Women who choose mathematics:

The external and internal factors influencing their participation in a math-related occupation

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ABSTRACT

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Given that females are not pursuing mathematics at the post-secondary and occupational level in the same numbers as males, this thesis examines the various reasons why women are drawn into a math-related career and explores the personal experiences of these women in order to gain a better understanding of the influences, support, events and interests that pushed them to choose this career path. Participants were fifteen women who have attained a degree in mathematics and/or are currently employed in a math-related career. Twelve participants were asked to complete a questionnaire and three participants were interviewed. Results demonstrate that parents, teachers and role models are important motivators. In addition, educational and occupational outcomes are guided by expectations for success, value and choice, and a high level of self-efficacy beliefs are required in order to persevere and succeed in a math-related field. Finally, recommendations are offered in order to increase girls' participation in mathematics at the educational level.

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Chapter I

Introduction

Gender differences and gender equity in schools and their effect on academic achievement has long been studied and debated. For the past few decades, research has focused on the achievement gap between the sexes, especially in mathematics and sciences. Research has shown that girls do not perform and participate in mathematics at the same level as boys (Sadker & Sadker, 1994; Fennema & Leder, 1990; Brush, 1980; Burton, 1986; Clewell, Anderson & Thorpe, 1992).

Although recent research suggests that there is a closing of the achievement gap between the sexes in mathematics (Gonzales et al., 2002), a problem still exists. Females are not pursuing mathematics at the post-secondary and occupational level in the same numbers as males. In the 2003/2004 school year, there were approximately 990,400 students enrolled in a Canadian university. Of these students, only 43,700 students (4.4%) were enrolled in mathematics or computer and informational sciences. Of these math and computer/informational science students, only 11,700 were females; this represents only 1.2% of the general student body and 26.8 % of the math/computer science student population (Statistics Canada, 2005). Also, there is a discrepancy between males and females in relation to the level of degree attained. For example, with respect to university enrollment in mathematics/physical sciences in the year 2000-2001,women earned 30.1% of the bachelor's and first professional degrees, 35% of Master's degrees, and 26.2% of Doctorate's degrees. In total, women accounted for 30.3% of total degrees in mathematics and physical sciences (Statistics Canada, 2003). It should be noted that the proportion of students of both genders enrolled in mathematics

programs is very low; but, mathematics is still predominately a male field, with men earning approximately three times the number of degrees at all levels.

There are an increased number of women working, but they are still concentrated in lower levels of the professional hierarchy and in female-dominated occupations. In 2005, 103.6 million Americans were full-time wage and salary workers; 56.4% were men and 43.6% were women. Yet, women made up only 31% of workers in the highest earnings category (U.S. Bureau of Labor Statistics, 2006). Despite the movement of many women into managerial and professional jobs, they are still concentrated in clerical and service jobs. Nearly half of women workers are employed in three occupational groups - sales, services, and administrative support - compared with approximately one-fifth of male workers (U.S. Bureau of Labor Statistics, 2003). Specifically focusing on math-related occupations, according to the National Science Foundation (2004) there are 1,405,000 men (69.2%) employed in mathematical and computer science related fields versus 625,000 women (30.8%). In Canada, there are approximately 1,048,500 people working in natural and applied sciences and related occupations; of these, 825,800 (78.8%) are men versus 222,700 (21.2%) females (Statistics Canada, 2004).

Lower levels of contributions from women in the fields of mathematics can be, at least partially, attributed to historical treatment of women, lack of opportunities for women, and attitudes of society towards women's roles (American Association of University Women, 1992). Research suggests there are no intellectual or physical barriers accounting for the gender imbalances present in our education system (Hanna, 1996; Fennema, 1996; Fennema & Leder, 1990; Eccles, 1987, 1994). This leads to the exploration of attitudinal and societal beliefs as the major contributors to gender

imbalances in mathematics and a major obstacle facing females and their participation and performance in mathematics; these beliefs are influenced by the socialization process, developing early in a child's life and continuing through adulthood. It is believed that gender differences stem from gender-role socialization (Eagly, 1987; Eccles, 1994). The relationship between gender achievement and mathematics may be a self-fulfilling prophecy based on gender expectations; girls are capable of achieving success in mathematics, but parents, teachers, and society perpetuate the myth that it is inappropriate for them to study and excel in this 'male' subject. These cultural and societal beliefs have been passed down through generations, allowing the cycle to continue. Successful intervention requires a thorough knowledge of the socialization process linked to these beliefs; if proper intervention does not occur, it leads to the lowered interest and achievement levels in mathematics for girls.

In this chapter the following topics will be explored: my personal experiences in mathematics, gender equity, and the importance of mathematics.

Math and Me

What lead to my own participation in mathematics?

In researching this topic, I have had the opportunity to reflect upon my personal reasons for participating in mathematics. What experiences led me towards a mathematics career? In high school, I always excelled in math. It came very easily to me, and I found that I was always one of the first students to finish my work in class. I liked the fact that the answers were always right or wrong; solving the problems felt like a game or a challenge to me. My father was also a big influence in my life; being a math teacher, he was always emphasizing the importance of mathematics. He always expected

us to get good grades, do our homework, and respect our teachers. On the other hand, I had a mother who was always amazed that math came so easily to her three children as it was a subject she struggled with throughout her educational experience. Whenever I needed help, it was my father that I went to.

What motivated me towards a mathematics career? Throughout elementary and secondary school, I had a father and a brother always pushing me to do my best; I felt that girls really could do math just as well as boys could, and I really needed to prove this to myself. However, when I began my university studies, my original program was not mathematics. I had somehow convinced myself that it would be too difficult to do. After one semester, I realized that math really was a passion of mine, and I was only hurting myself by avoiding it. I then continued my studies in mathematics until I became a math teacher.

What barriers did I overcome, and how? I had a few barriers throughout my educational experience; the biggest obstacle was living in my brother's shadow. He was only a year older than me and he was a genius in math. Teachers would expect a lot out of me when I took the advanced math classes in high school. Math came very easily to him; I often thought that it wasn't fair that I had to study so much harder to get the same grades. Throughout high school I studied really hard and achieved good grades; I was determined not to give up. In university, I was among the minority in my mathematics classes; there were usually at least twice as many males as females in my classes. All of my teaching assistants were also males. It was often intimidating to ask for help. Again, I did my best to get through these classes; I worked very hard to get to where I am today.

Today, I am a math teacher at an all-girls school. I am confronted with females in mathematics on a daily basis. I see girls excel and struggle in this domain; I also see girls who have decided at the age of twelve that they will not pursue math beyond the secondary level, and I see girls prevail and pursue mathematics beyond this level. I am determined to make each of their experiences as memorable and comfortable as possible. I am not expecting them all to continue their studies in mathematics, nor am I expecting them all to be gifted in mathematics. I am expecting them to give it their all because I truly believe that every student has the ability to achieve some level of success in mathematics (specific to each individual child). If I can change one girl's opinion about mathematics or encourage one girl to participate in mathematics, I have made a difference.

Gender Equity

What is gender equity (within a math classroom)?

The term gender equity can be described as "being fair and just toward both men and women, showing preference to neither sex nor concern for both sexes" (Funk, 2002, p. 2). At the end of a child's education, there should be no difference in what boys and girls have learned; girls should feel just as comfortable to participate in mathematics and pursue a career as their male counterparts. But studies have shown that boys and girls are not performing and participating in mathematics at the same level and are not being treated the same way in the classroom (Fennema & Leder, 1990; Chapman, 1997; Sanders, Koch & Urson, 1997; Sadker & Sadker, 1994). It is important that more information is gained to help promote equity in mathematics and provide a good education for both males and females. Fennema & Leder (1990) describe three

definitions of equity with respect to mathematics, which need to be implemented in the schools in order to provide equal grounds for both genders. First, equity as equal opportunity to learn mathematics; as children continue through their education, different patterns appear. Students are placed in different tracks and are given different options to study math. When given the choice, females are not choosing math in the same numbers as boys; the gap becomes greater as a child gets older. Second, equity as equal educational treatment; there exists evidence that equality in treatment of the sexes does not exist in most classrooms. Males interact more frequently with teachers, receive more attention and help, and receive more criticism and praise. Third, equity as equal educational outcomes; at the end of schooling, there should not be differences in attainment levels between the sexes. However, in general, at the end of high school, males have learned more math and different math than females. The need for equity within a classroom is essential; girls are affected beyond high school with their absence from mathematics, especially economically. It inhibits their participation in many occupations, career advancements, and career change.

Importance of Mathematics

Why study and participate in mathematics?

Math promotes critical thinking, problem solving, and provides greater career opportunities. Knowledge and skill in mathematics can open the door to many jobs; therefore, lower female participation in mathematics can affect the occupational futures of our girls. Lack of female participation in mathematics careers contributes to the loss by society of potential contributions, continued occupational segregation of the sexes, and lower incomes (Chapman, 1997). The amount of math girls take acts as a "critical

filter" limiting the jobs they can get, the colleges they can go to, and the college majors they can choose (Campbell, 1992; Hyde, Fennema, Ryan, Frost & Hopp, 1990). Most universities require courses in advanced mathematics and science for many majors; students who avoid these courses close off a wide range of future career options (Heid & Jump, 1993)

One of the main reasons to increase participation in mathematics for females is directly related to economics, both for individual and for society. As our world is becomingly increasingly more technological, there is a growth in mathematical-based occupations; the ability for workers to solve complex scientific problems and to use mathematical skills are essential components in order for our country to compete in the global marketplace. In addition, math-related jobs often yield a good income. Brown and Porter (1995) state that the most recent surveys show graduates in mathematics and computer science are at the top of the earnings list six years after graduation. In a CNN Money article, Schwartz (2000) reported that annual average salaries of general math majors with a bachelor's degree is $56,500, 17% higher than the average for all college grads. The U.S. Bureau of Labor Statistics (2005) reported for computer and mathematical occupations that the mean hourly wage is $32.26 and the mean annual wage was $67,100.

It is important to get more women participating in typically male-dominated fields in order to prevent further segregation of the sexes in the workforce, to avoid further concentration of women in lower levels of the professional hierarchy and in female-dominated occupations, and to have more women in the higher earnings categories.

The Primary Research Questions

Although there exists many barriers and obstacles for women in mathematics, there are still women who are pursuing careers in this field. The intent of this thesis is to explore the various reasons why women are drawn into a mathematics career and to explore the experiences of these women. By exploring their personal experiences in mathematics, I can gain a better understanding of the influences, support, events, and interests that pushed them to choose this career path. The main research question is: what internal and/or external factors influenced and/or encouraged their participation in a mathematics career? Sub-questions, which helped frame the questionnaire, are intended to explore the participants' personal, academic, and educational experiences in mathematics. Do these women share similar experiences? What experiences led them towards a mathematics career? What motivated them towards a mathematics career? What barriers, if any, did they overcome and how? What changes need to be made so that more girls will pursue mathematics?

The goal is to get a better picture of the socialization factors that encourage and/or discourage women from participating in math professions. It is hoped that by exploring the experiences of the women in this study, it can be used to help other females pursue mathematics. By identifying the various reasons that these women were drawn into a mathematical-related career, suggestions can be made for changes in the home and educational environments.

In the following chapter, various perspectives of the socialization process will be examined with respect to its importance on female participation in mathematics.

Chapter II

The Socialization Process and its Impact on Career Choices

In this chapter, I discuss the following questions: (i) how does the socialization process (both primary and secondary) affect a child's experience and learning of mathematics; (ii) what are the external factors affecting girls' participation in mathematics; and (iii) what are the internal factors affecting girls' participation in mathematics?

Children are born into this world and are then socialized to certain behavioural and cognitive styles. Parents act as the primary socializing agents and the school system (teachers, classrooms, peers) as the secondary socializing agent; gender differences get reinforced through childhood activities and educational practices. One key area where gender differences become apparent in schools is related to academic performance and participation in mathematics, particularly at the secondary school level; these gender differences also become apparent in the under representation of women in the educational and occupational realms related to mathematics. In order to explore the various reasons why certain women are choosing to pursue a math-related career, it is important to first look at the socialization process of both genders and explore the barriers that deter or prevent females from continuing in mathematical studies. Only then can we begin to understand the various factors affecting the continued participation of women in mathematics.

Some of the most vital learning occurs before a child even reaches the classroom. The most influential people in a child's life during this period are the parents; they act as primary socializing agents. Socialization refers to "the process through which the

individual takes on the ways of thinking, seeing, believing, and behaving that prevail in the society that he or she was born into" (Barakett & Cleghorn, 2000, p. 93). Parents help their children develop key skills and personality characteristics such as language, cognitive skills, self-control, morals, values, and identity. Although children may not be learning math skills directly, parents are demonstrating and solidifying two key components that have an effect on their children's academic success in school and in mathematics: gender roles and gender identity.

