two groups of women differed greatly in their self-confidence in their mathematical ability and their view of mathematics teachers. Recommendations for further research are discussed.

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Chapter One: Introduction

1.1. Context of the Study

Over the past two decades there has been extensive evidence that female students are reluctant to enroll in advanced mathematics subjects in secondary school (Greenfield, 1996; Hatchell, 1998; Linn & Hyde, 1989) and engage in career paths that require advanced mathematics skills (Dick & Rallis, 1991; Hanna, 2003).

In 1998 less than 1% of the 281 132 women enrolled full-time in Canadian university undergraduate programs were majoring in mathematics (Statistics Canada, 2001). While women represent over 56% of full-time Canadian university undergraduate students, they constitute only 44% of all students studying mathematics. Even though women's enrolment in undergraduate programs is on the rise, women's representation in mathematics is lagging well behind other disciplines, such as the health professions (Statistics Canada, 2004). On the other hand, careers requiring mathematics skills are growing (Canadian Education Statistics Council, 2000). As a result, women are not fully participating in one of the fastest growing sectors of our economy.

Historically, women were discouraged from pursuing careers in mathematics (Acker & Oatley, 1993; Brush, 1980; Mau & Domnick, 1995; Meece, Parsons, Kaczala, Goff, & Futterman, 1982; Sherman & Fennema, 1977). Some researchers contend that they continue to be discouraged from pursuing advanced mathematics courses and career paths (Hatchell, 1998). The reasons leading to the under-representation of women pursuing mathematics as a major in university are unclear.

Researchers have proposed that factors such as negative attitudes toward mathematics, socialization, poor teaching practices, limited exposure to extracurricular activities in mathematics, and lack of information about mathematics related careers may be possible causes of the under-representation of women in the field of mathematics (Gadalla, 1998; Hatchell, 1998).

Dick and Rallis (1991) examined the career choices of 59 women and 74 men with strong records of enrolment and achievement in mathematics and science in American high schools. Results of this study demonstrated that only 19% of women with strong mathematics and science backgrounds (compared with 64% of men with similar backgrounds) intended to pursue careers in science or mathematics. Dick and Rallis concluded that it could not be assumed that women who have excelled in science and mathematics in high school will pursue careers in science, mathematics and engineering: "Because even high school women with exceptional academic preparation in mathematics and science continue to choose careers in engineering and science in disproportionately low numbers, we can expect a continuance of the under-representation of women in these fields" (p. 290).

1.2. Purpose of the Study

The primary aim of this research project was to look at women's intentions to participate in mathematical disciplines at the university level. It focused on mathematically-able women's motivations. Women's intentions to participate in mathematical disciplines were examined and contrasted with women's intentions to pursue non-mathematics related programs.

1.3. Key Research Questions

This study investigates two questions:

1. Why are university-bound, mathematically-able women, given the expanding job market in mathematics, planning to major in mathematics in such low numbers?
2. Which factors play a role in influencing academically prepared women's decisions to take mathematics at university and which factors are the most influential?

1.4. Limitations and Significance of the Study

While the sample size is not sufficient for generalization to the wider population, the study nonetheless will add to the research on women's motivations for pursuing or not pursuing mathematics at the post-secondary level. It will offer more qualitative research on the factors affecting the educational choices of female students. Dick and Rallis (1991) concluded that interviews with mathematically capable, university bound women might be the most helpful means of gaining a more detailed picture of the forces and factors forming their career choices.

1.5. Plan of the Thesis

This thesis is organized as follows:

- Chapter two analyzes the literature relevant to the study.
- Chapter three is a framework of the research methods used in this study. As well, a set of codes is developed from the literature in this field to create an instrument for data analysis.

- Chapter four is an analysis of the data collected during the open-ended questionnaires.
- Chapter five is an analysis of the data collected during the interview stage.
- Chapter six is a discussion of the results and answers the two research questions framing this study. It also proposes and outlines future research possibilities.

Chapter Two: Literature Review

2.1. Introduction

A review of literature pertaining to participation in university mathematics education provides a context for the study. First, the enrolment figures of undergraduate university programs will be examined. Second, the under-representation of women in academic and employment fields related to mathematics will be reviewed. Third, possible factors related to, and affecting, enrolment in the field of mathematics will be explored. Finally, a model of the interplay of factors influencing career choices in mathematics will be examined.

2.2. Canadian University Enrolment Trends

Women's enrolment, as a percentage of students in undergraduate university programs, has risen steadily over the last three decades. In 1972, 255 371 students were enrolled full-time in university undergraduate programs, 98 098 of whom were women (Statistics Canada, 1994). Women thus represented 38% of all full-time undergraduate students enrolled in Canadian universities at this time. By 1998, women's enrolment had grown to 56% of students enrolled in Canadian university undergraduate programs (Statistics Canada, 2001). In addition, women represented 62% of all students enrolled part-time in university programs (Statistics Canada, 2001). The number of men and women enrolled in all university programs from 1990 to 1998 are displayed in Table 1. As can be seen in Table 1 women account for all undergraduate enrolment increases during this decade.

Table 1: Undergraduate Enrolment in All Programs at Canadian Universities from 1990-1999, by Gender (Statistics Canada, 2001)

Year	Total	Men	Women	% Women
1990-91	468 296	221 879	246 417	52.6
1991-92	485 461	227 712	257 749	53.1
1992-93	497 241	231 269	265 972	53.5
1993-94	499 555	230 113	269 442	53.9
1994-95	500 500	228 056	272 444	54.4
1995-96	498 189	224 417	273 772	55.0
1996-97	498 036	223 086	274 950	55.2
1997-98	497 072	220 309	276 763	55.7
1998-99	500 951	219 819	281 132	56.1

2.2.1. Mathematics University Enrolment Trends

From the early 70s to the early 90s, mathematics enrolment for men and women showed similar trends with varying degrees of fluctuation. Women's mathematics undergraduate enrolment increased at about a rate of 3% per annum, from the early 70s to the early 90s (Gadalla, 1998). Men's undergraduate enrolment on the other hand had a sharp increase, by about 10% per annum, from the late 70s to the mid 80s and then leveled off in the early 90s (Gadalla, 1998). Between 1990 and 1999, both men and women's enrolment in undergraduate mathematics programs dropped (see Table 2). Women's enrolment dropped from 3 504 in 1990/91 to 2 710 in 1998/99, while men have gone from 5 605 in 1990/91 to 3 496 in 1998/99 (Statistics Canada, 2001). This was a drop of 23% for women and 38% for men.

Table 2: Undergraduate Enrolment in Mathematics Programs at Canadian Universities from 1990-1999, by Gender (Statistics Canada, 2001)

Year	Total	Men	Women	% of Women
1990-91	9109	5605	3504	38.5
1991-92	9063	5515	3548	39.1
1992-93	8910	5457	3453	38.8
1993-94	8744	5292	3452	39.5
1994-95	7990	4727	3263	40.8
1995-96	7304	4267	3037	41.6
1996-97	6666	3865	2801	42.0
1997-98	6163	3508	2655	43.1
1998-99	6206	3496	2710	43.7

Note: Mathematics programs included in this table are mathematics, applied mathematics and statistics majors.

2.2.2. Enrolment Figures in Undergraduate University Programs

In addition to looking at the enrolment trends within mathematics, it is worthwhile to undertake an examination of enrolment in the discipline within the broader university community. The statistical data reveals that undergraduate students are enrolling in mathematics programs at a much lower rate than other university disciplines. In 1998, 500 951 university students were enrolled in full-time undergraduate programs with 6 206 enrolled in mathematics (Statistics Canada, 2001). Therefore, in 1998 less than 1.3% of undergraduate students were enrolled in mathematics (see Table 3).

Table 3: Full-time Undergraduate University Enrolment by Field of Study 1998 Comparing Women Only to Total Numbers (Source: Statistics Canada, 2000)

Field of Study	Number of Women Enrolled	Women as Percentage of Total	Total Number of Students Enrolled
Agriculture and biological sciences	24514	64%	38490
Education	38487	71%	54223
Engineering and applied sciences	10720	22%	48465
Fine and applied arts	11902	65%	18391
Humanities	27987	62%	44862
Physical sciences	6837	27%	25390
Social sciences	87598	58%	150765
Arts/science general	39792	59%	67057
Health professions	19637	72%	27330
Mathematics	2710	44%	6206
Not reported	10948	55%	19772

Mathematics enrolment is generally low, and women's proportion within that figure is lower than in some other disciplines such as health professions and social sciences. Women represent 44% of all students studying mathematics, while women represent over 56% of full-time Canadian undergraduate students.

2.3. Women's Post-Secondary Participation in Mathematics

Researchers have investigated a range of factors that they feel may account for women's lower enrolment in mathematics. Historically, research on poor enrolment in mathematics has focused on gender differences; there has been extensive research on the reasons for the lack of female enrolment in mathematics, at all educational levels (e.g. Acker & Oatley, 1993; Brush, 1980; Koller, Baumert, & Schnabel, 2001; Mau & Domnick, 1995; Meece et al., 1982; National Council of Teachers of Mathematics, 1989; Sherman & Fennema, 1977). The research has typically focused on social, educational, psychological and economic dimensions. Each of these dimensions will be explored in turn.

2.4. Social Explanations

Many researchers define socializers as the attitudes and expectations of others, such as: parents, teachers, counselors, and friends who influence a student's decision to pursue particular interests, in this case, mathematics (Haveman & Wolfe, 1994; Lam, 1997; Meece et al., 1982). In addition, the student's cultural milieu is a second social explanation that is seen to influence decision-making (Dick & Rallis, 1991). The division of labour by gender in society and cultural stereotypes held by society are part of the cultural milieu. The influence of socializers and cultural milieu will be examined as factors that could affect women's enrolment in mathematics.

