Mathematics Anxiety in Pre-Service Junior/Intermediate (J/I) Students

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Abstract

The present study examines the feelings of pre-service teachers at the J/I level's towards mathematics and the teaching thereof. Two instruments were used to examine the samples' feelings towards mathematics. The Mathematics Anxiety Rating Scale (Suinn, 1972), a 98 item likert format questionnaire accompanied by 8 open-ended questions were used to firstly evaluate participants' mathematics anxiety, and, secondly, to expand on their comfort levels with regards to mathematics and to the teaching of mathematics. A total of 149 J/I pre-service teachers in their professional year were sampled from an Ontario university. The Mathematics Anxiety Rating Scale (MARS) revealed a low mean MARS score for all participants. Participants acknowledged the J/I mathematics instruction course a source for reducing their anxiety towards mathematics.

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CHAPTER 1

Introduction

1.1 Research Question

The guiding research question that propels this study is: How do J/I pre-service teachers feel about teaching mathematics?

1.2 Sub-Research problem/questions

From the overarching research question four sub-questions helped to guide the focus of the research in a specific direction. They are:

1. How does the comfort level with mathematics of pre-service teachers affect their ability to teach mathematics?
2. What concerns do future J/I mathematics teachers have about teaching mathematics?
3. What are future J/I mathematics teachers' perceptions of the difficulties of teaching mathematics?
4. What are future J/I mathematics teachers' reflections on the math reform movement?

1.3 Purpose of the Study

With these questions in mind, it was hypothesized that there is a general discomfort with mathematics among the population of pre-service teachers. The purpose of this study was to find out what the level of discomfort is and how it will affect teaching practices. Investigations were made into gender differences, differences with regards to backgrounds and mathematics anxiety, as well as differences between age intervals and mathematics anxiety. It was hypothesized that the current math reform movement can aid in relieving these feelings of discomfort and to a degree help this population have a more positive outlook on teaching mathematics.

1.4 Description of the Study

The study was conducted using the already established Mathematics Anxiety Rating Scale (MARS) (appendix C) developed by Richardson and Suinn (1972). This 98-item questionnaire was combined with eight open-ended questions that further probed the participants' feelings about teaching mathematics. These eight questions followed the 98-item MARS questionnaire and were answered in a university examination response booklet. The population for this study is all J/I pre-service students in Ontario. The sample that was asked to participate was all pre-service J/I students at a university in Northwestern Ontario. The sample was approached during the regularly scheduled time for their J/I mathematics instruction class in their regular room. There were two weeks remaining in the participants' second term before their second in-school placements. After a short introduction to the study and to the instruments to be used, those students who agreed to participate were given the MARS questionnaire and the open-ended questions that followed. This was done during their regular J/I mathematics course class time to facilitate the students' time requirements. After the questionnaires were collected the data was closely scrutinized both qualitatively and quantitatively. The *Statistical Packages for Social Sciences version 11.5* (SPSS) was utilized for quantitative analysis.

1.5 Background/Rationale

The rationale for this study stems from the difficulties associated with teaching and learning mathematics. Those who will teach mathematics in elementary and intermediate schools and those who prepare those teachers in the pre-service program have borne witness to some hurdles in teaching mathematics to their students that appear to be mathematics specific. Mathematics as a discipline seems to have negative connotations for many people. This would not be such a dilemma if mathematics were an avoidable part of everyday life. However, this is not the case. Mathematics is a part of every person's life. It is an inescapable reality. We first learn how to manage mathematical problems beginning in elementary school and continue throughout the rest of our pre and post-secondary schooling. The study of mathematics can aid one in moving into a field that requires the use of mathematics or it can simply prepare one for life in general. In either case, it is a needed part of schooling. Since mathematics is such a fundamental part of life, it seems important for people not to fear mathematics or shy away from it out of discomfort with the subject. It is an unneeded stress that is avoidable. As evident in the literature review in chapter two, it is already known what kinds of discomfort with mathematics are experienced and when they begin to appear (refer to literature review). Using this knowledge we can begin to act to alleviate this discomfort. Treatment of this discomfort must begin in early schooling when this discomfort is first witnessed. Teacher training programs must be evaluated on their ability to prepare these teachers for students who have, or who may develop, this discomfort towards mathematics. Studying those pre-service teachers who share those feelings of discomfort with mathematics, and who may end up teaching at the J/I level, where these feelings have been found to begin to emerge, is an appropriate basis in diagnosing the problem. By studying this group we can not only ascertain what future teachers are feeling, but we can work with them towards alleviating that discomfort within themselves, as well as prepare them for students they may encounter with similar feelings. It is the hope of this study that by examining this population we will be able to prevent future teachers from entering the teaching field with a level of discomfort towards mathematics, and in so doing, we will aid in the prevention of future cases of students experiencing discomfort with mathematics.