When parents help their children develop appropriate attitudes and behaviours for social interactions and an understanding of social roles, they are teaching them gender roles. In the 1960s, the Social Learning Theory (Mischel, 1966) was used to describe the learning of gender-related behaviour. This theory hypothesizes that gender roles are learned because they are taught by social agents. Parents and other caregivers are believed to treat girls and boys differently from the beginning of life; this is referred to as "differential socialization". Girls are thought to be rewarded for certain behaviours and punished for others; these are not the same sets of behaviours as boys are rewarded or punished for (Jacklin & Baker, 1993).

Although many parents want equality between the sexes, most parents accept that men and women have fundamentally different roles in the family, which in turn gets transmitted to the children (Burton, 1986). An area where differential socialization by parents occurs is in the direct encouragement of gender-typed activities. Frequently, girls and boys are expected to help out with different tasks around the house and are involved in different types of extra-curricular or spare-time activities. Parents tend to be more physically active with their sons, and boys tend to get more opportunities to explore their

physical worlds. Gender role socialization gets reinforced through toys, clothing, and play. The phrase 'boys will be boys' has more detrimental effects than probably intended. Children learn very quickly their 'appropriate' role as a male or female. In relation to gender roles, children also get an understanding of masculinity and femininity, or gender identity. It is transmitted to children that it is acceptable for girls to be emotional and sentimental while boys need to be strong and tough. Both gender roles and gender identity develop during the socialization period and are a direct reflection of society or of cultural norms. Parents are simply reinforcing what they have learned in life, and the cycle continues.

Although primary socialization continues throughout a child's life, they are not the only agents of socialization; family, school, peer groups, and role models also act as socializers. The next stage in a child's life is entering school; it is here where gender roles and gender identity contribute to a child's experience of and success in school and mathematics. When a child enters the school system, they are beginning their second stage of socialization. Until now, the parents played the key authoritative roles in their lives. Children are now introduced to a variety of socializers including the teacher, classroom practices, and peers. By the time children start school, they have already acquired a set of attitudes and expectations of their gender roles; the school then reinforces these gender differences through various educational practices.

Children experience the classroom setting in a variety of ways; as boys and girls have been socially conditioned in different manners, a classroom or teacher's style will influence that child's experience. Children learn a social code of behaviour through patterns of interaction with others; the manner in which children are treated by teachers

and other adults in the school and teachers' classroom management strategies affect a child's learning. In primary school, subtle differences appear between the genders. Girls often perform at the same level or even better than boys in mathematics; however, around middle school this begins to change (Sadker & Sadker, 1994; Fennema & Leder, 1990; Burton, 1986). Children enter the early adolescent years (ages nine to thirteen) that are critical for psychological, social and cognitive development in the fields of math and science. Expectations to succeed decrease as girls pass through junior high; this precedes rather than follows the decrease in mathematical achievement. It is during this period that peer pressure to conform to traditional sex roles is most intense; children's opinions of themselves and confidence in abilities is either lowered or raised (Heid & Jump, 1993). Attitudes towards, achievement in, and aspirations in mathematics may sharply decrease; this may impact a student's participation in mathematics. Both external and internal factors will be examined in order to see their contribution and impact on girls' participation in mathematics.

External Factors

There are many external constraints that could influence continued participation in mathematics; among the most visible are adult influences (parents, teachers, role models), but also includes a child's peer group. The educational process is a journey filled with both academic and life lessons. Children may be subjected to differential treatment, adult expectations, mixed messages, and lack of encouragement both at home and at school. These social agents can either encourage or discourage students from considering nontraditional choices; typically, they can highlight and reinforce options that are consistent with gender-role stereotypes.

Parents

Parents tend to be the most influential people in a child's life; in this section, parental beliefs, parental expectations and aspirations, parental support, parental education, and Eccles' parent socialization model are discussed in relation to how each can impact participation in mathematics.

Although most parents want equality between the sexes, their beliefs, stereotypes, and expectations for daughters and sons differ. Adults (both teachers and parents) often underestimate the intelligence of girls; Sadker and Sadker's (1994) research shows that many adults believe boys are smarter in math and science beginning in early school years, despite the fact that the girls are getting higher marks. These adults believe that males possess an innate mathematical ability, and that girls can achieve good results but have to try harder. If girls bring home low grades, parents believe their daughters are not capable in those subjects; if boys bring home the same low grades in math or science courses, parents believe their sons are lazy and push them harder. Girls, especially the brighter ones, learn to underestimate their mathematical ability. Some parents commonly believe that math, especially advanced high school math, is more important for sons than daughters and would encourage their sons more than their daughters. Other studies, however, show that parents are enthusiastic about girls studying math and science and that they had high occupational aspirations for their daughters; yet often, these parents were themselves fulfilling sex-stereotyped roles in the family and making the same demands on their children (Burton, 1986). These academic perceptions persist throughout different levels of education and are transmitted to the children. The effects of parental beliefs and stereotypes are important because they impact on expectations and

goals parents develop for their children. This also impacts parents' perceptions of children's interests and talents and on ways in which parents interact with their children (Eccles, et al, 1993).

Parental expectations play a significant role in the development of gender differences in students' attitudes toward mathematics and their enrollment in these courses (Sadker & Sadker, 1994; Burton, 1986, Chapman, 1997; Schwartz & Hanson, 1992; Campbell, 1992; Eccles, 1987). A number of studies have shown that parents', and especially mothers' confidence in their children's math abilities has a greater impact on those children's confidence in their own math ability than do grades (Sadker & Sadker, 1994; Campbell & Beaudry, 1998). Eccles-Parsons, Adler, and Kaczala (1982) point to the positive impact of parents' confidence in their children's academic abilities on children's own self-perceptions and actual performance. This study shows that a parents' expectations for their children's performance in math had an impact on children's subsequent performance as well as on their view of their own math abilities; by late elementary school, this effect was stronger than the effect of the children's own current performance levels in math. In addition, it was found that parents' perception of their children's competence in mathematics was influenced by the children's gender, even when effort and ability were controlled for.

Research suggests there is a positive influence of parental academic aspirations on children's career development (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996, 2001). Parental influence affects a child's career development mainly through their impact on their children's self-efficacy appraisals, educational aspirations, and scholastic achievement. Bandura et al. (1996) found that parents who convey positive educational

aspirations and act on the belief that they can help their children achieve them, promoted their educational attainments both directly and by enhancing their cognitive and self-regulatory efficacy and raising their academic and occupational sights. In addition, children whose parents have academic aspirations for them are less likely to become involved in mischievous activities; these children tend to have a higher sense of efficacy, which allows them to resist peer pressure that might result in negative consequences. It has also been found that parents who believe that they can affect their children's development are more proactive and successful in developing their children's competencies than parents who doubt they can do much to influence their children's developmental course.

Girls who continue with an interest in math usually have more support and encouragement at home, especially in the earliest years (Burton, 1986). Parental support (or lack of) is important for a student's attitudes and participation and achievement in mathematics (Tocci & Engelhard, 1991; Ma & Kishor, 1997). Parents may unconsciously fail to provide support for their daughters' interest in mathematics, either by directing interests elsewhere or by giving all their support for education to their sons (Schwartz & Hanson, 1992). Parental encouragement is one of the major influences children cite as a reason for both course enrollment decisions and career choice; in addition, children list parents as one of the major sources for educational and occupational information and guidance (Eccles, 1987; Chapman, 1997).

Tocci and Engelhard (1991) found that parental support is a significant predictor of attitude towards mathematics; they found that the higher the perceived parental support, the better the attitude and the lower the level of anxiety. Parental encouragement

affects how children value mathematics and their expectations for success in this domain. Wilkins and Ma (2003) also emphasize that parental push has a significant and positive relation to the social importance and notions of the nature of mathematics that students place on mathematics (the same positive effect was found from teacher push and peer push). In addition, students who reported positive influences from their parents had significantly slower decline in their views of the importance of mathematics.

Using the Eccles' parent socialization model, Jacobs, Davis-Kean, Bleaker, Eccles and Malanchuk (2005) looked at four different ways in which parents influence their children: (1) by the general social-emotional climate they offer and by their general childrearing beliefs; (2) by providing specific experiences for the child; (3) by modeling involvement in valued activities; and (4) by communicating their perceptions of the child's abilities and expectations for performance. According to this model, the environment, role modeling, and message that parents provide regarding the value they attach to science and math activities are expected to influence a child's motivation to pursue those fields. Children then develop their own level of interest in math and science and integrate these interests or values into their self-systems. Eventually, the values that are incorporated into an individual's self-beliefs which will affect future task choices. They found that although girls' performance and self-perceptions of ability suggested that they feel competent in math, they are less likely than boys to find it intrinsically interesting and their parents are less likely to create math-supportive or math-promotive environments for them. Jacobs et al. (2005) conclude that the achievement environment in many homes is a gendered environment and that messages from parents about achievement continue to be sent through gender-typed filters.

Parental education and family social economic status (SES) has also been found to influence the participation and success in mathematics. Wilkins and Ma (2003) note that students whose parents were more educated reported higher perceived importance of mathematics; they believe that theses parents were likely to have taken more mathematics and therefore recognized the importance for future education and occupational success. Schnabel, Alfeld and Eccles (2002) found a correlation between parental education and SES and educational outcomes of children. They state that SES indicators and parental education correlate significantly with achievement indicators (tests and grades) and correlate with future academic plans (attending college). Bandura et al. (1996, 2001) also provide support for the structure through which socioeconomic, familial, academic and self-referent influences work to shape a child's career trajectories. It was found that familial SES influences parental perceived efficacy and academic aspirations, which in turn affect their children's perceived efficacy, academic aspirations and academic achievement. In addition, the more strongly parents believe that they can play a part in the children's academic development, the higher the educational aspirations they hold for them; aspiring parents build their children's academic, social and self-regulatory efficacy, raise their aspirations, and promote their academic achievements. As a consequence, the children's perceived efficacy and academic orientations shape their perceived efficacy for different types of career pursuits, playing a role in the careers they choose or do not choose. There is a cycle beginning with SES and ending with career choice; SES impacts on familial belief systems and then the parental beliefs impacts on their children's appraisal of their own academic capabilities and their educational vision.

Teachers

Another important adult figure in a child's life and an important key to the continued participation of females in mathematics are teachers. Teacher behaviour and classroom organization, teacher beliefs, and teacher expectations are discussed in relation to girls and mathematics.

Patterns of teacher behaviour and classroom organization can influence boys and girls differently (Fennema & Leder, 1990; Sadker & Sadker, 1994; Meyer & Koehler, 1990; Wilkins & Ma, 2003). Males and females have different classroom experiences because they approach learning differently and because teachers tend to treat them differently; both of these factors can affect female participation in mathematics. Teachers contribute and reinforce gender roles and imbalances in the classroom; if teachers treat their students differently, they will learn differently. A teacher's actions and words have bearing on a student; intentionally or unintentionally, teachers send a variety of messages to a student relating to their behaviour and their place in the classroom. In the past, research focused on sex-role stereotyping and how this influenced gender differences in math. This included teacher's remarks, sex-biased textbooks, and the sex of the teacher. Today, the focus is more on interactions between the teacher and the student. These interactions include types of questions being asked, who the teacher called upon to answer questions, how incorrect answers are handled, how and what type of praise or critique is given, and how requests for help are handled. Fennema & Leder (1990) discovered that males tended to receive more criticism, be praised more frequently for correct answers, have their work monitored more frequently, and are given more contacts with their teachers.

Consciously or unconsciously, most people hold some stereotypical beliefs with respect to gender, and a teacher is no different. These beliefs could influence the cognitive development of females and males; teachers themselves may have their own strong beliefs about gender roles. Teachers may have different expectations for their students and the usefulness of math in their futures. These beliefs are a reflection of the society as a whole and also demonstrate the extent to which students themselves have accepted and internalized these expectations and beliefs. In all classes, but especially math class, girls need to be given the same encouragement as boys to perform difficult tasks in order to increase their interest, confidence and capability.

A teacher's attitude and expectations greatly affect students; these expectations can be felt through facial expressions, eye contact, vocal tone and gestures. With respect to airtime, boys often gain more teacher help and attention, thus influencing achievement levels. Sadker and Sadker (1994) discovered that in a coeducational setting, girls compared with boys are five times less likely to receive the most attention from teachers, three times less likely to be praised, eight times less likely to call out in class, half as likely to demand help or attention, and half as likely to be called on in class. This greatly affects the female students, lowering their self-esteem and reinforcing male domination in subjects such as mathematics. Schwartz & Hanson (1992) found that teachers believing that participation is an indicator of learning are likely to ignore females because they participate less than males; males demanded more attention, complain more when they do not receive enough, and teacher and female peers expected them to get more attention. In the classroom, gender differences in learning styles exist. In addition, it was found that females tend to prefer conversational style that fosters group consensus and builds ideas

on top of each other; an interrelation of thoughts and actions is essential. Males, on the other hand, tend to learn through argument and independent activity. Most classroom discourse is organized to accommodate males learning patterns.