2.4.1 Socializers

It has been suggested that socializers such as the attitudes and behaviours of a student's mother, father, teacher, counselor, friends and others have an effect on enrolment choices (Dick & Rallis, 1991; Jodl, Michael, Malanchuk, Eccles, & Sameroff, 2001; Mau, Domnick, & Ellsworth, 1995; Meece et al., 1982; Paa & MacWhirter, 2000). In the past, within North America, many people held the belief that female students were intrinsically incapable of attaining high levels of mathematical achievement (Armstrong & Price, 1982; Collis, 1991; Fennema, 1974; Lantz & Smith, 1981; Meece et al., 1982). These beliefs were held despite studies demonstrating that females and males were performing at a much closer level than originally thought (Kimball, 1989; Leder, 1992; Tate, 1997). Hyde, Fennema, and Lamon (1990) as well as Friedman (1989) performed meta-analyses of studies that were conducted from the early 70s to the mid 80s on mathematics achievement and gender. They both found that sex differences in mathematics achievement were very small. Girls outperformed boys up until high school and then throughout the high school years and into university, differences favouring males were common. They also found that sex differences in performance have decreased over the years. Despite such evidence, some negative stereotypes about women's poor mathematical capacity remain (e.g., women don't have a 'head' for math). For example, teachers' beliefs about students' achievement successes and failures in mathematics were examined in a study by Fennema, Peterson, Carpenter, and Lubinski (1990). They found that first grade teachers tended to attribute boys' successes and failures in mathematics to ability, while girls' successes and failures were attributed to effort. When comparing their best boy to their best girl in mathematics achievement, teachers reported that boys were more competitive, more logical, more adventurous, volunteered more answers, enjoyed mathematics more and were more independent than girls.

Parents' beliefs also affect the likelihood that a girl will study mathematics or pursue a career in mathematics. Jodl et al. (2001), in their study of 444 seventh graders, (with approximately equal numbers of African American and European American males and females, from two-parent families), found that in the academic domain, parents' values predicted adolescents' occupational aspirations. Mau (1995) found similar results for science-related career choices. In her study of 930 eighth-grade female students she found that educational aspirations and perceived parental expectations were the strongest predictors for most of the students who aspire to science-related careers. Girls who could not envision themselves in particular jobs were less likely to choose those jobs or see them as an appropriate career path.

Paa and MacWhiter (2000) widened the realm of socializers beyond teachers and parents. In their study of 464 high school students' perceptions of various factors that might influence their current career expectations, they found that female students were influenced by mothers, female friends, and female teachers. Women, as well as men, reported three major background factors influencing career choices: ability, role models and the media. Super (1990) found that role models or key figures in the immediate environment of an adolescent were viewed to be an important predictor of a student's career aspirations. In the category of environmental factors, men ranked their influences as: father, mother, and male friends. Women ranked their influences as: mother, father, and female friends.

Mau et al. (1995) also examined the interplay of personality and socializers. They reported that women who pursue nontraditional careers characterize themselves as self-confident, very competitive, and either highly independent or highly dependent on others. Women who pursued nontraditional career paths such as mathematics said that they received direct encouragement from teachers, counselors, and significant others. These women reported having working mothers as role models, and parents with higher education and occupational levels. These women are usually a first born or the only child, hold fewer traditional attitudes towards women, and perceive less conflict between combining work and family.

2.4.2 Cultural Milieu

In addition to immediate socializers, the wider society may also play a role in a women's decision to pursue mathematics. Aspects of one's cultural milieu, such as society's division of labour by gender, and cultural stereotypes are another focus of research into women's mathematics participation (Dick & Rallis, 1991; Fennema, 1985; Paa & MacWhirter, 2000). When women contemplate their future in mathematics, do they see themselves represented in the field? At this time, the majority of women who are employed continue to work in traditionally female-dominated occupations. In 2001, women represented 70% of those employed in teaching, nursing and related health occupations, clerical or other administrative positions or sales and service occupations (Statistics Canada, 2002; see Table 4).

Nonetheless, women have increased their participation in several other fields between 1987 and 2001. Within business and financial occupations, women moved from 41% in 1987 to 50% in 2001 (Statistics Canada, 2002). Among doctors, dentists and other health professionals (excluding nurses), women went from representing 44% of the field in 1987 to 54% in 2001 (Statistics Canada, 2002). Although there has been a significant increase in some non-traditional occupations, women continue to lag behind in such fields as the natural sciences, engineering and mathematics. In 2001, women represented 20% of all professionals in these fields, just a slight increase since 1987 when women accounted for 17% of those employed in these fields (Statistics Canada, 2002: see Table 4). Women's overall employment rates have increased from 1987 to 2001 by more than 31%, while men have shown an increase of slightly more than 15%. Women's employment in mathematics-based occupations is increasing very marginally compared to other occupations. Employment trends suggest that women have been, and still are, under-represented in the field of mathematics (see Table 4), therefore few role models exist for women making career decisions at the end of high school.

Table 4: Distribution of Employment, by Occupation, 1987 and 2001 (Statistics Canada, 2001)

Occupation	Women 1987	Men 1987	Women as a % of total employed 1987	Women 2001	Men 2001	Women as a % of total employed 2001
Total Management	6.2	11.6	28.9	6.7	10.9	34.8
Business, Finance	1.9	2.1	40.7	3.0	2.7	49.6
Natural Sciences, Engineering, Mathematics	1.8	6.6	16.7	2.9	9.8	20.4
Social Sciences, Religion	2.3	1.9	47.8	4.1	2.1	62.0
Teaching	5.0	2.8	57.3	5.2	2.6	63.3
Doctors, Dentists, Other Health	0.9	0.9	44.1	1.2	0.9	54.4
Nursing, Therapy, Other Health-related	8.0	0.9	87.3	8.0	1.0	87.0
Artistic, Literary, Recreational	2.8	2.0	50.4	3.3	2.4	53.7
Clerical, Administrative	29.6	7.7	74.4	24.9	6.9	75.5
Primary	2.4	7.3	20.0	1.4	5.4	19.1
Sales and Services	30.9	18.5	55.7	32.0	19.9	58.1
Trades, Transport, Construction	2.0	27.1	5.3	2.0	24.7	6.4
Processing, Manufacturing, Utilities	6.0	10.4	30.2	5.1	10.6	29.1
Total	100	100	43.0	100	100	46.2
Total Employed (000s)	5299.3	7021.4		6967.1	8109.7	

Some researchers believe that cultural stereotypes play a particularly strong role in women's decision to pursue or not pursue mathematics. The American Institutes for Research (1998) reported that even if boys and girls are treated equally, receive the same career preparation, counseling and school-to-work programs, girls still tend to follow traditional career paths. They hypothesize that uneven gender distributions in occupational fields remain, possibly due to inadequate challenges to gender stereotypes in the work force. The American Institutes for Research (1998) thus suggest that in order to encourage students to explore nontraditional careers, school-to-work programs must take into consideration the influences of cultural expectations, gender-role stereotypes, mathematics and science stereotypes, self-concept, self-esteem, fear of success, family and life planning, the role of parents and peers, and support systems. They contend that gender stereotypes hurt both males and females by eliminating options and choices of both boys and girls (American Institutes for Research, 1998). Viewing science and mathematics as things boys do and art and dance as things girls do, serves as a major influence on academic course selection and achievement levels of both sexes (Walker, 1993). The perception by girls and society of mathematics as a male domain is therefore viewed as being a crucial factor in the handicap experienced by females in mathematics (Leder, 2001).

2.5. Educational Explanations

Educational factors also have persuasive effects on women's enrolment in mathematics. In particular, past school experiences, self-concept, perceived ability, and mathematics anxiety will be investigated as factors influencing enrolment choices.

2.5.1. Past Experiences

Ensuring mathematical competence is thought to be a key factor for increasing women's representation in the educational and professional field of mathematics (Dick & Rallis, 1991). In the past, mathematics has been stereotyped as a male domain (Friedman, 1989; Hyde et al., 1990). The last 30 years of research suggest a change in public attitudes. Recent studies have suggested that the gender gap in mathematics achievement is much smaller than originally thought and the small gap that does exist is decreasing (Friedman, 1989; Hanna, 2003; Hyde, Fennema, & Lamon, 1990; Kimball, 1989; Linn & Hyde, 1989; Tate, 1997). These findings were reaffirmed in the latest Programme for International Study of Student Achievement (PISA) study with Canadian 15 year old students where boys outperformed girls in mathematics but the difference was small (Bussiere, Cartwright, & Knighton, 2004).

Initially, researchers made biological arguments to account for the lack of female participation in mathematics, until improving achievement scores did away with this argument (Armstrong, 1981; EQAO Research Series, 1999; Fennema & Sherman, 1978; Kimball, 1989). There is no way of assessing how much, if at all, biology influences women's achievement in mathematics; therefore, other possibilities need to be examined. With a shrinking gender gap in mathematical performance, the average girl and average boy are more alike than they are different. Girls are now studying mathematics at the high school level at an increasing rate. In 1994 women accounted for 46% of students enrolled in OAC mathematics courses (Gadalla, 1998; see Table 5). While overall rates are unavailable, a small sample of four high schools in the the Waterloo district school board reports that girls accounted for 49% in 2004/05 and now account for 50 % of the enrolment in university required mathematics classes in 2005/2006 (L. Beetham, personal communication, April 12, 2006; I. Keena, personal communication, April 12, 2006; K. Mann, personal communication, April 12, 2006; M. Schroeder, personal communication, April 13, 2006).

Table 5: Enrolment in High School OAC Mathematics Courses, Ontario, 1994 (Gadalla, 1998)

	Total	Men	Women	% of Women
Mathematics	108 982	58 678	50 304	46.2

Nevertheless many women who are well prepared in mathematics, both in terms of previous course selection and achievement, are still choosing not to pursue mathematics university programs. This suggests that women's low enrolment in university mathematics programs is not solely related to mathematical avoidance. Dick and Rallis (1991) found this to be the case in their study of mathematically high-achieving male and female students. Even students who were capable of pursuing mathematics indicated that other factors, in addition to achievement, played a role in their decision to pursue mathematics. The influence of parents and teachers were mentioned more often by students pursuing a career in mathematics than by students not pursuing careers in mathematics.

2.6. Psychological Factors

While girls are now achieving in mathematics at levels close to those of boys in high school (Bussiere et al., 2004; Hanna, 2003), their interpretation of their experiences may be different. Some researchers suggest that psychological factors such as mathematical anxiety, perceived mathematical ability, and self-concept affect girls' decision whether to pursue mathematics (Chipman, Krantz, & Silver, 1992; Ethington, 1992; Hembree, 1990; Ma, 1999).