1.6 Personal Ground/Assumptions

As a new teacher with very little background in mathematics, I believe the idea of teaching mathematics stimulates a different reaction than that of teaching science or any other subject in which I may not have a vast background. For some reason I and, as I have observed, others see mathematics in a different light when compared to other school subjects. In my experience, with the exception of mathematicians or others with strong mathematics backgrounds, the overwhelming feeling from people seems to be that mathematics is intimidating not only to teach, but also to do. I completed my bachelor of education in 2000-2002. As part of my teacher training, I completed the P/J mathematics instruction course. Although I found it helped me not to fear teaching mathematics, my underlying feelings towards the subject were still ingrained. While I always felt people generally had a dislike for mathematics, it was not until I did my Bachelor of Education that I noticed there was a genuine fear of the subject. While I noticed the dislike of the subject, I also witnessed verbal and nonverbal signs of stress as caused by the reality of having to deal with mathematics. Most obvious was the general fear experienced by females in the program. In my limited teaching experience, I have witnessed students' reactions to mathematics. I spent six weeks in a grade three classroom where I did not notice any fear or dislike of the subject. However, as I moved into higher grades such as grades 6, 7, and 8 where I spent an equal amount of time, I began to notice adverse reactions to mathematics. Reactions ranged from frustration to angry expressions to avoidance. Generally speaking, with the exception of one or two students in each class at the grade 6, 7 and 8 levels, there was no ambition or desire for mathematics and few saw the relevance of it. This contradicts what I witnessed with the grade three class where students seemed to enjoy doing math and were eager to get started. Thus, it is possible that at some point throughout one's schooling negative attitudes are formed towards mathematics. In conducting this study, I expected to find many who have negative feelings toward mathematics and thus probably have some degree of mathematics anxiety. I expected this because the sample for the study is a group of people who do not have degrees in mathematics and who may actually have little to no mathematics background past high school. As an educated sample, as well as being possible future teachers, I expected that they would give good insight into how to aid in alleviating mathematics anxiety in J/I pre-service teachers as well as students at the J/I level.

1.7 Significance

The proposed study ventures into mathematics anxiety and remediation of that anxiety, fields that have already been explored. This study will further explore this area and will be significant on several fronts. Firstly, mathematics anxiety is a common anxiety among the general population, not just for students and teachers. This study will deepen that which is already known and will give further insight into mathematics anxiety. In doing so, this study attempts to illuminate new paths to take in alleviating such anxiety. Secondly, there has been a limited focus on the study of the prevalence of mathematics anxiety among university students of education who are enrolled in a training program to become teachers (Bowd and Brady, 2003, p. 25). Thus this study would contribute to the literature of studying math anxiety in future teachers' population. Thirdly, it is assumed that methods of treatment for mathematics anxiety will be offered by those in the sample. This should be evident through the qualitative aspect of the study. As possible future math teachers at the J/I level, these pre-service teachers may end up teaching mathematics to an age range that represents the statistical beginning of math anxiety. This can be seen in and through the math anxiety scores that begin to occur in intermediate classrooms (Ferguson, 1986, p. 149). As such, these possible future J/I math teachers are in an important position and have a unique opportunity to influence and reduce future cases of mathematics anxiety in their students' lives. Moreover, current pre-service practices in Ontario universities may be challenged with the results of the study. Lastly, it is also assumed that the National Council of Teachers of Mathematics (NCTM, 2000) mathematics reform, as demonstrated by the J/I mathematics instruction professor, will be endorsed as a means of alleviating mathematics anxiety in pre-service teachers with its principles and standards outlining approaches for the teaching and learning of mathematics.

1.8 Limitations

One of the greatest limitations in conducting this study is the use of the umbrella term, mathematics anxiety. The instrument to be used has been designed by its creators to "provide a measure of anxiety associated with a single area of the manipulation of numbers and the use of mathematics concepts" (Richardson and Suinn, 1972, p. 552). However, Rounds and Hendel (1980) found that "the unidimensionality of the MARS is yet to be demonstrated," (p. 139) and took that statement one step further by isolating two sub-constructs within the MARS, math test anxiety and numerical anxiety (p. 145). Ferguson (1986), even identified a third construct within the MARS, abstraction anxiety (p. 149). Resnick, Segal, & Viehe (1982) have also challenged the unidimensionality of the MARS (p. 44).