Role models/mentors

Role models can improve confidence, performance, and elevate aspirations (Bartholomew & Schnorr, 1994; Sheehan, 1995; Schwartz & Hanson, 1992; Jacobs et al., 2005). Parents, teachers, and other adult figures are often the most influential role models.

By providing support for their daughters, parents can affect mental health, self-esteem and achievement motivation. According to Jacobs et al. (2005), when parents provide messages about their own worldviews and values (for example, parents who love mathematics and talk about it, enroll children in math-related activities) they are conveying enthusiasm or interest in math. In addition, how parents spend their time and the sense of self-competence they project, send strong messages to their children about activities that are valued and acceptable ways to spend time. By exposing children early to math-related activities and games, parents are involving themselves with children in math-related activities; as a result, the child will learn to value that activity.

It is important for females to have role models and mentors working in the school; female students need to see women working and succeeding in math-related fields. As Sheehan (1995) states, female teachers are a small minority in several key areas such as mathematics (20.9%) and science (17.8%); the gender segregation in these areas continues to reflect traditional female roles and perpetuate stereotypes. In addition, there is an imbalance in administrative positions and secondary school teachers in Canada; 8%

of all females working in the education system are administrators, compared with 29% of male professional staff. Also, secondary female teachers make up 35% of the work force. Women hold fewer powerful positions than men, and students experience this in the school system every day. Teachers can also act as role models in terms of their behaviour and teaching style; they can increase a girl's participation and motivation in mathematics by sharing their interest and love for their subject.

Other adult figures, especially women, in mathematic-related careers can act as role models or mentors. Girls are often not given enough information about career possibilities requiring competence in advanced mathematics and they are not being introduced to women role models with successful mathematics careers. Girls need to be able to picture themselves enjoying and succeeding in these types of careers, especially since math is often perceived as a male domain. In addition, through their own occupation and experiences, role models can provide relevant information on available occupational options.

Peers

Peers are also important as they can influence math participation in a variety of ways: regarding math with negative connotations, involvement in different activities or pastimes, and providing or withholding support towards mathematic-related activities or careers.

As students reach adolescence, their peers' opinions become very important; they further perpetuate sex-role differentiation through various activities, friendship patterns, subject preferences, and career aspirations. Students may avoid math if their peer group regards it negatively for any reason (Fennema & Leder, 1990; Wilkins & Ma, 2003).

While males tend to have a preference for active games and pastimes which involve skills and mastery of objects, females often play together in a way that they practice skills related to mastery over people and interpersonal relationships (Fennema & Leder, 1990). These roles tend to conform to adults' expectations. As math is stereotyped as a male domain, this lowers female performance and participation. Girls do not want to be viewed by their peers as less feminine because they are involved in mathematics.

Bandura et al. (1996) note that children who are considerate of their peers and are accepted by them will experience a more favourable school environment that is more conducive to learning than if their peers reject them. In addition, students who doubt their intellectual efficacy are more likely to choose peers who have similar academic values and pursuits. Eccles (1987) shows that peers can affect occupational options to be seriously considered by providing or withholding support for various alternatives. This support can be direct (for example, laughing at a girl when she is interested in math) or indirect (anticipation of future spouse and the role they will play).

In summary, there are many external factors that can influence a female's continued participation in mathematics. As pointed out in this chapter, research has shown that parental beliefs, parental expectations and aspirations, parental support, and parental education all affect girls and their continued participation in mathematics. Another important adult figure in a child's life and an important key to the continued participation of females in mathematics are teachers. Teacher behaviour and classroom organization, teacher beliefs, and teacher expectations all affect a student's learning and can affect further study of the subject. Role models are also important adult influences as they can improve confidence, performance, and elevate aspirations. Finally, peers are

influential in a girl's choice of study and career path as they can regard math with negative connotations, be involved in different activities or pastimes, and provide or withhold support towards mathematic-related activities or careers.

Internal Factors

Students bring a variety of skills, prior knowledge, work habits, attitudes, and beliefs to the classroom; these variables interact with what happens in the classroom and influence learning of mathematics. Internal factors such as self-esteem, ability, talent, knowledge and mental and emotional health are much harder to recognize and attend to in the educational system than external factors. Internal factors and their effect on female learning are explored with respect to attitudes towards and beliefs about mathematics, self-esteem/confidence, usefulness of mathematics, math as a male domain, and math anxiety.

Attitudes towards and beliefs about mathematics

Attitudinal and societal beliefs are one of the major contributors to gender imbalances in mathematics and a major obstacle facing females and their participation and performance in mathematics; these beliefs develop early in a child's life and continue through adulthood. Attitudes and beliefs play a central role in mathematics achievement; attitudes affect achievement and influence success and the persistence in the study of mathematics. There is a positive relation between attitude and achievement based on the concept that the better the attitude a student has toward a subject or task, the higher the achievement or performance level tends to be (Schreiber, 2002; Tapia & Marsh, 2004; Eccles, 1987, 1994). Tapia and Marsh (2000) found that the better the students' attitude

towards mathematics, the lower the level of anxiety, the higher the self- confidence, the greater the level of enjoyment and level of motivation, and the more value the student place on mathematics as a subject. Research suggests that females hold more negative attitudes towards mathematics than males (Hyde et al., 1990; Wilkins & Ma, 2003). At the student level, there is also a positive relationship between a person's belief in his or her own ability to do well in mathematics and their respective achievement (Wilkins, 2004). Success or failure in math performance is greatly determined by personal beliefs; attitudes and beliefs can impact on individuals' performance levels and influence decisions to persist with studies in mathematics at higher levels (Tapia & Marsh, 2004; Forgasz, Leder, & Kaur, 1999).

Self-esteem/confidence

One of the greatest internal constraints faced by female students, especially in mathematics is confidence in their learning capabilities. Ma and Kishor (1997) define self-concept about mathematics as "a positive or negative orientation toward one's ability, performance, and success in the learning of mathematics" (p. 91). Perceptions of one's abilities are powerful moderators of achievement behaviour, suggesting low self-perception corresponds to lower levels of participation in math and sciences. Causal attribution is another gender-related perception and can be seen in the field of mathematics; research suggests that boys attribute their failure to external factors and success to ability or to themselves; they keep their confidence even with failure. For girls, the opposite occurs. They attribute their success to good luck or hard work and failure to lack of ability or their nontechnological minds (Pipher, 1994; Heid & Jump, 1993). With every failure, a girl's confidence is affected. Mathematics needs

confidence, trust in one's own judgment and ability to tolerate frustrations without becoming overwhelmed. Anxiety often interferes, and girls tend to give up easier for they have less confidence in themselves and their ability. Self-esteem is a critical element in a child's performance, behaviour, and ability to make choices; inequity in the treatment of females is a key factor in the loss of self-esteem. Females who stay in math experience hardships without the enjoyment their male counterparts tend to experience. Females tend to be more anxious, less confident about their abilities, and see fewer connections between math and application to their lives or society. In addition, girls tend to feel more peer pressure to avoid the male dominated subjects. Often, being smart conflicts with being popular. The assertive style of intellectual achievement conflicts with the passive, non-competitive role that many girls and boys expect from females. This may cause girls to opt out of advanced math courses that can affect access to certain careers later in life.

Research suggests there is a positive relation between self-concept and achievement (Ma & Kishor, 1997; Wilkins & Ma, 2003) and that females tend to have less confidence in their mathematical abilities than males (Pipher, 1994; Tapia & Marsh, 2000; Campbell & Beaudry, 1998). Perceived math competence tends to decrease for both males and females as they progress throughout their educational experience, but it often begins earlier and is more extensive for females (Wikins & Ma, 2003; Wilkins, 2004; Fennema, 1996; Campbell & Beaudry, 1998; Ma & Kishor, 1997). Ultimately, levels of self-concept can affect continued study of math.

Usefulness of mathematics

Self-confidence is also a very important key factor as it can lead to relevance or usefulness of a subject and motivation, two other very important factors in promoting participation of mathematics. A student's perception of the usefulness of a subject, immediately or in the future, impacts their decision-making and will also affect their performance or participation in that subject. If a student is not likely to believe that math has utility in their lives, they will not see the connection between math and everyday life. Tocci and Engelhard (1991) found a positive relationship between attitudes towards the usefulness of math in society and math achievement; in addition, these students had positive perceptions of encounters with math and positive reactions to the subject. Research suggests that males tend to believe that math is more useful to them than females (Tapia & Marsh, 2000; Tocci & Engelhard, 1991); another hindrance to female participation in this subject.

Students holding a more socially dynamic view of mathematics attach more value to mathematics and have more confidence in their mathematical capacities. They also tend to have more positive beliefs about their teacher and his or her functioning in the classroom; students holding positive beliefs about their teacher also consider math more valuable and feel more confident about it (Op't Eynde & DeCorte, 2003). In addition, those students who are more confident about the mathematical ability tend to be the ones who are convinced about the relevance of mathematics; this can create a solid motivational basis. The authors also found that higher achieving students have more positive beliefs about the relevance of and their competence in mathematics, but, given an equal achievement level, boys tend to attach more value to mathematics than girls and

are more confident about their capabilities. They also discovered that those students with low self-confidence are also not convinced of the importance of mathematics, which implies there is a group of students that will be very difficult to motivate for mathematics.

Wilkins and Ma (2003) note an important trend that students in high school become increasingly less positive with regard to attitudes toward mathematics and beliefs about social importance of mathematics. In addition, educational aspirations at the high school level are negatively related to change in attitudes and beliefs about social importance of mathematics; they attributed this change to the added pressure that accompanies meeting college entrance requirements such as success in a certain number of math courses. This study also found a negative change in students' attitudes toward and belief about social importance of mathematics throughout high school; in addition, boys had a significantly more positive attitude towards mathematics and a more progressive view of the nature of mathematics than girls. They found that peer influence, teacher push, parent push, and media exposure were all important determinants of this progressive view. They also showed that younger students develop more negative views about the social importance of mathematics and that boys exhibited less decrease in their beliefs than the girls.

If a student does not perceive math to be helpful in their future educational or career plans, they will not see the effort needed to succeed in this subject to be worthwhile. As a child progresses through school, math becomes increasingly difficult, and it also becomes optional. There are few reasons why students who struggle with math would choose to continue with this topic, especially if it is optional and they do not see a future career in a related field. Once math becomes an optional subject in school,

more boys than girls choose to study and continue in this subject; even those girls who persist in taking math course are more likely to find they don't like them (Leder, 1992; Schwartz & Hanson, 1992); enjoying a subject is key to succeeding at it. Trusty (2000) found that effects of course taking on choice of mathematics majors were stronger for women than men; it was found that for girls, eighth grade math test scores positively influenced math course-taking in high school which in turn positively influenced later choice of math majors. In addition, course taking is related to college-level achievement.

Math as a male-domain

From a very young age, children learn about gender roles and what is deemed acceptable for the different genders in our society. Children also tend to learn early on, directly or indirectly, that math is considered a male domain, "the perception that males are more suited to pursue studies in mathematic and science-related fields than are females" (Forgasz, Leder & Kloosterman, 2004, p. 391).

Fennema & Leder (1990) suggests that two aspects related to math as a male domain that may affect the participation and performance of girls in mathematics are sex-role congruency and fear of success. From an early age, children learn about gender roles and how society views the different genders. If a female feels that studying math is inappropriate for girls, her achievement in the subject will be affected. She may feel she will not fill her appropriate sex role by pursuing math. She might also feel that teachers have lower expectations for her success or that she is not feminine if she is successful. For many girls, the disadvantages outweigh the advantages of studying math. Females who do succeed in math are being pulled in a variety of directions. There is conflict between attaining success in math and fulfilling the typical female role in our society.

These females could fear success because success is accompanied by negative consequences. This includes the girl's loss of her sense of femininity and self-esteem and the social rejection because of her success (Heid & Jump, 1993).

Eagly (1987) hypothesizes that sex differences are the product of social roles that regulate behaviour in adult life. According to the social role theory (Eagly, 1987), gender differences in math and science are attributable to different gender-role expectations which encourage conformity to specific roles and behaviours. Girls and boys differ in their attitudes about and interest in mathematics because they accept different gender-role expectations.

Fennema (1996) found that by the middle school years, both girls and boys stereotype mathematics as a masculine discipline. Other studies, however, have shown that most males and females do not gender stereotype math and believe that mathematics is gender neutral (Forgasz et al., 2004; Leder & Forgasz, 2002). Yet other studies have shown that attitude differences between males and females with respect to the masculinity of math as a subject do exist, but it is the males who are more stereotyped in their perceptions (Hyde et al.,1990; Tocci & Engelhard, 1991). If a female feels that studying math is inappropriate for girls, her achievement and participation in the subject will be affected; she may feel she will not fill her appropriate sex role by pursuing math. (Fennema & Leder, 1990; Ma & Kishor, 1997). This conflict may also cause anxiety.