2.6.1. Self-concept and Self-Perceived Ability

Meece et al. (1982) found that a student's self-perceived ability is directly related to educational and career choices. If a student's perception of achievement is higher, he or she will be more likely to enroll in a particular mathematics course. A more recent study by Douglas (2000) found that a student's mathematical self-concept is directly associated with a student's performance in mathematics.

Researchers have found that by junior high school, boys have a higher self-concept regarding their mathematics ability than do girls (Acker & Oatley, 1993; Brush, 1980; Fennema & Sherman, 1977; Mau et al., 1995; Meece et al., 1982; Robertson, 1988). Collis (1991) described what she called the "We can but I can't" paradox: girls strongly advocate female's abilities in mathematics as a whole, but are doubtful about their own mathematical abilities.

Interestingly, Leder (1992) found that girls are less likely to feel confident about their abilities in mathematics even when they perform as well as boys. Girls rate their ability in mathematics lower than males and expect to do less well on mathematic tests (Stipek & Gralinski, 1991) when, in fact, girls perform as well or even better than boys on school mathematics tests (Friedman, 1989; Tate, 1997). Moreover, boys have a tendency to attribute failure to luck and success to high ability, while girls were less likely to attribute success to high ability and attributed failure to low ability (EQAO Research Series, 1999; Stipek & Gralinski, 1991).

2.6.2 Mathematics Anxiety

Researchers have conducted exhaustive studies on the belief that mathematics anxiety is one of the major factors in the lack of female participation in higher education mathematics. Mathematics anxiety is described as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (Richardson & Suinn, 1972, p.551). People who have mathematics anxiety tend to avoid mathematics, which can create problems. Wilson (1997), for example, pointed out that anxiety about mathematics and statistics could result in impaired performance, mental anguish, and avoidance of statistics and mathematics courses needed for professional advancement. This eliminates several career choices for individuals, particularly women.

Some researchers have proposed that females have higher mathematics anxiety than males (Wigfeild & Meece, 1988) while other studies have shown that males and females do not differ in reporting mathematics anxiety (Ohlson & Mein, 1977). Researchers have found that women and men like mathematics equally, the difference lies in women having less confidence when it comes to learning mathematics (Hyde et al., 1990; Stipek & Gralinski, 1991).

2.7. Economic Explanations

In this section economic factors will be examined as possible factors affecting women's enrolment in undergraduate mathematics programs. These factors include interests and career aspirations.

2.7.1. Career Aspirations and Interests

Foot and Pervin (1983) suggest that the perceived economic value of return on an educational program is a very strong determinant of a student enrolling in a particular post-secondary program. For men, this may be the case. However, American researchers have found that upon leaving high school women's interests generally influence their choice of a career or educational path, whereas men are more concerned with money (Dick & Rallis, 1991; Paa & MacWhirter, 2000). Parsons (1981) found that a student's intent to continue taking mathematics courses is directly affected by his or her estimation of the economic and personal value of mathematics courses. A person's values and life goals can influence the value one attaches to certain activities; hence activities that are consistent with these beliefs are seen as more valuable. It was found that females were less likely to hold mathematics-related values than males.

Finally, while there is little research in the field on employment opportunities as an explanation for low enrolment the statistics on this area should be included as one possible contextual explanation.

2.8. Employment Opportunities

Limited job prospects in Canada is, in fact, not an issue, as full-time employment rates of mathematics majors are higher than full-time employment rates of social sciences and fine and applied arts (see Table 6).

Table 6: Canadian Labour Force Status of 2000 Bachelor's Degree Recipients in 2002 by Field of Study (Statistics Canada, 2004).

Field of Study	Full time %	Part time %	Sub-total %	Unemployment rate %
Agriculture and biological sciences	90	**	92	**
Education	74	12	87	9
Engineering and applied sciences	88	**	90	8
Fine and applied arts	65	18	83	9
Health professions	84	12	95	2
Humanities	73	14	88	7
Mathematics and physical sciences	84	**	87	11
Social sciences	80	7	88	8
Business and management	89	**	93	5
Total	81	8	90	7

Note: Graduates who pursued further education after their 2000 graduation are excluded from this table, as are the graduates for whom the labour force status could not be calculated.

** These numbers where not reliable enough to release.

Source: National Graduates Survey (Class of 2000), April 2004. Centre for Education Statistics, Statistics Canada

In 2002, 84% of mathematics and physical science graduates were employed full time. Three fields of study had higher rates of full-time employment; engineering and applied sciences, business and management as well as agriculture and biological sciences with full-time employment rates of 88%, 89% and 90% respectively.

2.9. Model of Career Choices

While all of the factors outlined earlier are likely to have some impact on a women's decision to pursue or not pursue mathematics in university, the more interesting question is: how do these factors work together? Which factors play the more influential role in mathematical career choice? In order to address this, we must turn to an overarching model of career choice in mathematics.

In this section a number of the models that have been developed over the years to explain the factors that influence student's career choices are reviewed. These models include: a conceptual model linking dimensions of parenting to adolescent occupational aspirations; a model based on the race, gender, and socioeconomic status of students; a general model of academic choice; and, a model based on the interplay of factors influencing career choices in mathematics.

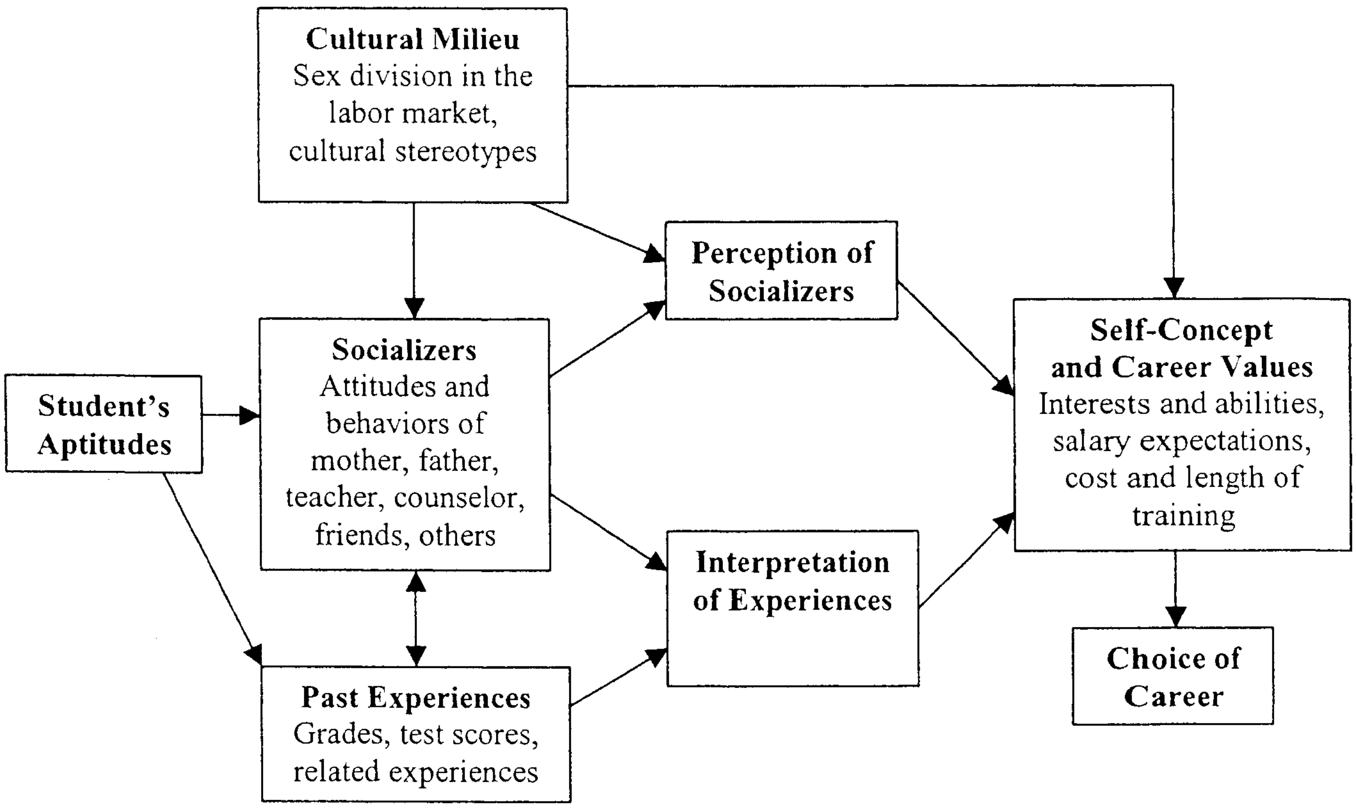
Jodl et al's (2001) model links dimensions of parenting and adolescence to occupational aspirations. This model argues that parents' values and beliefs affect youths' values and beliefs both directly, and indirectly, through specific parental behaviours. Positive identification with parents allows students to internalize their parents' values. A youth's personal values and beliefs, that have been directly and indirectly affected by the other factors in the model, will have the final effect on the student's occupational aspirations. This model deals solely with parental factors influencing career choices and neglects other factors that researchers have found to have an effect on academic and career choices (i.e. teachers, cultural milieu, and counsellors, past experiences, self-concept and career values).

Reyes and Stanic (1988) developed a model that considered factors such as societal influences, teachers' attitudes, curriculum, classroom processes, student attitudes and student achievement. This model proposes how these factors interact to affect student achievement. The model, however, does not go as far as to demonstrate how these factors, as well as student achievement, affect a student's decision to pursue an educational or occupational path.

Meece et al. (1982) developed a general model of academic choice. Meece's model argues that academic choice is related to a student's expectation to succeed and the value given to the particular task. The model makes the assumption that a student's interpretation of past experiences and socialization greatly affect achievement behaviours. As well, expectations and values are influenced by students' perceptions of their own abilities, task difficulty and goals.

Dick and Rallis's (1991) model of career choices, which takes into account more factors, is adapted from a general model of academic choice developed by Meece et al., (1982). This model is the most comprehensive because it includes more of the factors discussed in the literature on factors influencing career choices, such as socializers, cultural milieu and past experiences. Therefore, I will adopt this model to examine how these factors work together to influence an individual's decision to enroll in a particular program (see Figure 1).

Figure 1: Model of career choices from Dick and Rallis, 1991, as adapted from Meece et al., 1982.