Eccles (1986) found that women perceive male-stereotyped occupations as more difficult, but not as more important than female-stereotyped occupations. Also, this study revealed that females expected to be less successful in mathematics, regardless of actual abilities. These findings were confirmed by Ethington (1992) who also found that

females tend to value mathematic-and science-related careers less than female-stereotyped occupations.

Math anxiety

Feelings of anxiety have been linked with low performance in mathematics, which can then have an effect on participation in mathematics. Tapia & Marsh (2002) found that math anxiety is directly related to previous school math performance. In addition, it is inversely related to positive attitudes in mathematics. Math anxiety affects self-confidence, enjoyment and motivation in mathematics. Tapia's (2004) study found that students with no math anxiety scored significantly higher in enjoyment than students with high math anxiety, students with little or no math anxiety scored significantly higher than students with some or high math anxiety in measures of self-confidence and motivation, and that students with some math anxiety scored significantly higher in motivation than those with high math anxiety.

Math anxiety, which tends to affect females more than males, may predispose students towards avoiding math and sciences. Altermatt and Kim (2004) discovered that as early as elementary school, girls report they are more worried than boys about school performance. They found that the worrying was related to negative outcomes for girls such as lower levels of academic confidence and higher levels of uncertainty about how to be successful. They offer a variety of theories why females worry more than males such as females are more likely than males to feel that poor performance is the result of uncontrollable factors, such as low ability, females are more concerned than males with pleasing others, and females may be more likely than males to experience anxiety in competitive environments. Altermatt and Kim (2004) concluded that females increased

levels of anxiety may discourage them from pursuing admission to top-level programs in top-level schools and after admission, may lead females to avoid courses and majors they are clearly capable of handling. The end result is that females may fail to pursue careers in mathematics.

In summary, internal factors can have a direct impact on girls' participation in mathematics. Attitudes and beliefs play a central role in mathematics achievement; attitudes affect achievement and influence success and the persistence in the study of mathematics. As mentioned in this chapter, females tend to have more negative views related to mathematics. Perceptions of one's abilities are powerful moderators of achievement behaviour, suggesting low self-perception corresponds to lower levels of participation in math and sciences. In addition, research suggests that females tend to have a lower level of confidence towards their math abilities. Self-confidence, in turn, affects a student's perception of the usefulness of math, now or in the future, impacts their decision-making on both performance and participation of mathematics. Once again, research suggests that females do not place as much importance on mathematics as males. Children also tend to learn early on that math is considered a male domain; their continued study in this field may not fit with their appropriate gender role. Finally, feelings of anxiety have been linked with low performance in mathematics and that females tend to experience more anxiety than their male peers.

Impact on Career Choices

What effect do these mathematic experiences have on the future of girls?

Female enrollment in university indicates the number of women attending has increased so that they are currently the majority; however, when looking at the majors

they are choosing, a discrepancy exists in math-related fields (Sadker & Sadker, 1994; Statistics Canada, 2003). The under representation of women in math-related careers can affect the futures of our girls. As suggested earlier, it contributes to the loss of potential contributions to math and science, continued occupational segregation of the sexes, and lower incomes (Chapman, 1997). Hyde et al. (1990) assert that mathematics is the "critical filter" that prevents women from having access to higher paying, more prestigious occupations. Expectations of success appear to be powerful determinants of women's career choices. In addition, women's mathematical ability and beliefs about that ability are critical filters in screening women out of more nontraditional career fields. The work of Eccles (1987, 1994) and Bandura (1986, 1997) point to the impact of expectations of success, value, and choice and of self-efficacy beliefs on career choice.

Eccles' Model of Achievement-Related Choices

Eccles' (1987, 1994) model of achievement-related choices studies the motivational and social factors influencing long and short-range achievement goals and behaviours such as career aspirations, vocational choices, course selections, persistence on difficult tasks, and the distribution of effort across various achievement-related activities. This model assumes that educational, occupational, and achievement-related choices, whether consciously or unconsciously, are guided by the following: one's expectations for success on the various options perceived as being appropriate, the relationship of these options to short and long range goals and to one's core self identity and basic psychological needs, an individual's gender role and general self-schema, and the potential cost of investing time in one activity rather than another. It is believed that these are shaped by experiences, cultural norms, behaviour and goals of parents, teachers,

role models and peers. It is assumed that each of these factors influence both the expectations for future success at the various achievement-related options and the subjective value attached to these options. As a result, these expectations and the value attached to the various options are assumed to influence choice among these options. This model attempts to legitimize women's choices while recognizing the effect of gender-role socialization on the determinants of these choices.

Eccles suggests that expectations for success should depend on the confidence an individual has in their intellectual and other relevant abilities, on their estimates of the difficulty of various occupations and on estimates of external or social barriers to their success. These beliefs will have been shaped over time by experiences with related activities, by individual interpretations of these experiences, and by beliefs regarding opportunity structures in their culture.

Educational and vocational decisions (course enrollments, college majors, occupational choices) are influenced by the value that an individual attaches to various options they believe are available to them. Even if an individual anticipates success at a task, they will not undertake it unless they value it; value involves components such as interest and usefulness. Value is influenced by whether an individual anticipates liking the work, whether work is seen as instrumental in meeting long or short range goals, whether people have insisted they consider or not consider this occupation, whether positive or negative experiences in associated activities (school, extra-curricular) and whether occupation is seen as too time-consuming.

This model also suggests that individuals continually make choices, both consciously and unconsciously, regarding how they will spend their time and efforts.

These choices are usually influenced by socialization pressures and cultural norms. Eccles describes choice in three categories: perceived field of options (many options are never considered because they are unaware of their existence, whereas other options are not considered because of inaccurate information of the options or the possibility of achieving this option), psychological influences on choice (choices are influenced by self-schemes and individual's educational and occupational stereotypes), and complexity of choice (achievement decisions are made within the context of a complex social reality that presents each individual with a wide variety of choices, each of which has both long-range and immediate consequences).

In summary, both gender and individual differences in educational and occupational choices can be linked to differences in individuals' expectations for success and subjective task value. With respect to gender differences in math-related occupations, according to this theory, women are less likely to enter these fields than men because they have less confidence in their abilities and because they place less subjective value on this field. Gendered socialization in the home, at school, and with peers plays an important role in shaping these individual differences in self-perceptions and subjective task values.

Bandura's Social Cognitive Theory

This theory emphasizes the relationship between personal and environmental factors, which are dependent upon each other. In Bandura's social cognitive theory (1986, 1997), the person is the agent of change; the central construct of this theory is self-efficacy, confidence in one's ability to successfully perform a given task or set of tasks. This helps determine whether an individual will initiate, persevere, and succeed at

particular endeavours. Aspirations are "influenced by self-appraisal of capabilities. The stronger the perceived self-efficacy, the higher the goal aspirations people adopt and the firmer is their commitment to them" (Bandura et al., 1996, p. 1208). Social cognitive researchers believe that the under representation of women in math-related careers may be attributed to the self-beliefs that women hold about their capabilities (Bandura, 1997; Zeldin & Pajares, 2000).

According to Bandura (1986, 1997), people form their self-efficacy perceptions by interpreting information from four sources: mastery experiences (how one interprets past successes or failures in accomplishing a task; continued success will produce higher self-efficacy while continued failure can lower self-efficacy beliefs), vicarious experiences (learning new reactions by watching someone else performing a task and then doing it ourselves, observational learning), verbal persuasions (positive verbal messages and social encouragement which helps an individual keep the effort and persistence needed to succeed), and physical and emotional states (amount of stress or tension, positive mood states).

Research suggests that academic motivation, interest, and academic achievement is affected by a child's beliefs in their efficacy to regulate their own learning activities and to master difficult subject matters (Bandura et al., 1996). In addition, efficacy beliefs shape career aspirations and pursuits during early formative years. The stronger the students' efficacy beliefs, the more occupational options they consider possible, the greater the interest they show in them, the better they prepare themselves educationally for different careers, and the greater their persistence and success in their academic work. Unless a person believes they can produce desired outcomes by their actions, they have

little incentive to act or to persevere when confronted with difficulties (Bandura, 1997; Lent, Brown & Hackett, 1994). If an occupation is seen as being beyond one's capabilities, it will be eliminated from consideration despite the positive aspects related to that career.

In summary, self-efficacy is formed through mastery experiences, vicarious experiences, verbal persuasions, and physical and emotional states. The higher the level of self-efficacy, the greater the chance a person will prepare, persevere, and succeed in particular occupational fields.

This chapter focused on the socialization process and its impact on female participation in mathematics and career choice. In the following chapter, I present the study and explore the participants' responses from the various questions in the questionnaire.

Chapter III

The Study: Findings and Discussion

This chapter first describes the methodology used in this study. I then present the findings of the study according to the responses from the questionnaires and interviews by addressing three different questions: (i) why were these women drawn into a math-related career; (ii) what obstacles did/do these women face; and (iii) what advice, encouragement, and/or recommendations can these women offer for other females and their participation in math?

Methodology

This study of women's participation in mathematic-related careers set out to explore the various reasons why women are drawn into a mathematics career and to explore the experiences of these women. By exploring their personal experiences in mathematics, I gained a better understanding of the influences, support, events, and interests that pushed them to choose this career path. In addition, I hoped that their experiences and insight could be used to help other females and their participation in mathematics.

Subjects

Fifteen women, ranging in ages from twenty to seventy, fit the criteria for subject selection; these women had attained a degree in mathematics and/or are currently employed in a mathematics-related career that relies on the use of mathematics or has had mathematics as a prerequisite. Several careers fulfilled the criteria for this study: actuaries, mathematics teachers, mathematics professors, engineers, data analysts, and

architects. The participants were selected by a combination of snowball sampling and primary contacts.

It is important to begin by describing my overall perceptions of the fifteen women in this study based on their interview and questionnaire responses. In the process of speaking with these women and reading their responses, I got an overall sense that I was dealing with a very confident and positive group of women. The majority of the women spoke of positive home and educational experiences with math and received support and encouragement from both parents and teachers. Perhaps this is a result of the socio-economic status (SES) background of these women's families; as will be discussed in the next section, the majority of women in this study had at least one parent who has attained a postsecondary degree. Although it was not my intent to research SES, its effects may certainly have played a role in the attitudes and self-esteem of the women in this study. It should also be noted that five of the women attended private schools at some point in their educational experience. It was also clear that the women in this study all possessed a certain level of ability with respect to mathematics, but more importantly, they enjoyed the subject. In my opinion, in order to pursue a career in mathematics (and be happy) you must possess a certain mathematical ability and you must enjoy the domain.

Materials

This study used a qualitative design that consisted of a ten-question questionnaire and interviews (Appendix, p. 81). Twelve women completed the questionnaire that was designed to investigate the internal and/or external factors that have influenced their participation in mathematics. It also included a general background section to identify age, educational background (where and what degree) of the participant and her parents,

and occupation of the participant and her parents. Participant information can be found in Tables 1 through 5 (p. 83) and parental information Tables 6 through 10 (p. 85). Three of the participants were interviewed using the same ten questions in order to get a more in-depth account of their experiences in mathematics.

Procedure

The participants were contacted by phone or e-mail and the questionnaire was sent via e-mail and by mail, depending on the participants' choice. They were asked to complete the questionnaire and return it to the researcher within a two or three-week period. With respect to the three interviews, I met with each of those women in their homes between January 2006 and April 2006. Each interview was tape recorded and then transcribed verbatim.

Ethical Considerations

The survey was not anonymous as some of the participants returned the questionnaire via e-mail. The participants were made aware that their identity and place of employment would remain confidential. Since all the subjects were older than fourteen years of age, they were all able to give their own consent to participate in the study.

Limitations of the Study

First, the ages of the participants are not evenly distributed; as I am in the 20 - 29 category, many of my contacts are also in that age category. Ten of the fifteen women are under the age of 40; it would have been nice to have the same number of participants in each age category as they could have very different math-related experiences.

Second, it was difficult to find literature that researched reasons why women chose to participate in male-dominated fields; almost all of the literature I found, looked at the reasons why women did not choose to pursue these careers. I would have liked to see more research on successful women in male-dominated fields and their personal reasons for success.

Third, some of the questionnaires required a follow-up as some of the responses required a bit of clarification or a more in-depth answer; this was not possible as the majority of the participants do not live in Montreal and were communicating to me through e-mail. I had to interpret their responses or draw my own conclusions. Although the interviewing process allowed for a more in-depth analysis and probing to certain questions, there are some participants who lived fascinating lives involved in mathematics and I would have loved a chance to meet with them and further discuss their thoughts and experiences in math.