Dick and Rallis (1991) theorize that a student chooses a career based on interests, belief about their abilities, and the perceived value of pursuing a particular career. The student's perception of socializers and their interpretation of experiences directly affect his or her self-concept and career values. In addition, socializers such as attitudes and behaviours of parents, teachers, counsellors and friends, as well as a student's past achievements and performances in mathematics influence a student's career choice. A student's aptitude plays a role in shaping his or her experiences and can shape the socializers' attitudes and expectations for the student. The cultural milieu and society that we live in influences the attitudes and expectations of a student's socializers as well as a student's perception of their own ability and career values. This model is helpful as it shows clearly how the different factors have an influence on career choice. Therefore, this model will be adopted as a way to structure this study, leading to the survey and interview questions as well as subsequent analysis codes.

Chapter Three: Method

3.1. Research Questions

1. Why are university-bound, mathematically-able women, given the expanding job market in mathematics, planning to major in mathematics in such low numbers?

2. Which factors play a role in influencing mathematically academically-prepared women's intentions to take mathematics at university and, which factors are the most influential?

3.2. Theoretical Model

Dick and Rallis's (1991) model of career choice was used to frame this study. Consistent with Dick and Rallis's model of career choices, it was anticipated that the following variables would affect female students' career and educational choice in mathematics:

1. Student's aptitude
2. Cultural milieu
3. Socializers
4. Past experiences
5. Self-Concept and career values

The study was structured to determine whether these variables affected women's intention to pursue mathematics beyond the secondary level. The survey and interview instruments, as well as the analysis codes, were derived from these variables.

3.3. Design of the Study

This is a two-stage, mixed-methods research study. In the first stage, open-ended questionnaires (see Appendix A) were given to students in two Grade 12 mathematics classes. In the second stage, follow-up interviews (see Appendix B) were conducted with ten female students. The first stage was designed to determine whether the overall picture of intention to pursue mathematics is similar to patterns found in earlier studies. In addition the survey data from the first stage was used to select the smaller sample for the interviews in the second stage. The second stage consisted of ten student interviews, which allowed me to clarify and deepen my understanding of the factors affecting a mathematically-capable woman's decision about pursuing mathematics -- providing data to answer my second research question. The selection of ten students, five of whom were not pursuing mathematics, allowed me to gather data to address my first research question.

3.3.1. Stage 1: Selection of the Sample

In Stage 1, a list of high schools in the Waterloo District School Board was created. From this list, two classes where chosen based on ease of access, that is, two classes from one school that was willing to support the study. This *convenience sample* (Cohen, Manion, & Morrison, 2000) comprised two Grade 12 classes of Advanced Functions and Introductory Calculus for university-bound students. The sample of students completing the questionnaire was twenty-seven male and thirty female students.

3.3.2. Stage 1: Open-ended Questionnaire

The open-ended questionnaire (see Appendix A) was designed to gather the following information using short answer responses:

1. Gender
2. Mathematics courses completed in high school
3. Students' perception of factors influencing their decision to take or not to take mathematics courses (i.e. ability, interest, career need, encouragement from others)
4. Students' perception of which socializers influence their career choices (i.e. mother, father, teacher, counsellor, friends, etc.)
5. Planned undergraduate university enrolment
6. Students' perceptions of the two most important reasons for choosing a university undergraduate program of study
7. Career goal(s)
8. Students' perceptions of the two most important reasons for choosing a career

The questions were designed to find women who fit the criteria to answer the first research question (i.e. mathematically capable women who were or were not going on in mathematics) as well as to gather information on each of the variables from the model to address the second research question (See Table 7).

Table 7: Survey Instrument

1. Model of Career Choice Variables	2. Open-ended survey questions derived from the model of career choices.
Student Aptitude	1. What is your typical grade range in mathematics? a) 100-90 b) 89-80 c) 79-70 d) 69-60 e) 59-50 f) Below 50
Cultural Milieu Sex division in the labor market, cultural stereotypes	2. I am … a) Male b) Female
Socializers Attitudes and behaviors of mother, father, teacher, counsellor, friend and others.	3. What person(s) influenced your career choices?
Past Experiences Grades, test scores, related experiences	4. What high school mathematics courses have you completed?
Self-Concept and Career Values Interests and abilities, salary expectations, cost and length of training	5. Why did you choose to take these mathematics courses? 6. What was the most important factor to have an affect on your choice of a University major? 7. What was the most important factor to have an affect on your choice of a career?
Career Choice	8. What do you plan on studying at university? 9. What are your career goals?

3.3.3. Stage 1: Conducting the Survey

In order to find classes to participate in this study I spoke to principals and teachers in the Waterloo District School Board. Once I received verbal confirmation that they would be willing to participate, letters asking for approval to survey the classes were sent to the Waterloo District School Board, the school's principal and the classroom teacher (see Appendix C). This letter included the purpose and the significance of the study, as well as data collection methods. Teachers where informed that students were participating on a voluntary basis and that all information provided would be kept securely stored and confidential at Lakehead University. Students were not required to participate, and could refuse to answer any of the questions or withdraw at any time.

Data were gathered during the spring of 2004. A cover letter and letter of consent were given to participants during a regularly scheduled mathematics class. The classroom teachers introduced me to their students and then I explained the nature of the study to the Grade 12 class. During the next scheduled class that I attended those students who had permission were given an open-ended questionnaire. If the students did not have permission or chose not to participate they where instructed by their classroom teacher to work on their homework. Participants were asked to put their name on questionnaires in order to identify possible interview candidates. A copy of the cover letter and letter of consent for students are found in Appendix D and E respectively, and for parents in Appendix F.

3.4. Stage 2

Initiation of the second stage occurred after the completion of data analysis related to Stage 1. This timing was required as the questions utilized in Stage 2 were derived from data collected in the first stage and from the pertinent literature.

3.4.1. Stage 2: Interviews

Dick and Rallis (1991) concluded that given the inherent limitations of surveys and the rarity of women choosing nontraditional careers, interviews with these women might be the most helpful means of gaining a more detailed picture of the forces and factors forming their career choices. Therefore, interviews were used to gain insight beyond that provided in the Stage 1 questionnaires, into why academically-capable women are choosing to pursue or not to pursue a mathematics degree. The development of interview questions was based on Dick and Rallis's (1991) model of career choices outlined in Table 8.

Table 8: Interview Instrument

Model of Career Choice	Interview questions derived from the model of career choices.
Student Aptitude	1. What marks do you usually obtain in mathematics?
Cultural Milieu Sex division in the labor market, cultural stereotypes	2. What level of education did your mother last complete?
	3. What does your mother do for a living?
	4. What level of education did your father last complete?
	5. What does your father do for a living?
Socializers Attitudes and behaviors of mother, father, teacher, counsellor, friend and others.	6. What person(s) influenced your career choices?
	7. Who has been the most influential in your educational choices?
	8. What are your parents' opinions of mathematics?
	9. Describe your mathematics teachers.
	10. What are your parents' career expectations of you?
	11. How important is your attaining a university or college degree to your parents?

Model of Career Choice	Interview questions derived from the model of career choices.
Past Experiences Grades, test scores, related experiences	12. What high school mathematics courses have you completed? 13. Have you ever thought of pursuing a career in mathematics? 14. How do you feel about mathematics? 15. Describe a positive experience you have had in mathematics. 16. Describe a negative experience you have had in mathematics.
Self-Concept and Career Values Interests and abilities, salary expectations, cost and length of training	17. Why did you choose to take these mathematics courses? 18. How important is attaining a university or college degree to you? 19. What program are you interested in studying at university? 20. What are your career goals? 21. What are your reasons for pursuing this career? 22. What is your main reason for pursuing this career?
Career Choice	23. What do you plan on studying at university? 24. What affected your choice of a university major? 25. What are your career goals? 26. What affected your choice of a career?

The interview questions can be found in Appendix B. Some questions asked during the open-ended questionnaire are repeated in the interview; this was done to clarify responses and provoke thought on a particular component in question.

3.4.2. Stage 2: Selection of the Sample

In Stage 2, students were chosen for interviews based on their responses to the open-ended questionnaire, in particular, their choice of major. Ten female students were selected for interviews, five of whom have chosen to pursue mathematics at university and five of whom have not. Based on the first stage of results, only five women had decided to pursue mathematics at university, therefore all five were interviewed. Three criteria were used in order to select only 5 women to interview from the 25 remaining who were not pursuing mathematics at university. First, those women pursuing college or other non-university career paths were eliminated. Second, those women pursuing education in fields closely related to mathematics such as engineering or science were removed. The final criteria utilized to narrow the selection was the women's self-reported achievement in mathematics throughout high school. The top achievers (above 70%) were selected for an interview. Therefore, the ten women chosen were all highly academic, well-prepared, university-bound students. Selection of these five women allowed me to gather detailed data on why capable women were not pursuing a mathematics degree.

3.4.3. Stage 2: Conducting the Interviews

Ten students were selected based on their responses and approached to participate in a follow-up interview. If a student said "no", the next best candidate would have been asked to participate. Fortunately, the first ten students selected agreed to participate in the study. Permission for follow-up interviews had been obtained from both the students and parents (of students under 18 years of age) during the first stage of the study. The interviews took place during school hours in the school library as well as the classroom.

Each interview was tape recorded and transcribed by me. The identity of the participants in the open-ended questionnaires and interviews, as well as school names, were kept confidential.

3.5. Data Analysis Procedures: The Development of Interview Codes

Based on the model of career choices from (Dick & Rallis, 1991), I created codes that reflected the organization of the model (see Table 9). Column 1 is a list of the factors from the model of career choices from Dick and Rallis (1991). Column 2 is an explanation of the model factors as described by Dick and Rallis (1991). Column 3 is a list of codes in bold based on expected student responses developed from the literature on studies discussed in Chapter 2. In this study I used the codes to begin the analysis of the transcripts of the interviews. They supported my analysis of whether I found similar influences on women's intention to pursue mathematics as was found in the research literature.