Findings & Discussion

With respect to the literature on the barriers facing women and their participation in mathematics, the comments from these women suggest that they had the appropriate support from external factors (discussed in the following section) and had the appropriate strength in their internal factors in order to pursue mathematics beyond the secondary level (discussed in the following two sections). From their responses, it was clear that these women had positive attitudes towards mathematics; these attitudes affected their achievement and influenced their success and persistence in the study of math. Research suggests that individuals who have a positive attitude towards mathematics have a higher achievement level, lower level of anxiety, higher self-confidence, greater level of

enjoyment, greater level of motivation, and place more value on math (Schreiber, 2002; Tapia & Marsh, 2000, 2004; Eccles, 1987, 1994). The comments in this study supported this research. In addition, research suggests that positive attitudes influence decisions to persist with mathematics (Tapia & Marsh, 2004; Forgasz et al., 1999); this research is confirmed by the fact that these women pursued mathematics in postsecondary studies and are now working in math-related fields.

Why were these women drawn into a math-related career?

Questions 1 to 5 were designed to explore the external and/or internal reasons that these women choose to pursue an occupation in mathematics. It investigated (i) their earliest experiences with math; (ii) experiences or events that they believed may have lead them to pursue these careers; (iii) who or what influenced them the most towards this career; (iv) whether their goal career path had always been towards math; and (v) their general beliefs on their main reasons for choosing this career.

Within this section, four main themes became apparent when looking at the various reasons that these women were drawn into a math-related occupation. All of the women in this study were influenced by parental support, encouragement, and education, were motivated by role models, were guided by expectations for success, value, and choice, and had developed high self-efficacy beliefs. The combination of these factors resulted in their continued participation in a math-related field.

Theme I:
Parental support, encouragement, provision of math-related activities, and education all play an important role in developing interest in and continued participation in mathematics

When asked: *what were some of your earliest experiences in mathematics*, more than half of the women mentioned their parents in some form. As Burton (1986) stated, girls who continue in mathematics have more support at home, especially in the earliest years. Some of the women in this study recount how their parents helped them: Diane remembers her mother helping her learn the multiplication tables, Eleanor spoke of her mother teaching her about fractions and addition and subtraction, Penny talked about how her mother taught her percentages in a summer because she was skipping the next year of school, and Ricki recalls her mother going over math flash cards with her. Fran remembers her parents having workbooks and her parents teaching her basic math; her mother was a stay-at-home mom so she was always taking the time to teach her new things. Betty used to solve all the problems in her textbooks just for fun and when her father saw this, he bought her other booklets on modern mathematics. Georgina shares that her earliest experiences with math weren't very good and she always relied on her father as her own personal tutor; as she gained more confidence in math, he would always joke about not being needed any more.

For all of the above situations, parents were providing their daughters with specific math-related experiences and were modeling involvement in these activities; this allowed their daughters to see that math can be fun and is gender-appropriate for girls. In addition, two participants mentioned their parents were also involved in a math-related career, yet another influence on developing and encouraging their daughter's involvement in math. Eleanor's mother was a math/science teacher and began teaching her math at a

very young age, while Penny's father was a computer scientist with an undergraduate degree in math, and would sometimes discuss various aspects related to math with Penny.

When the women were asked about *an experience or event that you believe may have led you to pursue a math-related career*, twelve of the fifteen women mentioned their parents or home-life as an important factor.

Many of these women came from families who believed that math and its related careers were important. Jenna had a mother who would always remind her that "mathematics is important in life." Cynthia tells how her father is an engineer (metallurgist) so she has "always known about engineers and what the iron ring means" and Inga has many engineers in the family who have told her to "take math and science, keep all your options open!" Anne states:

> My parents believed that only good careers involved mathematics and science. I come from a highly educated family; both my parents are engineers and both my grandmothers went to university. I was always encouraged to do well.

Such comments coincide with research that maintained that children whose parents support and encouraged them at home place more value on mathematics (Wilkins & Ma, 2003; Jacobs et al., 2005).

It is also important to look at the education and socio-economic status (SES) of these women's families (mother and father) as it can play a significant role with respect to the career path of a child. Both of these factors affect the educational outcomes of children (Schnabel et al., 2002; Bandura et al., 1996). With respect to their mother's education and highest level of education attained, one has a master's degree, five have a bachelor's degree, three have a college certificate, and six have no postsecondary schooling. With respect to their father's education and highest level of education, two

have a PhD, five have a master's degree, three have a bachelor's degree, one has a college certificate, and four have no postsecondary schooling (Tables 6 - 10, p. 85). Two points need to be noted with respect to the parents who did not have any postsecondary education. First, both Diane and Ricki's parents were immigrants to Canada; quite often, parents immigrate to another country in order to make a better life for themselves and their children. Many immigrant parents have to make many personal sacrifices to provide their children with opportunities that they themselves were not privy to. It should also be noted that both Jenna and Wilma are themselves over 50 years of age, placing their parents in an era when many people did not get a postsecondary education. Therefore, excluding these four women's parents from this sample, all of the women, except one, has at least one parent who has attained a postsecondary degree. This appears to correlate with the research mentioned above; it is likely that the educational outcomes of these women were influenced by their parents' education. SES impacts familial belief systems and then parental beliefs impact on their children's appraisal of their own academic capabilities and their educational vision (Bandura et al., 1996).

Given the examples cited by the women in this study of parental support, encouragement, exposure to math-related activities, and education that they were exposed to during their formative and educational years, and since all of these women are now working in a math-related career, it confirms that all of these factors affect a daughter's educational outcomes and career choice.

Theme II:
Role models and mentors are important motivators

Research shows that role models improve confidence, performance and elevate aspirations (Bartholomew & Schnorr, 1994; Schwartz & Hanson, 1992). It was shown in the previous section that parents can act as important role models to their daughters; they sent important messages to these women that mathematics is a valued and acceptable way to spend their time.

Four of the women mentioned teachers when recalling: *what were some of your earliest experiences with mathematics*. These teachers had an impact on these women, especially after three of the women originally had had a bad experience with math. The following comments demonstrate the effect a teacher can have on a student:

> *Cynthia:* The earliest experience that I remember is about Grade 4 and 5. I had a female teacher in grade 4 and had real problems with division. I then went to grade 5 to a male teacher and after he taught division I had no problems with it. For some reason the female teacher wasn't teaching it in a way I could learn it.
>
> *Georgina*: My earliest experiences weren't very good. I struggled with math and when my father and mother were to go away on any vacation, I would have a nervous breakdown when I was very young because I thought my dad was my personal tutor and he would help me with anything. I managed just fine. It wasn't until about grade 8 when I had a teacher that allowed us to work in a group and then my marks in math soared. I think I became confident in myself and I could totally do it.
>
> *Penny:* In junior high school, which I did in Israel, I did not have a very good math teacher and she was not very supportive of girls, but rather only encouraged boys. When I came to the US and started high school in Austin, Texas, I had a very good 9th grade geometry teacher who taught us to do proofs. He also ran the math club, which I joined, and we participated in local math competitions. I had several good math teachers in high school and we even did calculus with proofs, although overall our school was not very good academically.

Other women also cited experiences with teachers when asked for: *an experience or event that you believe may have led you to pursue a math-related career.* Georgina mentions that she started to like math in grade 8 due to her teacher, Penny recounts how various math professors mentored her, and Steph had a very good professor in high school whose methods in teaching mathematics were "really easy and good." Ricki also mentioned her grade 3 teacher who encouraged her to know her multiplication tables and made her like math and also her grade 9 math teacher who started a competition within her class. Diane credits her good teachers who always bolstered her self-confidence and had clear expectations and Heidi stated that she really enjoyed her high school math teachers and classes. These comments parallel research that discusses how teachers (role models) can improve a student's confidence, performance and elevate their aspirations (Bartholomew & Schnorr, 1994; Schwartz & Hanson, 1992).

The impact of parent and teacher role models became apparent when the women were asked: *who or what had the most influence with respect toward your entry into a mathematics-related field.* Twelve of the women responded with a parent or a teacher. Of the six women citing their parents' influence, five of them stated that one of their parents was already working in a related field (math teacher, engineer, research scientist). The other six women spoke of a teacher's influence; these women mentioned the following reasons: great teachers; received positive reinforcement for their success in math; pushed by teacher to enjoy higher level math; made math fun; competent and strict, yet enjoyed what she was doing.

It should also be pointed out that none of the women in this study cited anyone as a role model besides their parents or teachers; however, when suggesting what changes

needed to be made at the educational level (question 10 - this will be discussed in further detail in the last section) many of the women stressed the importance of exposing women to appropriate female role models working in math-related careers.

Theme III:
Educational and occupational choices are guided by expectations for success, value, and choice

Eccles (1987, 1994) claims that people should prefer occupations that they think they can succeed at and that have high value for them. Eccles believes that these expectations are shaped by activities, interpretations of these activities and by beliefs regarding opportunity structures.

With respect to expectations for success, the women in this study are confident in their intellectual abilities. When asked: *what do you believe are your main reasons for choosing a career in mathematics*, thirteen of the fifteen women mentioned being good at math; this in turn, gave them the confidence needed to succeed and increased their expectations for success. These responses parallel research that confidence is related to achievement (Ma & Kishor, 1997; Wilkins & Ma, 2003). The more confident a woman is in her mathematical abilities, the more likely she is to participate or further involve herself with math. These women choose math because they knew they had the proper skills and ability to do it, that they would be comfortable in it, and that they would succeed at it. Many received praise and positive reinforcement from their parents and teachers for being successful in math. Many of them also pursued mathematics because it was a challenge to them; they enjoyed the level of complexity and problem solving involved with this domain.

With respect to value, Eccles claims that in order to succeed in a particular area, one must value that task; they must be interested in it, anticipate liking it, and find it useful. Throughout the questionnaire and especially in the question: *what do you believe are your main reasons for choosing a career in mathematics*, all of the women, except one, mentioned liking math as a subject. They cited various reasons for liking math such as: the precision and objectivity (you can clearly be either right or wrong in math), it was like a puzzle, it was fun, they enjoyed learning it, it was challenging, they loved problem solving, it was easy to study and learn, it made sense, and it was interesting. In addition, many of these women mentioned the usefulness of math such as its importance "in understanding the world around them", "math is everywhere", "you need math to be in control of many aspects of life", "mathematics is the foundation of any modern area of endeavors: even genetics needs mathematicians", and it offered a "secure career (always in demand)" and many "job prospects." Such comments coincide with research that suggests a positive relationship between attitudes towards usefulness of math and subsequent math achievement and confidence in their math abilities (Tocci & Engelhard, 1991; Op't Eynde & DeCorte, 2003). Value is also placed on a certain task based on positive and negative experiences in associated activities. When answering: *what were some of your earliest experiences with mathematics*, the majority of the women cited positive experiences related to mathematics; many women had parents who involved them in math-related activities, showing them that math could be fun and appropriate for them to study and participate in. Women mentioned multiplication games, flash cards, and card games as a family pastime. These women were not only confident in their math abilities, they also valued it immensely.

In relation to choice, often options are not considered as a person is unaware of the options or has inaccurate information about the options (this topic will be discussed in the final section). The two respondents who had little choice in their direction were the two eldest participants, Jenna and Wilma. Both of these women had limited options after graduating from high school, and both of them chose to pursue teaching. As Jenna states:

> It has to be put into a certain context of that time. For a woman, the choices were simple: nurse (I hated blood), secretary (I had too much of an independent spirit to obey a boss), and schoolteacher. It was a series of circumstances that lead me to math.

Wilma had a similar experience. She says "I graduated from high school in 1956. At that time, girls chose teaching, nursing or secretarial work."

Choices are made when there is a match between an individual's own self-image and an occupational selection. Many of the women in this study choose their respective career paths based on how math fit with their personality or way of life. For example, Diane states:

> I was always very interested in the abstract - i.e. music, and I saw math as related to music, and carried meaning and beauty in and of itself. I saw math as another language through which Nature could be discovered and expressed. It was never about "getting a job" or "the real world" to me; it was about trying to understand the world around me. That is what grabbed my attention. I think having been exposed to a part of the world that was very different from my reality (i.e. Malta - where my parents are from where they spoke a language I didn't understand) I inherently valued language as a tool for understanding and learning about the world

When Anne answers: *what had the most influence with respect toward your entry into a math-related field*, she says:

> Probably the job prospects, and the type of job I would get. I wanted to be judged for my work, and not for how charming I was, or how well I could please my boss. I did not want to have to deal with politics between 9-5. I wanted to solve problems and I wanted an opportunity to be allowed to work quietly on my own, then show what I can do.