Table 9: Template for Code Development

1. Model of Career Choice (see figure 1)	2. Explanation	3. Expected student responses
Student Aptitude	The student must have the belief in their own abilities, that they are intellectually capable of pursuing a mathematics career.	Collis (1991) described what she called the "We can but I can't" paradox: girls strongly advocate females' abilities in mathematics as a whole but are **doubtful about their own mathematical abilities**. If a **student's perception of achievement is higher**, he or she will be more likely to enroll in a particular mathematics course (Leder, 1992). **Attitude is directly related to mathematical performance** (Douglas, 2000). **Girls rate their ability in mathematics lower** than males and expect to do less well on mathematics tests (Stipek & Gralinski, 1991). Research has suggested that boys have a tendency to attribute failure to luck and success to high ability, while **girls were less likely to attribute success to high ability and attributed failure to low ability** (EQAO Research Series, 1999; Stipek & Gralinski, 1991).

1. **Model of Career Choice (see figure 1)**	2. **Explanation**	3. **Expected student responses**
Cultural Milieu	The cultural milieu that a student and their socializers live in will have an influence on the attitudes and expectations of the students' socializers as well as the students' perception of the socializers.	The American Institute for Research (1998) reported that even if boys and girls are treated equally, receive the same career preparation, counseling and schools to work programs, **girls still follow traditional career paths.** **The perception of mathematics as a male domain** is viewed as being a crucial factor in the handicap experienced by females in mathematics (Leder, 2001).
Socializers	Socializers exert and influence on the student through their attitudes and expectations, they also provide experience and influence how the student perceives those experiences.	**The attitudes and behaviours of a student's mother, father, teacher, counselor, friends and others** have an effect on enrolment choices (Dick & Rallis, 1991; Jodl et al, 2001; Paa & MacWhirter, 2000). **Parents' values** predicted adolescents' occupational aspirations (Jodl et al., 2001).
Past Experiences	Students must have the academic preparation to pursue a mathematical career. They must also have positive mathematical past experiences.	Students who are capable of pursuing mathematics have indicated that other factors in addition to achievement played a role in their decision to pursue mathematics. **The influence of parents and teachers** were mentioned more often by students pursuing a career in mathematics more than by students not pursuing careers in mathematics (Dick & Rallis, 1991).

1. Model of Career Choice (see figure 1)	2. Explanation	3. Expected student responses
Self-Concept and Career Values	Students make their career choices based on their beliefs about themselves and their own abilities as well as the value of different careers. A careers value is determined by intellectual interest, salary expectations as well as cost and length of training.	A study by Parsons (1981) showed that a student's intent to continue taking mathematics courses is directly affected by his or her **estimation of the economic and personal value of mathematics courses**.

3.6. Limitations

The main limitation of this study is the size of the sample. Qualitative research methods help gather rich in-depth information but can not necessarily be generalized nor deemed statistically significant. Nevertheless, this study will add to previous research and theories by contributing a more detailed picture of the factors shaping these students' career choices.

3.7. Ethical Considerations

This study followed all ethics procedures and guidelines for research as outlined by Lakehead University. All participants signed a letter of consent (Appendix E) and parents signed a letter of consent for participants under the age of 18 (Appendix F). The participants were made fully aware that they could withdraw without penalty of any sort, at any time during the study. There was no apparent risk of physical or psychological harm. All information provided will be kept securely stored and confidential at Lakehead University. The purpose was to gain an understanding of the factors influencing women's participation in mathematics majors.

Chapter Four: Results Stage One

4.1. Comparing Men and Women's Patterns of Study and Career Choice

The data were analyzed in three different ways: comparing men to women generally, comparing students who intend to pursue mathematics after high school versus those who do not, comparing women who intend to pursue mathematics to those who do not.

In the first analysis I found that there were almost equal numbers of women and men enrolled in the two advanced mathematics classes. Males reported that their grades in mathematics were much higher than their female counterparts (see Table 10). These reports cannot be verified as I did not have access to the grades.

Table 10: Students Self-Reported Mathematics Grades

Mathematics Grades	Percent of Females (N=30)	Percent of Males (N=27)
100-90	13.3	29.6
89-80	20.0	44.4
79-70	43.3	18.5
69-60	20.0	7.4
59-50	3.3	0.0
Below 50	0.0	0.0
Total	100.0	100.0

Based on the direction of the study a number of students with self-reported grades of less than 70% were removed from the sample, (7 females and 2 males), in order to compare students with high achievement in mathematics. Thus the sample consisted of 23 women and 25 men who had an average grade higher than 70%.

These women and men were taking mathematics courses in high school for substantively different reasons (see Table 11). Most women (56%) indicated that they were taking high school mathematics courses in order to pursue a particular career such as medicine. They were taking mathematics courses because they are pre-requisites for future educational endeavours rather than because of their personal interest in mathematics. In contrast, the largest proportion of men indicated they were pursuing high school mathematics courses out of interest (44%) and as a result of ability (32%).

Table 11: Percent of Students Indicating Specific Factors and Influences on Their High School Mathematics Course Selection Choices

Reasons for taking mathematics courses in high school	Percent of Females (N=23)	Percent of Males (N=25)
Ability	26.1	32.0
Interest	17.4	44.0
Career Need	56.5	24.0
Encouragement from Others	0.0	0.0
Total	100.0	100.0

More students in this study were planning on pursuing a university degree than is the case in the general high school population. Approximately 4 out of 5 male and female students were planning to attend University after high school (see Table 12).

Table 12: Percent of Students Indicating Their Plans After High School

Plan after high school	Percent of Females (N=23)	Percent of Males (N=25)
Job	0.0	0.0
Start a Business	0.0	0.0
Military	0.0	0.0
Trade School	0.0	0.0
College	17.4	12.0
University	82.6	88.0
Total	100.0	100.0

Of all the possibilities offered, the students identified a parent of the same gender as the greatest influence in their career choice (see Table 13). One out of three women reported that they had been influenced by their mothers to pursue a particular career, while two out of five men where influenced by their fathers to pursue a specific career.

Table 13: Percent of Students Who Indicated a Specific Socializer Influencing a Career Choice, by Gender

Person who influenced career choices	Percent of Females (N=23)	Percent of Males (N=25)
Mother	34.8	4.0
Father	13.0	40.0
Teacher	26.1	20.0
Counsellor	13.0	16.0
Friend	13.0	20.0
Total	100.0	100.0

There was a substantive difference between the academic choices of mathematically well-prepared men and women (see Table 14). On the one hand, men and women planned to pursue mathematics in equally low numbers (18 – 21%). On the other hand, more than three times as many men (50%) as women (15%) were going on to pursue engineering. Over 50% of women chose programs of study in the health professions and in education, while only 22% of men chose programs of study in the health professions. No mathematically capable men chose to go into education. Based on the direction of the study I narrowed the study by a further four women and three men who were the students pursuing college rather than university. The remaining sample consisted of 19 women and 22 men who were high achieving students in mathematics, going on to university.

Table 14: Percent of Students Choosing a Particular Program of Study

University program of study	Percent of Females (N=19)	Percent of Males (N=22)
Mathematics	21.1	18.2
Health Professions	42.1	22.7
Engineering and Applied Sciences	15.8	50.0
Fine and Applied Arts	0.0	0.0
Education	10.5	0.0
Agriculture and Biological Sciences	0.0	0.0
Humanities	0.0	0.0
Physical Sciences	0.0	0.0
Social Sciences	5.3	0.0
Arts General	0.0	0.0
Science General	5.3	9.1
Total	100.0	100.0

Women and men reported somewhat different influences in their intention to pursue or not to pursue mathematics (see Table 15). In this study, males were equally influenced by pay and genuine interest in a subject, whereas females were mostly influenced by genuine interest in a subject.

Table 15: Number of Students Indicating Specific Factors and Influences on Their Choice of University Major, by Gender

Factors affecting University major	Percent of Females (N=19)	Percent of Males (N=22)
Influences of Socializers	3	0
Job Availability	1	2
Pay	1	10
Genuine Interest in Subject	14	10
Total	19	22

In summary, there were substantive differences between men and women's interests and aspirations in regards to further education and careers. The open-ended questionnaires revealed that:

1. Females' intentions to pursue a particular career were linked to genuine interest whereas males' reasons were linked to pay as well as genuine interest.

2. The number of women choosing a career in mathematics were almost identical to the number of men pursuing mathematics.
3. Men were four times more likely to pursue a career in engineering than women.
4. Some highly prepared women in mathematics were choosing to pursue education and health related professions.
5. Similar numbers of women and men (35% and 40% respectively) were influenced by the same gender parent to pursue a specific career.
6. Most females were choosing to take mathematics courses in high school because of career needs rather than an interest in mathematics.

Overall, men and women who intend to go on in mathematics were doing so in similar numbers, and for similar reasons, out of interest in the topic and, in part, as a result of influence from their same gender parent.

4.2. Comparing future Mathematics Majors to Non-Mathematics Majors

In the second comparison, the data of mathematically able students (average over 70%) were broken down by those who were pursuing mathematics versus those who were not. Those students pursuing mathematics beyond high school were mostly influenced by their teacher (see Table 16).

Table 16: Percent of Students Who Indicated a Specific Socializer Influencing a Career Choice, by Interest in Mathematics

Person who influenced career choices	Percent of students Pursuing Mathematics (N=9)	Percent of students Not Pursuing Mathematics (N=39)
Mother	11.1	20.5
Father	22.2	28.2
Teacher	55.6	15.4
Counsellor	11.1	15.4
Friend	0.0	20.5
Total	100.0	100.0

Interestingly, students planning to go on to study mathematics at the university level did so overwhelmingly because of interest in the subject. Those students who were pursuing other majors did so for a much wider range of reasons.

Table 17: Non-mathematics Versus Mathematics Major Students Indicating Specific Factors and Influences on Their Choice of University Major

	Choosing a University Major in Mathematics (N=9)	Not Choosing a University Major in Mathematics (N=32)
Influences of Socializers	1	2
Job Availability	0	3
Pay	0	11
Genuine Interest in Subject	8	16
Total	9	32

In summary, there are important differences between future mathematics majors and non-mathematics majors' interests and aspirations. The open-ended questionnaires revealed that:

1. Students choosing to pursue mathematics as university major were doing so because of genuine interest whereas students not pursuing mathematics gave reasons linked to pay as well as genuine interest.
2. Students in the mathematics group were influenced most often by their teacher (56%) to pursue a career in mathematics.

4.3. Comparing Women's Patterns of Pursuing versus not Pursuing Mathematics

In the third comparison, those women who were pursuing mathematics were compared to those who were not. There were also patterns of difference within the mathematically capable group between those who went on to choose mathematics and those who did not. Not surprisingly, women who were pursuing a mathematics major indicated that their grades in mathematics were much higher than females not pursuing mathematics as a major. (At this point I narrowed the analysis by seven students who reported grade averages below 70% achievement in mathematics as too low to be considered high achievers in mathematics.)

Table 18: Female Students' Report About Their Own Abilities in Mathematics

Self-reported Mathematics Grades	Number of Females Pursuing Mathematics (N=5)	Number of Females Not Pursuing Mathematics (N=25)
90-100	2	2
80-89	1	5
70-79	2	11
60-69	0	6
50-59	0	1
Below 50	0	0
Total	5	25

The two groups of mathematically able women were taking mathematics courses in high school for very different reasons. Women who were intending to pursue mathematics after high school were doing so based on ability, while women who were not intending to pursue mathematics after high school were taking high school mathematics courses because of career needs (see Table 19). This indicates that female students were taking mathematics courses because they were pre-requisites for future educational endeavours, not because of their personal interest in mathematics.

Table 19: Number of Female Students Indicating Specific Factors and Influences on Their High School Mathematics Course Selection Choices

Reasons for taking mathematics courses in high school	Number of Females Pursuing Mathematics (N=5)	Number of Females Not Pursuing Mathematics (N=18)
Ability	4	2
Interest	1	3
Career Need	0	13
Encouragement from Others	0	0
Total	5	18

The pattern of influence changes when females were divided into those who were pursing mathematics and those who were not. Women who were intending to pursue mathematics as a career identified teachers as their person of greatest influence (see Table 20). Female students not intending to pursue a career in mathematics reported that 2 out of 5 had been influenced by their mothers to pursue a particular career.

Table 20: Percent of Females Students Who Indicated a Specific Socializer Influencing a Career Choice

Person who influenced career choices	Percent of Females Pursuing Mathematics (N=5)	Percent of Females Not Pursuing Mathematics (N=18)
Mother	20.0	38.9
Father	0.0	16.7
Teacher	60.0	16.7
Counsellor	20.0	11.1
Friend	0.0	16.7
Total	100.0	100.0

Women choosing to pursue mathematics and women not pursuing mathematics reported somewhat similar influences in their choice of university major (see Table 21). Both indicated a genuine interest in the subject.

Table 21: Number of Students Indicating Specific Factors and Influences on Their Choice of University Major, by Interest in Mathematics

	Choosing a University Major in Mathematics	Not Choosing a University Major in Mathematics
Factors affecting University major	Females (n=5)	Females (n=14)
Influences of Socializers	1	2
Job Availability	0	1
Pay	0	1
Genuine Interest in Subject	4	10
Total	5	14

In summary, there were important differences between women choosing to pursue mathematics and women not intending to pursue mathematics. The open-ended questionnaires revealed that:

1. Female students were taking high school mathematics courses because they are pre-requisites for future educational endeavours.
2. Women who were intending to pursue mathematics as a career identified teachers (60%) as their greatest influence.
3. Similar numbers of females' intentions to pursue mathematics or not pursue mathematics were influenced by genuine interest in pursuing a particular career.

Chapter Five: Stage Two Results and Analysis

5.1. Introduction

A summary of the data gathered during interviews is reported in this chapter. The chapter was organized into five sections: students' aptitudes, cultural milieu, socializers, past experiences and finally, self-concept and career values. The participants were placed into two groups: mathematical (those intending to pursue a career related to mathematics) and non-mathematical (those intending to pursue a career not related to mathematics). The data were coded according to the codes developed in Table 9. The results of this coding can be found in Appendix G.

5.2. Students' Aptitudes

The ten female students interviewed for this study had taken a wide variety of mathematics and science courses. All participants had strong high school academic preparation in mathematics and reported high achievement in mathematics. The mathematics group had three out of five participants reporting mathematics grades above 80%, while the five interviewees in the non-mathematics group all reported mathematics grades above 80%. The two groups, however, differed in their perception of their abilities. The mathematical group felt they were good at mathematics. Despite their high achievement in mathematics, the non-mathematics group perceived themselves as being poor at mathematics. This is a surprising and unexpected finding. Past research has concentrated on differences in confidence in mathematics between boys and girls (Collis, 1991,; Leder, 1992), but little research has focused on the differences in confidence amongst girls; instead, they have typically been treated as a monolithic group.

5.3. Cultural Milieu

There were differences found in the cultural milieu of the two groups. The mothers of students who were not inclined to pursue a degree in mathematics varied in educational background from high school dropouts to university graduates. Regardless of education level, all of these women were either housewives or held traditional female occupations such as teacher, waitress or secretary. The fathers of these students had all completed high school and most had gone on to complete either university or professional school. They held jobs such as accountants, tradesmen and lawyers, which have traditionally been classified as male-dominated fields.

The mothers of students who intended to pursue a degree in mathematics were mostly high school graduates who had completed university or college programs. More mothers (three of the five) held non-traditional employment in business, management and administrative positions. The fathers of these students had all completed high school and most had gone on to complete either university or college. They all retained traditionally male-dominated employment in the fields of such as farming, construction, mathematics and management. Therefore while the fathers of both groups had similar education and careers, the mothers differed in education and careers.

5.4. Socializers

When asked who was the most influential person affecting their career choice, eight of the ten students responded mother, father, family or teachers. In particular, during the interview, all five women who were pursuing a degree in mathematics identified their mother and their teachers as being the most influential on their choice of major. None of the women who were intending to pursue a degree in non-mathematical fields identified solely their mother as influencing on their choices of majors. Rather, three out of the five females in the non-mathematics group reported being influenced by their family. The overwhelming majority of participants thought that making money and being happy were the most important factors in the minds of their parents when deciding on what career path to follow.

5.4.1. Non-mathematical

When asked what they thought their parents' opinions of mathematics were, participants responded that their parents viewed mathematics as very important but a difficult subject to understand. One participant elaborated, "I don't think they were very good at math in school and probably wouldn't mind if their children had to rely on a calculator for any necessary math functions." A second student responded, "I think they would agree that you either got it or you don't."

This group described their own mathematics teachers as being extremely intelligent, middle-aged males who lacked interpersonal skills. One participant added, "Two of the teachers I had in high school were quite tough. The last teacher I had seemed quite brilliant but often I felt that he didn't explain things very well." Other participants described their mathematics teachers as, "strict and stern". Most of the students in the non-mathematics group felt their teachers did not care and made them feel stupid. One participant responded, "The last teacher I had seemed quite brilliant but often I felt that I was in a university level class because it all seemed so difficult." Contrary to the stereotype voiced by the other students, one participant stated that "most of my high school mathematics teachers were down to earth, three females and one male, I got along well with the female teachers, they were very patient. The male teacher -- I disliked him and therefore the subject."

5.4.2. Mathematical

When asked what they thought their parents' opinions about mathematics were, participants responded that math was extremely important to their parents and that their parents enjoyed mathematics. As one participant stated, "My parents think math is very important…math is the core of everything." A second student responded, "My mom always liked math, she wanted to be an accountant." Another student said, " My parents think math is very important business-wise, and personally."

This group described their own mathematics teachers as funny, brilliant and eccentric males or encouraging, caring and helpful females who were easy to understand. One participant stated, "Mrs. D., I loved her because her teaching style was so easy to comprehend." A second student described her teachers as "Female, encouraging, excellent teachers who took the time to help everybody." In contrast however, and similar to the first group, another student responded, "My math teachers were your typical brainy and eccentric characters wearing brown pants." A second student described their teachers as: "Really weird and old, but very smart and looks funny."

In summary, the students pursuing mathematics generally had parents who enjoyed mathematics and typically described their teachers as female, helpful and caring. The students who were not pursuing mathematics generally had parents who thought mathematics was difficult and described most of their teachers as male, intelligent and not very good teachers.

5.5. Past Experiences

All of the students interviewed had completed all of their required high school mathematics courses as well as the high school mathematics preparations courses for university. Participants were asked to describe a positive and negative experience they had in mathematics. Those participants in the mathematics group as well as the non-mathematics group had similar responses. They both described a positive and a negative mathematics experience in relation to either being successful or non-successful on a test, or having a positive or negative experience with a mathematics teacher.

Positive experiences were described as "doing well on a test, figuring out a tough problem", "getting excellent grades" and "teachers who went above and beyond." Another student said,

> I really enjoyed calculus, mostly due to my teacher; he makes it fun, interesting and genuinely cared about his student's success. I swear every spare minute he had was spent giving extra help.

Examples of negative experiences were: "In Grade 11 my math teacher sucked the life out of math…", " Asking a teacher once when I would ever apply what he was teaching in real life and him telling me to just do my work", "failing a test" and "seeing my grades slip a bit." Not surprisingly, during the interview two of the students who were part of the non-mathematics group expressed that a negative experience in mathematics was not being able to see the real life relevance of the mathematics concept they were learning at the time; for example one interviewee said, "One word: Calculus! Boring and I don't see any real life relevance." The mathematics group expressed no such concern.

5.5.1. Non-mathematics

The non-mathematics group described mathematics as something they had to take, as not interesting and stated they were unaware of any career opportunities related to the field of mathematics. One participant clarified, "I dislike math and don't see the point, it just isn't interesting." A second student responded, "Math bores me and I don't see the significance or the jobs related to the field other than teaching." When asked if they would pursue a career in mathematics, all members of this group answered a very clear no without any hesitation.

5.5.2. Mathematics

The mathematics group described mathematics as fun, challenging and enjoyable. One participant stated, "I enjoy math." Another student said, "I like mathematics, because it is challenging." When asked if they would be pursuing a career in mathematics, they mentioned particular careers they wanted to pursue. One participant stated, "I want to eventually operate my own business and will need a strong mathematical background." A second participant said, "Yes, pure math or an actuary, it looks interesting and my dad is an actuary, but I am a little reluctant because I don't like set rules and want to be creative." A third student replied, "Yup, I did well in high school math and it is something that really interests me. I am more interested in people and social interactions than number crunching so I am thinking of teaching."