When asked: *throughout your childhood and educational experiences, have you always been interested in pursuing a career in mathematics*, Cynthia claims that her interest in pursuing a career in math "is in my nature" and that it is based on "personality and strengths." Eleanor claims that she knew from early on that math would be in her job. She says that "it ties into the way my mind works; I have always been more scientific than artsy and if you're in any field in science you have to use math."

It is very clear that the women in this study were confident in their math abilities and had high expectations for success. They also valued the importance of mathematics and its related fields of study. Finally, the choices that lead them to their subsequent careers were partially based on a match between their own self-image and their occupational choice. These three aspects helped guide their educational and occupational choices.

Theme IV:
High self-efficacy beliefs are required in order to persevere and succeed in a math-related field

Perceived self-efficacy is a key factor in career choice and development; this helps determine whether an individual will initiate, persevere and succeed at particular endeavours. The higher a person's perceived self-efficacy to fulfill educational requirements and occupational roles, the greater their interest, preparation level, and staying power in their career pursuits. In interviewing these women and analyzing their responses, it is clear that they all have a strong sense of self and are confident in their abilities; these self-efficacy beliefs were formed through mastery experiences, vicarious experiences, verbal persuasions, and physical and emotional states.

The following responses and examples came from the two questions: *what were some of your earliest experiences with mathematics* and/or *give an example of an experience or event that you believe may have led you to pursue a math-related career.*

In relation to mastery experiences, the majority of these women cited positive and successful experiences throughout their home and educational experiences with mathematics; their continued success in this domain produced higher self-efficacy beliefs. Often, women are not as likely to continue in male domains when their judgments of personal competence are low. These women knew they were good at math and they knew they could be successful working in this field.

Positive verbal messages and social encouragement, verbal persuasions, helped these women keep the effort and persistence needed to succeed. Many of the women in this study received verbal persuasions from parents and teachers that helped reinforce their self-efficacy beliefs. As Eleanor states "I was always getting praise from my teachers, telling me I was the highest in the class as far as math was concerned" and Diane recalls that she "received a lot more positive reinforcement for my success in science." Societal views may have also played a role. As Penny reveals, "growing up in Israel, academics is very important and especially math and science" and Jenna says "sciences were popular at this time. It was socially prestigious." These examples of verbal persuasions aided in developing and maintaining a higher level of self-efficacy.

Many of the childhood experiences revealed in the previous sections are examples of vicarious experiences. Often, boys and girls experience different sex-typed experiences in their childhood; girls tend to have a limited exposure to sources of information necessary to develop strong self-efficacy perceptions in traditionally male-

dominated careers. This study, however, shows that these women were exposed to various math-related activities through their parents. These women observed and learned from their parents; this influenced and strengthened the development of their self-efficacy beliefs.

What obstacles did/do these women face?

Questions 6 to 8 looked at the overall barriers facing women in mathematic-related occupations by exploring (i) these women's obstacles in pursuing their studies and/or career; (ii) their beliefs on why so few women choose mathematics careers; and (iii) what they would do differently (related to their career) if they could. In this section, I will present the participants responses to these questions from the questionnaire.

The women in this study revealed very similar responses with respect to the barriers they faced and other women may face. The following four aspects were revealed: feelings of isolation/lack of role models, math as a male domain, family life and career conflict, and difficulty of math.

Feelings of isolation/lack of role models

As mentioned in the previous section, role models can help improve confidence and elevate aspirations; in addition, they are an important source for career information. According to many of the women in this study, lack of female role models in typically male-dominated fields continues to be a problem. Steph claims:

> There are very few role models, so you can't ask anyone for advice on how to make it all work. Personally, I haven't seen anyone do it successfully so I can't be sure it's possible. Even when you do see women in a science/math role it is never the boss, usually support staff, so how do you break into that to start with?

Diane shares a similar view:

> Very few female role models; I believe I was and still am often comparing myself and trying to measure up to old male professors with 25 years of teaching and research experience. It took a lot of convincing for me to pursue an academic career for this reason.

Without seeing other women working and succeeding in these fields, women can feel isolated and start doubting their capabilities and whether they made the correct career choice. Wilma shares that "for most of my career, I was the only female math teacher in the department." Diane says that another obstacle was "having mostly (self-confident-seeming) male colleagues that I had to get used to dealing with while protecting my feelings." When Jenna attended an all-girls high school in the 1960s, advanced sciences were not offered to girls; however, Jenna was determined and sought permission to be a student at the all boy's school in order to pursue sciences. She recalls being "the only girl in a class full of boys." Times have definitely changed since Jenna was in high school, but even within the last decade, women are still feeling like a minority in their classes. Steph explains that "I also found my physics classes a challenge at first as I was one of the only girls in a class of 16 and that was intimidating, particularly at the age of 16 and particularly when we were studying traditionally male subjects like the workings of a car for example." Progress has definitely been made over the past few decades, but women are still underrepresented in typically male-dominated fields.

Math as a male domain

If a female feels that studying math is inappropriate for girls, her achievement and participation will be affected; she may feel she will not fill her appropriate sex role by pursuing math (Fennema & Leder, 1990; Ma & Kishor, 1997). There were a variety of

reactions from the women in this study with respect to the masculinity of mathematics. First, there were women who experienced a societal pressure that viewed math as a male domain. Penny shares that in "junior high school, which I did in Israel, I did not have a very good math teacher and she was not very supportive of girls, but rather only encouraged boys." Jenna, one of the oldest participants, shares that at "the end of the 60s, the educational system made it difficult for women to pursue and study sciences. There were girls schools in which advanced sciences were not even offered." Anne simply states that math has "been for long a male bastion in Canada" and Georgina believes that math is "seen as a man's field and therefore women might feel nervous or that it's not something that we're capable of doing." Steph states that often women do not see themselves in a math career because it is seen as "taboo - it's a field specifically for men." The comments of these women suggests that research indicating both males and females stereotype math as a masculine discipline and that women perceive male-stereotyped occupations as more difficult than female-stereotyped occupations (Fennema, 1996; Eccles, 1986; Ethington, 1992).

Other women in this study, however, do not feel that the domain of math is as gendered as it used to be or that a problem even exists.

> *Penny* : Sexism in the academic establishment used to be a big factor but I feel that now, at least in math, it is only among the older faculty, and young mathematicians are very open and encouraging to women. In fact, sometimes this is too much and ends up backfiring when female students are pushed to take on research projects, etc., which they are not yet ready for, or go to top graduate schools without adequate undergraduate preparation. Many women drop out at the beginning of graduate school for that reason.

> *Eleanor*: There were more males than females in my classes, but there always have been in CEGEP and university. In CEGEP, I was in first-choice pure and applied at Dawson and it was about 70% guys and 30% girls. Its always just been the way it is. I never felt like a minority. It was kind of a given.
>
> *Anne*: I lived in a society in which women were encouraged to do well. There were no such prejudices that men were better than women at anything intellectual.
>
> *Heidi*: I know a lot of women who are in math-related careers and I find that the schools I teach in are mainly female math departments.
>
> *Jenna*: I don't feel that there are that few women in the domain of math. In university, there were more women than men in our classes, and the CEGEP where I work. Also, there are more women in the department of mathematics. In our science classes in CEGEP, it seems to me that there is an equal amount of girls and boys, and the girls succeed very well.

These comments tend to side more with studies that suggest most males and females do not gender stereotype math and believe that math is gender neutral (Forgasz et al., 2004; Leder & Forgasz, 2002). It is interesting, in this group of women, to see these different opinions. They are all working in similar domains, yet have very different views on how society genders mathematics. Overall, these women did not let societal views, whether positive or negative, interfere with the pursuit of their careers; they overcame any sex-role congruency or fear of success (Fennema & Leder, 1990) that may have affected their participation in mathematics. Although it hasn't been easy for all of the women, they have all achieved success in a male-dominated field, while maintaining their sense of femininity and self-esteem.

Family life & career conflict

Eccles (1994) claims that one of the effects of gender role socialization is the perceived conflict of traditional female values and roles with the demands of male-typed

achievement activities. Many of the women in this study voiced this concern. Quite often, male-dominated careers involve long hours and are not as conducive or allowing for female-related absences (maternity leave, absences due to children's sickness or activities). It can be a very difficult decision to pursue a career that may affect the amount of time an individual can devote to their family life. Diane admits, "I am concerned about when and how I will have babies and start a family while balancing my career." Steph reveals that there is "a culture of long working hours that is not compatible with a family life" and Penny admits that "there are a lot of pressures on women to get married and start a family, which often leads to dropping out of a math career." She also claims that an "objective obstacle is having a family, which I fortunately started only after having a tenure-track job, but it still takes a significant amount of my time and attention." Betty reveals the conflict between family sacrifices and work she experienced when starting her own family.

> When my first research paper in pure mathematics was accepted for publication, I went to give birth to my first son. I wasn't able to do much progress in my research in the next year. I was simply too tired at night and the problems I was working on were not sufficiently exciting to keep me awake when the baby was asleep at night. I was falling asleep on my desk, dreaming the problems out but not solving them (as it happened to some great mathematicians such as Srinivasa, Ramanujan or Norbert Wiener). So I decided to have the second child right away (the second son was born 20 months after the first), to shorten the child rearing period in my life. It is only 5 years later that my second research paper in mathematics appeared. In the meanwhile, my husband did his PhD, post-doc stages (in other countries, leaving me on my own with two children for about two years altogether), and obtained his habilitation in microbiology. I did not expect him to give up his work to help me with the children more, so that I, too, could have more time for research. I wasn't convinced that my research was worth his sacrifice. His domain of research appeared to me so much more important than mine: he was dealing with deadly viruses; his research could save lives. Mathematics certainly applies in the construction of diagnostic machines, and thus can

> indirectly contribute to saving lives, but I wasn't convinced my research in ring theory had even a seed of any useful application.

As can be seen by the comments of these women, having a family and juggling a career are not easy; it makes it even harder when your career is in a typically male dominated field where your colleagues are not experiencing (or understanding) the same pressures that a woman may feel towards fulfilling her appropriate sex role and being a dedicated mother and wife. Raising a family and working in a math-related field can be done, but, as these women state, it is not easy and takes a lot of hard work.

Difficulty of math

A few of the women also mentioned the level of difficulty or amount of hard work they needed in order to achieve their career goals. A common misconception among individuals regarding math is that it is difficult or hard to do; often, these views materialize into beliefs and students (both males and females) can start doubting their true abilities. The following women spoke of the difficulties they have faced. Both Diane and Inga mention the level of difficulty they experienced in their educational path. Diane claims that her "undergraduate degree was too hard! Very little T.A. support and little one-on-one interaction with professor. Human/social element to learning was almost non-existent (mostly textbook learning)." Inga also claims that the educational path is a "very long, arduous program with many obstacles." Other women mentioned the difficulties related to their career. Cynthia claims that you "need to be prepared to do a lot of work", Ricki (an actuary) says "these actuarial exams are really tough. It's a hard field to get into" and Jenna describes why she believes more women are not entering math-related occupations:

> The principal reason, I think, is the difficulty of that type of study. For example, our students don't want to teach math or sciences in CEGEP. They see the long and hard path of study to get there and the little social recognition one gets in return.

Although many of the women voiced obstacles they experienced in studying and pursuing mathematics, they perceived math to be helpful in their future educational or career plans, and they saw the required effort needed to succeed in this subject to be worthwhile.

The women in this study, and their comments in this section, have shown the various reasons why so few women are participating in math-related careers. Comments in *difficulty of math* demonstrate that many females are not confident in their math abilities; mathematics is often viewed as a difficult subject and many females internalize this belief, doubting their true potential. In addition, some of the women in this study, who are already succeeding in a math-related field, mentioned the difficulties and hard work associated with their occupations; other females might estimate that the difficulties of a math-related field as too complex and not worth their time and effort. Finally, the comments in all of the sections (*feelings of isolation/lack of role models, math as a male domain, family life and career conflict*, and *difficulty of math*) clearly show the external and societal barriers faced by many women pursuing male-dominated fields; this could be another reason that more women are not participating in math-related careers. These women have shared their experiences of obstacles and have pointed out what other females may be thinking about math and its related occupations. Many females may estimate that there are too many external and societal barriers to their success in a male-dominated field, resulting in their lack of participation in this field.

What advice/encouragement/recommendations can these women offer for other females and their participation in math?

Questions 9 and 10 were aimed at getting insight from these successful math participants on (i) encouragement or advice to other female math participants and (ii) what they thought could be done at the educational level to promote participation of girls in mathematics.

When asked: *what encouragement or advice could you offer to other female's participation in mathematics*, the following three pieces of advice were identified by the women in this study: required ability and effort, females in mathematics, and rewards of a math-related career.