5.6. Self-Concept and Career Values

Participants were asked what their reasons were for pursuing a particular career as well as why they chose to take high school mathematics courses. Generally participants reaffirmed that interest in a particular subject was the main reason for pursuing a career. Money, job availability and the influence of socializers were also mentioned.

5.6.1. Non-mathematics

When the non-mathematics participants were asked their main reason for pursuing a particular career (non-mathematical), their general response was interest as well as money. One participant also responded, "the possibility of making a difference." A second participant said, "I wanted to go into a field in which I am interested, that I enjoy and that I feel I can learn and grow in." Two participants simply responded, "money." When asked why they chose to take mathematics courses in high school, these participants responded that courses were mandatory.

5.6.2. Mathematics

All participants who were interviewed responded that genuine interest was the main reason they were planning to pursue a career in mathematics. One participant added, "the opportunity teaching provides for one to make a difference in the lives of children and our future generations." A second student responded, "I like number crunching and the accomplishment of finishing a project." When asked why they chose to take mathematics courses in high school, participants responded that they enjoyed mathematics courses and saw them as prerequisites for future studies. "They were prerequisite and I am good at them" and "I hope it would help me at university, I wanted to open as many doors as I could."

Chapter Six: Discussion and Conclusions

6.1. The Questions

In this chapter an evaluation of the results found in stage one and stage two are brought together to answer the research questions. This evaluation is followed by a summary of the key findings, final remarks and implications for future research endeavours. The discussion is structured by the research questions.

1. *Why are university-bound, mathematically-able women, given the expanding job market in mathematics, planning to major in mathematics in such low numbers?*

My findings are similar to those of Kimball (1989) and the literature reviews found in the EQAO Research Series (1999), in that females are highly capable of pursuing mathematics at the university level. In my sample of two university-entry mathematics courses a total 48 out of 57 students reported achievement above 70%. Females made up 48% of the total reporting grades above 70%. The attitudes toward mathematics-related careers appear to be independent of achievement levels; that is, despite the ability to go on in mathematics most women (78%) in the sample were not. Similar to Rallis and Ahern's (1986) study of a high school graduating class, even when women did participate and excel in mathematics, significant differences in the planned careers persisted between men and women.

The women in this study choosing to pursue mathematics did so due to an interest in mathematics, or perceived job opportunities and financial stability. The non-mathematical group on the other hand chose not to pursue mathematics due to lack of interest, and the perception that mathematics careers were poorly paid and were hard to find. How can these women view mathematics so differently? The second research question was developed to explore the factors that have contributed to these different views.

2. *Which factors play a role in influencing academically prepared women's decision to take mathematics at university and which factors are the most influential?*

After analyzing the responses of the 10 female students and examining their educational choices beyond high school, like Dick and Rallis (1991), I found that socializers, cultural milieu and past experiences influenced the self-concepts and career values of these female high school students. Results of my survey demonstrated that only 21% of women with strong mathematics backgrounds planned to pursue a university education in mathematics.

Differences between socializers, psychological factors and interest were noted between female interviewees from the mathematics group and the non-mathematics group in his study. They are summarized below.

Socializers. First, females choosing to pursue a mathematics degree acknowledged being influenced more often by their mothers and teachers when choosing to pursue a mathematics-related career than the non-mathematics group. This finding is consistent with research that suggests that female career expectations related to mathematics are influenced by mothers, female friends, and female teachers. These key role models in their immediate environment are viewed as important predictors of a students' career aspirations (Paa & MacWhirter, 2000; Super, 2000).

The female interviewees who have chosen to pursue a career in mathematics generally came from a home with mothers who have a university education and are professionals such as teachers, entrepreneurs and civil servants. Female students who do not intend to pursue mathematics as a career have mothers who have less university education and hold more traditional employment such as housewife, waitress and babysitter. These findings are similar to Mau et al. (1995) who noted that women who pursue nontraditional careers such as mathematics received direct encouragement from teachers, had working mothers as role models, and parents with higher education and occupational levels.

When asked about their parent's attitudes towards mathematics and their mathematics teachers, female students pursuing mathematics said they thought their parents really liked mathematics and viewed it as a very important subject. These female interviewees also reported that they had great mathematics teachers and that most of their mathematics teachers were female. In contrast, the non-mathematics group students believed their parents were not very good at mathematics and found mathematics to be difficult. Most students had male mathematics teachers, who they felt were poor teachers who did not care and made them feel stupid. These findings suggest that for some females, their perception of their parents' attitude towards mathematics as well as their opinion of their mathematics teacher impacted their decision to pursue mathematics at university. However, from the data collected it is very difficult to tell how much influence socializers have on students' career choices because students were not asked to rank the socializers that impacted their decision to pursue an educational path or career.

Psychological factors. The second difference noted in this study was that the attitudes towards mathematics of both groups were very different. The females pursuing mathematics said that mathematics made sense, that it was challenging, fun and that they loved numbers. Those females not pursuing mathematics stated that they did not feel comfortable with mathematics, that it was boring despite high achievement levels and further, that they did not see the relevance of mathematics and had taken it only because it was a requirement. This finding is consistent with those of Leder (1992) and Stipek and Gralinski (1991) who found that in spite of demonstrated abilities in mathematics, females choosing not to pursue mathematics beyond high school displayed low self-confidence and expressed low opinions of their mathematical abilities.

Interest. The final difference noted in this study was that females were choosing to take mathematics courses in high school based on career needs, not an interest in mathematics. Females who participated in this study expressed a need to be genuinely interested in a career. Dick and Rallis (1991) found similar results, concluding that women's interests influence their choice of a career or educational path whereas men were typically more concerned with money. This latter point was not found in my study as both men and women were pursuing mathematics out of interest.

6.2. Summary of the Major Findings

The aim of this research study was to examine women's intention to participate in mathematical disciplines at the university level, specifically their motivations for pursuing mathematics. These motives were examined through a comparison of mathematically-able women intending to enrol in both mathematical and non-mathematical programs.

The female students interviewed for this study were eager and willing to share all aspects of their journey towards choosing an education and career path. The findings of this study suggest that parents and teachers are an extremely important influence on female students when deciding to pursue mathematics beyond high school. In addition female students reported that genuine interest in a subject as the most important deciding factor when choosing a career path.

6.3. Implications for Further Research

The findings of this study suggest a number of directions for future research.

1. What is the age at which development of academic interests begins and how do socializers influence this development throughout one's academic life? How do parents and teachers influence females' academic interests? We need to determine how to create a positive attitude towards all subject areas.
2. Which socializers play the strongest role in influencing career choices?
3. Further investigations need to take place to determine why females who are achieving high grades in mathematics perceive that they are not good at mathematics. How did they achieve their high grades? Did they seek tutoring or extra help?
4. We need a further understanding of how high school students make career choices. What do they know about potential careers and the labour market?

6.4. Post Script and Concluding Statements

Based on the findings of my study, I have concluded that it cannot be assumed that women who have excelled in mathematics in high school will pursue careers in mathematics. Research suggests that women are enrolling in mathematics courses in high school in order to gain strong general preparation for university and to meet prerequisites for specific educational programs. In order to encourage more females to pursue mathematics we must find a way to make mathematics more meaningful for those female students who have lost interest in mathematics.

Also, this study suggests that socializers plays an important role in determining educational choices beyond high school. It is likely that females enrol in university mathematics courses because they are genuinely interested in the subject, have been encouraged by parents, teachers, or both, to pursue such studies and have excelled over the years in mathematics.

The findings of this study indicated that parents as well as teachers played an important role in female students choosing to pursue mathematics at university. What is unclear from the research is when and how important a role socializers play in influencing career choices in young women.

6.5. Epilogue

Since 2000, the final year in which Statistics Canada had data on women's participation in mathematics at the undergraduate level or mathematically related careers there has been relatively little change. Overall enrolment in mathematics remained stable between 1998 and 2002 with an increase in 2003 of 15%, most likely reflecting the general increase in enrolment resulting from the double cohort[1] entering university (King, 2003). Women's enrolment in mathematical disciplines has, despite an overall increase, remained relatively stable in proportion at about 42% of the total enrolment (M. Burton, Statistics Canada, personal communication, April 20, 2006) see Table 22. Overall enrolment in undergraduate degrees for women has reached a record high of 58% (Statistics Canada, 2004). In summation, once the bulge of the double cohort graduates from university women's enrolment in mathematics will remain relatively low in comparison to enrolment in other disciplines such as health, as well as in proportion to men.

[1] In 2003 both the final year for OAC students, and Grade 12 students, will be eligible to enter university.

Table 22: Undergraduate Enrolment in Mathematics Programs at Canadian Universities from 1990-2004, by Gender (M. Burton, Statistics Canada, personal communication, April 20, 2006)

Year	Total	Men	Women	% of Women
1990-91	9109	5605	3504	38.5
1991-92	9063	5515	3548	39.1
1992-93	8910	5457	3453	38.8
1993-94	8744	5292	3452	39.5
1994-95	7990	4727	3263	40.8
1995-96	7304	4267	3037	41.6
1996-97	6666	3865	2801	42.0
1997-98	6163	3508	2655	43.1
1998-99	6206	3496	2710	43.7
1999-00	6460	3660	2805	43.4
2000-01	6225	3565	2665	42.8
2001-02	6575	3765	2805	42.7
2002-03	7140	4060	3080	43.1
2003-04	8145	4600	3550	43.6

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Appendix A: Career Choices Open-ended Questionnaire

Name:______________________________

1. I am …
   A) male B) female

2. How do you usually perform in mathematics?
   A) 100-90
   B) 89-80
   C) 79-70
   D) 69-60
   E) 59-50
   F) Below 50
   Explain:______________________________
   ____

3. What high school mathematics courses have you completed?
   A) Grade 10 Mathematics
   B) Grade 11 Mathematics
   C) Grade 12 Mathematics
   D) Principals of Mathematics
   E) Foundation of Mathematics
   F) Functions and Relations
   G) Functions
   H) Mathematics of Personal Finance
   I) Mathematics of Everyday Life
   J) Functions and Calculus 1
   K) Functions and Calculus 2
   L) Geometry and Discrete Mathematics
   M) Data Management
   N) College/Apprenticeship
   O) College Technology
   P) Others:______________________________
   ____

4. Why did you choose to take these mathematics courses?
   A) Ability
   B) Interest
   C) Career need
   D) Encouragement from others
   E) Other
   Explain:______________________________
   ____
   ____

5. What are your plans after you finish high school?
   A) Job
   B) Start a business
   C) Military
   D) Trade School
   E) College
   F) University
   G) Other
   Explain:____

6. What person(s) influenced your career choices?
   A) Mother
   B) Father
   C) Teacher
   D) Counselor
   E) Friend
   F) Other
   Explain:____

7. If applicable, what do you plan on studying at University?
   A) Mathematics
   B) Health Professions
   C) Engineering and Applied Sciences
   D) Fine and Applied Arts
   E) Education
   F) Agriculture and Biological Sciences
   G) Humanities
   H) Physical Sciences
   I) Social Sciences
   J) Arts General
   K) Science General
   L) Other:____

8. If applicable, rank the following factors in order of importance in having an affect on your choice of a University major.
   ____ A) Influences of socializers (parents, teachers, counsellor or friends)
   ____ B) Job availability
   ____ C) Pay
   ____ D) Genuine interest in subject
   ____ E) Other
   Explain:____
   ____
   ____
   ____

9. What are your career goals?
   A) Management
   B) Trades, Transport, or construction
   C) Teacher
   D) Health Profession
   E) Business and Finance
   F) Engineer
   G) Mathematician
   H) Artist
   I) Clerical or Administration
   J) Sales and Services
   K) Social Sciences
   L) Natural Sciences
   M) Other:____
   ____

10. Rank the following factors in order of importance in having an affect on your choice of a career.
   ____ A) Influences of socializers (parents, teachers, councelor or friends)
   ____ B) Job availability
   ____ C) Pay
   ____ D) Genuine interest in subject
   ____ E) Other
   Explain:____
   ____
   ____
   ____

Appendix B: Interview Questions

Student Aptitude

1. What are your usual marks in mathematics?

Cultural Milieu

2. What level of education did your mother last complete?
3. What does your mother do for a living?
4. What level of education did your father last complete?
5. What does your father do for a living?

Socializers

6. What are your parents' career expectations of you?
7. How important is your attaining a university or college degree to your parents?
8. Who has been the most influential person in your life regarding your education? Explain.
9. What are you parents' opinions of mathematics?
10. Describe your mathematics teachers.

Past Experiences

11. How do you feel about mathematics?
12. Describe a positive experience you have had in mathematics.
13. Describe a negative experience you have had in mathematics.
14. What high school mathematics courses have you completed?
15. Why did you choose to take these mathematics courses?

Self-Concept and Career Values

16. How important is attaining a university or college degree to you?

17. What are you career goals?

18. What are your reasons for pursuing this career?

19. What is your main reason for pursuing this career?

20. Have you ever thought of pursuing a career in mathematics? Explain.

Choice of Career

21. What program are you interested in studying at university?

22. What person(s) influenced your career choices?

23. What affected your choice of a university major?

24. What affected your choice of a career?

Appendix C: Letter of intent and permission

I am writing to ask for permission to conduct the study, factors influencing women's participation in mathematical disciplines, in the Waterloo District School Board high schools. I, Denise Pelletier, a graduate student at Lakehead University in the faculty of education, would like to conduct the study to determine which factors contribute to academically well-prepared women's decision to participate in mathematical disciplines at the university level. Research shows that in 1998/1999 less than 1.3% of undergraduate students were enrolled in mathematics at the university undergraduate level.

The intent of this research project is (a) to investigate students' participation in mathematical disciplines, (b) to look at low enrolment in mathematics as it pertains to women. To accomplish this goal, I would like to survey 3 grade 12 classes in your school board, concerning their experiences in mathematics and their career goals. The questionnaire will take approximately 20 minutes of student's time. Ten students will be asked to participate in follow up interviews. Teachers and students will be informed that students are participating on a voluntary basis and all information provided will be kept securely stored and confidential. Students are not required to participate, can refuse to answer some of the questions and can withdraw at any time without penalty.

All information provided by students will remain confidential, no one but me will know their identity, and securely stored at Lakehead University for a period of not less than seven years. The findings of this project will be made available to you at your request. Please provide your contact information if you would like to receive a summary of my findings.
Thank you very much for your assistance.

Sincerely,

Denise Pelletier
Graduate Student
Faculty of Education
Lakehead University

Appendix D: Letter of Consent

Dear Participant:

I am conducting a study on women's participation in mathematics at the university level. To accomplish this goal, I would like you to fill in a few questions concerning your experiences with mathematics and your career plans.

This survey will take approximately 20 minutes of your time. You may also be asked to participate in a follow-up interview. Participation in this study is voluntary and you may choose to withdraw at any time. Note that this study has no impact on grades.

All information you provide will remain confidential, no one but me will know your identity. Surveys will be securely stored at Lakehead University for a period of not less than seven years. The findings of this project will be made available to you at your request. Please provide your contact information on the consent form if you would like to receive a summary of my findings.

Thank you very much for your assistance.

Sincerely,

Denise Pelletier
Graduate Student
Faculty of Education
Lakehead University

Appendix E: Consent Form

My signature on this sheet indicates I agree to participate in a study by Denise Pelletier, on Women's Participation in Mathematics at the university level. It also indicates that I understand the following:

1. I am a volunteer and can withdraw at any time from the study.
2. There is no apparent risk of physical or psychological harm.
3. The data I provide will be confidential and stored for a period of not less than seven years.
4. I will receive a summary of the project, upon request, following the completion of the project.

I have received explanations about the nature of the study, its purpose, and procedures.

____

Signature of Participant Date

Address (if summary is requested):

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Appendix F: Parental Consent Form

My signature on this sheet indicates I agree to allow my daughter____________________ to participate in a study by Denise Pelletier, on Women's Participation in Mathematics at the university level. It also indicates that I understand the following:

1. My child is a volunteer and can withdraw at any time from the study.
2. There is no apparent risk of physical or psychological harm.
3. The data my child provides will be confidential and stored for a period of not less than seven years.
4. I will receive a summary of the project, upon request, following the completion of the project.

I have received explanations about the nature of the study, its purpose, and procedures.

____

Signature of Parent or Guardian   Date

Address (if summary is requested):

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Appendix G: Codes for Mathematical and Non-Mathematical Career Choices

Table 23 shows how the codes developed in Chapter three relate to the choices made by the 10 students interviewed in this study. Column 1 has a list of the codes developed in chapter 3 based on the literature review. Column 2 and 3 shows the codes developed by analyzing the data from the interviews with the 10 women. The transcriptions of data were carefully analyzed using codes to identify situations, student perspectives and attitudes. Numerous codes emerged and are summarized in columns 2 and 3 of table 23. Each code is followed by the number of students for whom the code is applicable.

Table 23: Codes for Mathematical and Non-Mathematical Career Choices

Codes for Model of Career Choices (see Table 9)	**Mathematical Career Choice n=5**	**Non-mathematical Career Choice n=5**
Student Aptitude Doubtful about their own mathematical ability Student's perception of achievement is higher Attitude is directly related to mathematical performance Girls rate their ability in mathematics lower Girls were less likely to attribute success to high ability and attributed failure to low ability	Students rank their mathematics ability as high (n=5) Usual mathematics mark 90-100 (n=2) Usual mathematics mark 80-89 (n=1) Usual mathematics mark 70-79 (n=2)	Students rank their mathematics ability as moderate to low (n=4) Usual mathematics mark 90-100 (n=2) Usual mathematics mark 80-89 (n=2) Usual mathematics mark 70-79 (n=1)

Codes for Model of Career Choices (see Table 9)	Mathematical Career Choice n=5	Non-mathematical Career Choice n=5
Cultural Milieu Girls still follow traditional career paths The perception of mathematics as a male domain	Students' mothers are professionals (n=5) (teacher, entrepreneur, civil servant, assistant manager, interior designer)	Students mothers hold traditional working class employment (n=4) (waitress, housewife, babysitter, clerk)
	Students' fathers are professionals (n=3) (actuary, social worker, media specialist)	Students' fathers are professionals (n=3) (chartered accountant, lawyer, accountant)
	Most mothers have university education (n=4)	Mother's have some university education (n=2)
	Most fathers have a university education (n=4)	Fathers have some university education (n=3)
	Students believe that a university education is extremely important to their parents (n=5)	Students believe that university education is somewhat important to parents (n=3)

Codes for Model of Career Choices (see Table 9)	Mathematical Career Choice n=5	Non-mathematical Career Choice n=5
Socializers	Attaining university degree is very important to parents (n=5)	Attaining university degree is somewhat important to parents (n=3)
The attitudes and behaviours of a student's mother, father, teacher, counselor, friends and others	Mother and teachers most influential in career choice (n=5)	Family is most influential (n=3)
Parents' values	Parents both like mathematics (n=4)	Students believe parents not very good at mathematics (n=3)
	Great mathematics teachers (n=4)	Poor mathematics teachers (n=5)
	Most students had female mathematics teachers (n=3)	Most students had male mathematics teachers (n=5)
		Mathematics is difficult (n=4)
	Math is viewed as being very important to students parents (n=5)	Have to take it (n=5)
Past Experiences	Enjoy mathematics (n=5)	Dislike mathematics (n=4)
The influence of parents and teachers	Excellent teachers (n=4)	Poor teachers (n=5)
	Good at mathematics (n=5)	Only took mathematics because I had to, requirements (n=5)
		Failing a test (n=3)
	Mathematics makes sense (n=4)	Don't see the point (n=2)
	Mathematics is challenging (n=3)	Teachers who don't care and make me feel stupid (n=3)
		Mathematics is hard (n=4)
		Not interesting, Boring (n=4)
		Don't see the significance (n=5)

Codes for Model of Career Choices (see Table 9)	**Mathematical Career Choice n=5**	**Non-mathematical Career Choice n=5**
Self-Concept and Career Values	Interested in mathematics (n=5)	Not interested in mathematics (n=5)
Estimation of the economic and personal value of mathematics courses	Job availability (n=4)	Don't see the jobs related to the field (n=5)
		Poor job availability (n=5)
	I am good at mathematics (n=5)	I am not very good at mathematics (n=4)
	Financial stability (n=4)	Poor pay (n=3)