Required ability and effort

The women in this study admit that they enjoy and are happy with their career choice, but they also acknowledge that there is a level of skill and ability needed to survive in a math domain and it requires hard work and confidence. As Eleanor points out: "I think there is a certain amount of skill that you need and I definitely think there is a certain level of interest that you need." Diane's advice: "practice, practice, practice!" and Anne reveals that the "field requires some consistent effort." Betty believes it is important to "seek to understand the nature of the person's talent, her interest, her family situation and plans" before making career choices and Diane adds "take pride in who you are, your individual abilities and quirks, and the fact that you are doing your best - have faith that theses will all fulfill a purpose eventually in what you choose to do." She also adds: "don't take criticism too seriously." Many of these women also stress the importance of persevering in these types of careers, as they are not always easy.

Georgina encourages girls "not to give up", Inga advises to "keep all your options open" and Jenna tells the girls to "go for it! Do what you want to do, what you feel like doing, no matter what anyone else thinks." Penny sums it up nicely by saying:

> It is most important to believe in yourself and in your abilities. To that effect, you must justify this confidence by working hard and building up a strong background in the basics of mathematics at the high school and university level. There is no advantage in moving ahead too quickly! If you have a strong background and you have some native ability you will be able to build on that.

Females in mathematics

Other type of encouragement and advice from the women in this study was to find a way to deal with the demands of family life and career and to realize, before entering the field, that women are going to be underrepresented. They claim it is something that you need to deal with and find a way to live with. Fran reveals the following:

> When I went to school, there were still a lot of females, but there is always the feeling that there are not as many of you as there are guys. So there's that thing you kind of just get over. People look at you funny when they ask you what you're in or what you do or what you took in school. People don't expect to hear that from a girl. People are surprised to see that.

Wilma (a teacher for 39 years) admits, "in terms of teaching math, it is good for girls to see women in that field. For most of my career, I was the only female math teacher in the department." Penny also offers advice to those women thinking about how they are going to juggle family life and their careers. She says:

> it is important to realize that the demands society makes on women (such as having a family) affect the amount of time and concentration available to them to do mathematics. The solution, in my opinion, is not necessarily to opt out of one aspect or the other, but to try to plan your life to handle both, and to give yourself a break, in the sense of not asking too much of yourself at any one point in time. It is no use to compare yourself to others (male or female) in terms of success or productivity or creativity

> because every person has their own personality and strength, and there is room for many different types in mathematics.

Rewards of a math-related career

Although these women will admit that it is not always easy being in a male-dominated field, the majority of them acknowledge the rewards involved in this type of domain. Anne states that "there are tremendous opportunities for women in mathematics, especially now that they are underrepresented." She also adds that "people always give you more credit and respect than deserved if you are good in mathematics." Betty warns that a person must really be dedicated to the subject in order to pursue it academically in graduate studies. She states that "I think it would be unfair to encourage a person to pursue a career in pure mathematics if that person is not 100% convinced of the worthwhileness of such research." Finally, both Ricki and Steph offer simple advice to those females interested in pursuing a math-related career. Ricki says that " if you enjoy it, go for it" and Steph reveals that "it's rewarding at the end!"

Overall, these women realize the demands and hardships of a math-related career, but more importantly, they are in these fields because they enjoy mathematics and have found success. For those girls beginning or thinking about pursuing a career in math, they need to be ready for challenges and difficulties along the way, but the benefits and rewards in the end are worth all the obstacles they may face along the way.

When participants were asked: *what do you think can be done at the educational level to help promote the participation of girls in mathematics*, the following three main areas of change were revealed: (i) role models and career advice; (ii) parents, teachers and society; and (iii) involvement in math-related extracurricular activities.

Role models and career advice

There was an overwhelming response from these women that girls need more exposure to females working in math-related fields and career options need to be made more available to students. Nine of the fifteen women stressed the importance of these factors in order to get more females participating in mathematics. Here is what they had to say:

> *Anne*: girls need more exposure to women working in Mathematics. Career talks: invite more women in mathematical fields. And try to bring girls into workplaces where women work in mathematical fields (this could be combined with career days for women who can bring the girls into the work place). Perhaps we can dispel the myth that we are all 250 lb, geniuses, and radical feminists, working 12-hour days and no life beyond work...or whatever impression girls might have.
>
> *Cynthia*: I think it is a good idea to have women talk to girls at schools to let them know what we do and why we do what we do. Again, sharing experiences to let girls know what is ahead of them and what to expect can be helpful. I have never spoken to a group just to some individuals trying to make some decisions when applying to universities.
>
> *Diane*: How about hiring some women. I mean really, throughout all of the math, physics, chemistry, and engineering courses I took in high school, undergrad and grad school combined (that would be 13 years of classes), exactly TWO of them were taught by women. I never counted before, but that's pretty sad.
>
> *Eleanor*: I think what I could have really used was some form of guest speaker. A female guest speaker who is doing a career related to math. And then some form of list of some sort of what kinds of careers are related to math because I had no idea until university what a major in math, a BSc in math, could get you
>
> Fran: more examples of jobs or types of fields you can get into. More hands-on stuff. It's so abstract that it's sort of scary. It's kind of like, what am I going to do with it? And that's why I took applied math because I thought it was going to be very applied, even though I didn't know what that really meant. Every time you're doing something, if you're doing math and they don't realize it – even basic things. Then they would realize that maybe they are interested in math.

> Heidi: Show how much math is used in several careers. How having the basic understanding of math can make many concepts easier to understand.
>
> Inga: I think students do not have a clear picture of which careers actually involve math or require strong math skills as a pre-requisite.
>
> Penny: exposure to GOOD role models: women that are respected, smart, down-to-earth and likeable, self-confident and beautiful.
>
> Steph: Better careers advice. Actually suggest that they could be professors one day if they wanted to. Don't discount traditional male roles, maybe girls want to design car engines.

These women are already in a math-related field, yet are identifying their own individual lack of exposure to good role models and to women working in math-related fields, in addition to the lack of accurate information on career possibilities and options. They are also stressing the importance of these factors. As a consequence to the lack of role models and career information, it shows how many girls may not be participating in mathematics simply because they do not have the proper exposure to the options available to them. As Eccles (1987, 1994) claims, when individuals choose from among several options, they do not consider the full range of objectively available options in making their selection - their perceived field of options is narrow. The model claims that many options are not considered because they are unaware of their existence; the above comments clearly support this research.

Parents, teachers, and society

Another area where these women think improvements need to be made is with external factors (parents, teachers and society). Eight of the fifteen women mentioned one or more of these factors when offering their insight on changes that need to be made at the educational level. It was surprising, given the amount of literature on the impact of

parents on their children's mathematical performance and participation, that only three women mentioned parental influence. Since these women are involved in math-related fields, either they did not realize their parents had such an effect on them and their participation in mathematics and/or they are simply unaware of the strength of this influence. I strongly believe that parents are the starting point in changing girls' views on participating in mathematics. Wilma (a teacher for 39 years) says that "some parents felt it more important to educate their sons" and Penny states that "teachers and parents are the key in giving girls confidence, but also demanding strong performance out of them. Encouragement based only on gender and not on results sends the wrong message."

More of the women in this study offered some advice for teachers. Diane suggests that teachers "encourage group work and ways to talk about the content. Also, lots and lots and lots of positive reinforcement." Ricki states that "teachers should enjoy their subject - I learned lots from teachers who were enthusiastic about math." Jenna also states that it "is also important for elementary and high school teachers to be trained in mathematics in a way that math is not perceived as a series of formulas that don't make sense and cannot be used." Georgina (a first-year teacher) suggests trying to make math fun for the students by incorporating math-related games and having the students

> work within a group, I think that helps because then they don't find it so daunting. They're able to sit back, it's more fun than doing real math. They get to sit down with manipulatives and work through it. They really enjoy it. Maybe approach it in a more fun aspect, like problem solving aspect where you get to work in groups and use manipulatives.

Finally, several women acknowledge that overall, societal views need to change or be modified towards girls and their participation in male-dominated fields. The following comments touch on discrimination, societal views on math/science-related

careers, misconceptions of math and being "smart", and game and toys marketing. Here is what some of the women had to say:

> *Betty:* There certainly shouldn't be any kind of discrimination against girls, be it overt (by saying that girls are less gifted in mathematics) or covert (by, e.g. highly praising a girl for a minor achievement, but telling the boy who did the same level of work that it is just "good" and that he should therefore try a more challenging problem).
>
> *Jenna*: I have the impression that fewer students want to enter math – boys or girls. To encourage young students to go into science, the society has to respect and validate sciences in order for more young people to pursue these studies. The effort, the perseverance, the long-term vision, and the pleasure of learning by simple curiosity has to become part of societal values. Nothing in our society, permits the teaching of these values to our youngsters. It seems that we are more into an "easy" culture, where things are more short-term and disposable. Careers in math need to be more highly valued and better paid – with this, there will be more young students (girls and boys) that would chose these careers.
>
> *Cynthia:* There seems to be this perception that engineers are really smart. Sure I am smart but not really smart, there are lots of others that are smarter than me. I am an engineer because that is the way my brain works not because I am smart. Maybe girls feel that they are not smart enough to go into math-related fields.
>
> *Inga*: Mathematics based toys for young children are still geared for boys, marketed to boys. Stories about math are great! Kids love characters and role models!

Involvement in math-related extracurricular activities

Finally, five of the women spoke of their success when they were involved in math-related activities. Tanya recalls that "in grade school, I attended Saturday math classes which I really enjoyed" and Penny says that "I myself found being in the math club and doing math competitions at the high school level to be fun." Ricki, Steph and Wilma all found success with their participation in math competitions and suggested getting more girls involved. As Wilma (a math teacher for 39 years) recalls: "I always

encouraged girls to participate in math contests. Those who did were usually encouraged by the results and thus gained confidence in their ability." Trying to get girls more involved in math-related activities, both inside and outside of school, can be an incredible motivator to continue to pursue mathematics.

It was interesting to see what suggestions the women in math-related fields have concerning increasing participation among girls at the school level. Their comments have simply touched the surface on what needs to be done to encourage more girls to participate in math-related fields. Further recommendations will be made in the next chapter.

Chapter IV

Conclusions, Recommendations and Future Implications

Conclusions

This study investigated the internal and external factors influencing women's participation in a math-related occupation. Three main questions were addressed: (i) why were these women drawn into a mathematics career; (ii) what obstacles did/do they face; and (iii) what advice, encouragement, and/or recommendations can these women offer for other females and their participation in math?

First, it was shown that parental support and encouragement is important as it can affect a child's attitudes towards mathematics, their participation in math, and their related level of achievement in the subject. It also impacts on academic aspirations and career-choice development. When parents provide specific math-related experiences, they influence a child's motivation to pursue this field. Children, in turn, begin to develop their own level of interest in math and integrate these interests into their own self-systems. These interests eventually affect future task choices. These parents created a math-supportive and math-promotive environment for their daughters, encouraging and supporting their daughter's interest in math (Jacobs et al., 2005). The women in this study were taught from a very early age of the social importance of mathematics, and as a consequence, always regarded math and its related field of study as a valued and important domain. The SES level of these women's families and parental education was also a factor; it was not my intent to research SES, but perhaps it played a significant role in developing interest in and continued participation in mathematics for these women.

Second, these women showed that role models were important motivators in their decision to pursue a math-related career; the two most important role models were parents and teachers. A parent's enjoyment of math and their past and present math ability influence the value their child places on this domain; if a child sees a parent succeeding and enjoying the field of mathematics, they can also begin to see themselves participating and succeeding in this field. Teachers have their own beliefs and perceptions; they can feel when a child is happy and confident in their math abilities. This in turn, may affect how a teacher treats this child. Research also stresses the importance of teacher push that can result in more positive attitudes towards mathematics and beliefs about its social importance and slower decline of both attitudes and beliefs (Wilkins & Ma, 2003).

Third, the comments of the women in this study revealed that their educational and occupational choices were guided by expectations for success, value, and choice. They were confident in their abilities, they felt they would be successful at math-related occupations - they estimated the appropriate level of difficulty of their various occupations. Finally, this study shows that perceived self-efficacy is a key factor in career choice and development; this helps determine whether an individual will initiate, persevere and succeed at particular endeavours. The higher a person's perceived self-efficacy to fulfill educational requirements and occupational roles, the greater their interest, preparation level, and staying power in their career pursuits (Bandura, 1986, 1997). These women all displayed a high level of self-efficacy beliefs that had been developed through the mastery experiences, vicarious experiences, and verbal persuasions experienced throughout their early childhood and educational experiences.

There were three main categories of obstacles faced by these women, and women in general, throughout their educational experiences and career path. Many experienced feelings of isolation and lack of role models. Role models can improve confidence, performance and elevate aspirations; without them, women can feel isolated and start doubting their capabilities and whether a math-related career is really the best career choice. Feelings were mixed on whether math was or was not viewed as a male domain; some of the women feel that lack of female participation is due to the stereotyping of math as a masculine discipline, while others believe that math is not as gendered as it used to be or even gendered at all. Another big concern for these women was the conflict between a family life and career; often, it is difficult for women to pursue a career that may affect the amount of time she can devote to her family. Finally, the women voiced concerns of the lack of human and social interaction and the amount of hard work and effort needed to persevere in this field.

The final question addressed advice, encouragement, and recommendations that these women can offer for other females and their participation in mathematics. In terms of advice, these women gave three main pieces of advice: first, in order to pursue a career in mathematics, there is a required level of skill, ability, and effort needed to survive in this field; second, women need to find a way to deal with and adapt to the demands of family life, career life, and lack of women in this type of career; third, females need to know and believe that math-related careers will be rewarding in the end.

With relation to recommendations that could be done at the educational level to increase female participation in mathematics, the women offered three main areas where changes needed to be made. First, they suggested to increase the number of role models

and career advice offered in schools in order to give students a better and more informed idea of the types of jobs and careers that are available in math-related fields. Second, they offered advice for parents and teachers to encourage female participation; in addition, they voiced their concerns on the overall need for societal views to change with respect to gendered subjects and domains. Finally, they suggested that we try to increase the involvement of girls in math-related activities, as many of them enjoyed these programs when they were in school.

Following on the recommendations made by the women in this study, I will now make some further suggestions for changes that need to be made at the educational level in order to increase participation of girls in mathematics.

Recommendations

Both external and internal factors have been shown to affect the participation of females in math-related studies and occupations. When looking at possible solutions, external constraints are easier to identify and change; often, internal constraints are missed or ignored by parents and school systems. How can these factors be dealt with in order to facilitate and encourage girls' participation in mathematics? Changing societal views will take time; the more immediate goal is to support and nurture the developing educational and career interests of girls in mathematics. Thus based on previous research and this study, I would like to suggest some practical educational classroom practices when teaching mathematics at the elementary and secondary school level.

Early intervention is a key factor that can affect a child's success and participation in mathematics, particularly at the middle school (grades 6 through 8); it is during this period that female interest, achievement, and self-concept in math begins to decline.

Students start to avoid math in high school, when it becomes optional; girls need to be convinced before this period (when attitudes are forming) that math can be enjoyable, appropriate for all students to pursue and useful in attaining many career goals. In order to foster interest and awareness, teachers can introduce toys that are related to math and science, such as Lego, building blocks, or even sports and they encourage girls to interact with age-appropriate software, websites, or listservers that focus on math-related careers for women (Smith, 2000). They can also involve girls in programs, field trips, and camps that focus specifically on math and science and are geared towards female learning. Teachers also need to understand and respect female learning styles and encourage participation by using appropriate instructional activities and curriculum; present students with challenging mathematic and lessons structured so that math problems reflect girls' experiences and emphasize practical, real life applications (Schwartz & Hanson, 1992). It is also important that girls are provided with the appropriate role models and career information; girls can be introduced to women working and succeeding in male-dominated fields whether this be through a guest speaker, a field trip, or a career day. Also, school counselors need to encourage and support the interest and enrollment of students in mathematics courses so that their career and life options will not be permanently limited

Positive self-concept is an important characteristic to nurture in girls; it is important to provide all children with experiences that build confidence in their ability to perform in math situations. A higher level of confidence may increase a willingness to participate more fully in everyday situations that require an understanding of math (Wilkins, 2004). In order to foster self-esteem and positive attitudes, teachers need to

encourage and reward risk-taking behaviour and provide a "girl-friendly" classroom; it was found that girls have more positive attitudes toward math in classrooms characterized by low levels of competition among the students, high levels of cooperative learning or individualistic learning structure, and high levels of teacher communication of the value of math and its link to various occupations (Eccles, 1987). In addition, teachers need to recognize the causes of math anxiety such as poor math instruction, negative attitudes about math, negative math experiences and low self-esteem in order to help students cope with these factors (Woodard, 2004). Girls need to be encouraged to persevere when confronted with difficult situations, to relax, and to believe in themselves. Give them permission to take their time and to make mistakes before solving the problem. Earlier and more frequent feedback on student performance will also help to reduce achievement anxiety of all students.

Educators need to be aware of their own stereotypical beliefs and of stereotypical portrayals of both genders in textbooks, curricula and even the media; they also need to counteract these biases by acknowledging them and talking about it. Girls need to feel that they can pursue and excel in male-dominated fields. In order to counteract biases and stereotypes, teachers need to teach girls about mathematical history and to show them that women have made significant contributions to the mathematics field. They need to evaluate questioning techniques used in classrooms to ensure that higher-order questions are asked of all students and that wait-time and cues are not inequitably distributed. Teachers should also set high expectations for all students and use reinforcement to let them know they are making progress (Funk, 2002). Finally, schools also need to play their part; they need to ensure that math departments include female staff and they should

provide career programs that include a range of nontraditional fields. Girls need help to evaluate the relative importance of careers and family, the importance of economic independence, and accurate and detailed information about the educational and occupational options available to them (Eccles, 1987). These are but a few examples that educators can try to implement in their classrooms; more teacher training and further research is needed in order to better support and nurture the developing educational and career interests of girls in mathematics.

Future Implications

In looking at the various reasons and experiences of women who are drawn into a mathematical career, I have gained a better understanding of their journey toward and decision to pursue a mathematical-related career. It is important that we gain a deeper understanding and awareness of the factors that may cause girls to avoid careers in mathematics in order to gain better insight of how to make changes so that they will have greater success in participating in mathematics.

I am hoping that the future implications of this study will be put into practice in a variety of ways. First, my teacher colleagues, my school, and I could use these findings as I have the intent of sharing my findings with them. A variety of strategies and solutions have been mentioned above, but these changes actually need to be implemented. Second, I have the intention to use the findings of this thesis to help grow as a teacher and to help the students attending my school. After investigating the factors that affected the women in this study and their participation in mathematics, I hope to be able to use their experiences and insight and implement their suggestions in order to help my students. Finally, with respect to future research, as a math teacher, I will always be

committed to helping my students, and in particular, girls' participation in mathematics. I will use the findings to further research possible solutions or strategies that may help keep girls interested and pursuing mathematics.

To conclude, noticeable differences between female and male participation and performance in math begin to occur at the secondary school level. Both external and internal factors affect a girl's learning, and it is key to identify and implement various strategies to counteract gender biases that may be occurring within the classroom. Although progress has been made in gender equity within schools in the last few decades, there are still fewer women participating in math-related fields in higher education and in the workforce. Cultural and societal influences about a female's role have been passed down through generations and continue to get transmitted to future generations by parents, teachers, and society as a whole. A female's social learning and negative beliefs about herself with respect to mathematics is detrimental to both themselves and the society. Schools are an excellent site to create change; practices, values, expectations and beliefs of both individuals and society must be examined in order for change to occur. We are fortunate to be living in the type of society where gender equality can be asked for and should be given; however, this is easier said than done. As parents and educators, we must do all that we can to increase female participation in male-dominated domains. However, we must also value female achievement and female career choice; it may be choice, rather than avoidance, that keeps females from participating in male-dominated disciplines. We need to ensure that our daughters, as well as our sons, the future of our society, are receiving the same opportunities without biases or expectations standing in their way to success.

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Appendix

Questionnaire: Women in mathematical-related fields

1. What were some of your earliest experiences with mathematics?

2. Please give an example, if any, of an experience or event that you believe may have led you to pursue a math-related career?

   home:

   educational:

   cultural:

   other:

3. Who or what had the most influence with respect toward your entry into a mathematics-related field?

4. Throughout your childhood and educational experiences, have you always been interested in pursuing a career in mathematics? Explain.

5. What do you believe are your main reasons for choosing a career in mathematics?

6. Did you feel that there were obstacles while pursuing your studies and/or career? If so, please explain.

7. Based on your experiences, why do you believe that so few women choose math-related careers?

8. Would you do anything differently related to the path toward your career?

9. What encouragement or advice could you offer to other female's participation in mathematics?

10. What do you think can be done at the educational level to help promote the participation of girls in mathematics?

Background Information

Please identify the following:

1. Age group: 20 – 29 30 – 39 40 – 49 50 – 59 60 +
2. Educational Background: elementary (location):

   secondary (location):

   post-secondary (location):

   type of degree(s):
3. Parental Educational Background (location):

	Mother	Father
elementary (location):		
secondary (location):		
post-secondary (location):		
type of degree(s)		

4. Occupation:

   Participant:

   Mother:

   Father:

TABLE 1

Participants: 20 - 29 years of age

Name	Educational Background	Degrees	Occupation
Diane	Ontario (public)	B Sc (science & math) Ph D (chemistry)	Post-doctoral fellow Research Assistant
Eleanor	Quebec (public)	B Sc (math & computer science)	Rollout analyst
Georgina	Ontario (public)	B Sc Honours (math) B Ed	Math Teacher
Ricki	Ontario (public) Quebec (public)	BA (math)	Actuarial analyst
Steph	Mexico (private)	Actuarial science	Actuarial analyst
Tanya	Ontario (pub)	B Sc Honours (math)	Actuarial analyst

TABLE 2

Participants: 30 - 39 years of age

Name	Educational Background	Degrees	Occupation
Cynthia	Ontario (public)	B Eng (applied science civil)	Engineer
Fran	Ontario (public)	B Math, Honours	Data analyst & forecaster Computer programmer
Heidi	Ontario (public)	BA (math/geography) B Ed	Math Teacher
Penny	Isreal (public) US (public)	B Sc (math) Ph D	University Professor (math & statistics)

TABLE 3

Participants: 40 - 49 years of age

Name	Educational Background	Degrees	Occupation
Inga	Quebec (public) Quebec (private)	B Sc (architecture) B Arch	Architect

TABLE 4

Participants: 50 - 59 years of age

Name	Educational Background	Degrees	Occupation
Anne	Bucharest (public) Ontario (public) England (public)	B Sc (math) Ph D	University Professor (math & statistics)
Betty	Poland (public) Egypt (private) Syria (private)	B Sc (math) Ph D	University Professor (math & statistics)
Jenna	Quebec (public) Quebec (private)	B Sc (math) M Sc (math) Ph D	CEGEP math professor

TABLE 5

Participants: 60 & + years of age

Name	Educational Background	Degrees	Occupation
Wilma	Ontario (private) Ontario (public)	BA M Ed	Math teacher (retired)

TABLE 6

Participants: 20 - 29 years of age
(parental information)

Name	Educational Background	Degrees	Occupation
Diane's mother	Malta (public) no secondary	none	Seamstress
father	Malta (public)	none	Tailor
Eleanor's mother	Lebanon (private) France (public)	B Sc B Ed	Science/math teacher
father	Iraq (private) England (public)	B Eng MBA	Engineer
Georgina's mother	Ontario (public)	Nursing	Nurse
father	Ontario (public)	B Sc	Accountant
Ricki's mother	Poland (public)	none	Office coordinator
father	Poland (public)	none	Tool & dye machinist
Steph's mother	Mexico (private)	Diploma (secretarial studies)	Homemaker
father	Mexico (public)	B in psychology	Business owner
Tanya's mother	Hong Kong (pub)	none	Factory-line labourer
father	Hong Kong (pub)	B Eng, M Eng	Engineer (retired)

TABLE 7

Participants: 30 - 39 years of age
(parental information)

Name	Educational Background	Degrees	Occupation
Cynthia's mother	Ontario (public)	B Ed	Kindergarten teacher
father	Ontario (public)	B Sc	Research scientist
Fran's mother	Ontario (public)	none	Homemaker
father	Ontario (public)	none	Farmer
Heidi's mother	Ontario (public)	B Ed	Elementary teacher
father	Ontario (public)	B Ed, BA (psych)	Elementary teacher
Penny's mother	Israel (public)	BA, MA	Child Psychologist
father	Israel (public) US (public)	B Sc, M Sc, Ph D	Computer Scientist

TABLE 8

Participants: 40 - 49 years of age
(parental information)

Name	Educational Background	Degrees	Occupation
Inga's mother	Australia (private) South Africa (private) England (private) Quebec	Secretarial college	Secretary
father	Quebec (public)	B Eng, M Eng	Engineering Professor Private consultant

TABLE 9

Participants: 50 - 59 years of age
(parental information)

Name	Educational Background	Degrees	Occupation
Anne's mother	Bucharest (private)	B Eng	Engineer
father	Burcharest (private)	B Eng, M Eng	Engineer
Betty's mother	Poland (public) Canada	TESL	Office clerk
father	Poland (public) Canada	M in Urban Studies	Business manager
Jenna's mother	Quebec (pub) some secondary	none	Homemaker
father	Quebec (public)	technician	Electrician

TABLE 10

Participants: 60 & + years of age
(parental information)

Name	Educational Background	Degrees	Occupation
Wilma's mother	Ontario	none	Homemaker
father	Ontario no secondary	none	Farmer & cheese maker