1.9 Ethical Considerations

In this study, ethical considerations were an important priority. Primarily, the study and its instruments were approved by the Board of Ethics at the University (Appendix E). Upon approval from the Board of Ethics, all participants were informed as to the nature of the study and to the degree of involvement that was expected. They were given a proper overview of the instrument that was to be used. They signed a consent letter only after they were completely informed and chose to continue to participate. All participants were given the assurance that their anonymity and confidentiality would be preserved. Participants were not coerced into participation. Participants' involvement did not affect their standing in the pre-service J/I mathematics course. Participants were informed that should they have any desire to withdraw during the course of the study, they would be permitted to do so without any consequences. There were and are no evident mental or physical risks to participants in completing the questionnaire. All participants will have the opportunity to view the final results should they so desire. All data are stored at the university for seven years following the conclusion of this study, and furthermore at the conclusion of that time, all data will be destroyed.

1.10 Definitions of Terms

The following are descriptions of terms used throughout the thesis.

Pre-service: Pre-service in this paper refers to those students who are in their final year of education at the university level before they are qualified to enter the teaching field as professionals.

J/I level: J/I level refers to a set of levels of teaching within the educational system in Ontario. J/I stands for Junior/ Intermediate and refers to those grades that fall within grades 4-10, with Junior being grades 4-6 and Intermediate being grades 7-10. In pre-service educational programs, pre-service teachers are educated and prepared to teach in a pair of levels. The levels are paired off as follows, P/J (Primary-grades 1-3/Junior-grades 4-6), J/I (Junior/Intermediate-grades 4-10) and I/S (Intermediate/Senior-grades 9-12).

MARS: MARS stands for Mathematics Anxiety Rating Scale. It is a scale developed by Richardson and Suinn (1972), who claim it measures “anxiety associated with a single area of the manipulation of numbers and the use of mathematics concepts” (p. 551).

SPSS: SPSS stands for Statistical Packages for Social Sciences. It is a software program developed by S.P.S.S. Inc. which analyzes quantitative data.

Session: The term session was used by many respondents in their answers to the open ended questions. The term session refers to one class of instruction that is 1.5 hours in duration. This was the length of time that the respondents had for a regular class during their professional year in the Faculty of Education for J/I mathematics instruction.

Rote Learning: Rote learning refers to a way of learning in which the learner is passive. The learner learns through repetition and memorization.

Professional year: Professional year refers to the final year of study for pre-service teachers prior to the completion of the bachelor of education program. For those enrolled in the one year program, the professional year is their complete program. For those enrolled in the concurrent program, their professional year is the final year of their program.

Teachable: Teachable refers to the disciplines that are considered part of the elementary or secondary school disciplines in which a pre-service teacher can teach.

Early and late in reference to age: The terms *early* and *late* are used in combination with an age range such as twenties or thirties to describe a participant's age range. Early twenties refer to a participant who is between the ages of 20 and 24, while late twenties refer to a participant who is between the ages of 25 and 29. Similarly, early thirties refer to a participant who is between the ages of 30 and 34, whereas late thirties refer to a participant who is between the ages of 35 and 39. These terms were used as participants were asked to describe their age range, and not their specific age.

CHAPTER 2

Review of Literature

There is a vast amount of literature regarding mathematics anxiety. Ma (1999) said that while, some anxiety is beneficial to performance, at a certain point it undermines performance (p. 521). Furthermore, Hembree (1990) noted, "Research of mathematics anxiety has prospered, spurred by increasing perceptions that the construct threatens both achievement and participation in mathematics" (p. 34). This poses a very significant problem as mathematics is an inescapable part of everyday life. The literature ranges from discussing how the sexes differ on math anxiety to personality types that may be more prone to mathematics anxiety. The literature gives us a good platform from which to begin this study.

2.1 General Test Anxiety

When first considering mathematics anxiety, we must be able to distinguish it from general test anxiety. Several researchers have differentiated between the two constructs and believe that the two constructs are separate. While general test anxiety and mathematics anxiety may be related, one group of researchers concluded "that mathematics anxiety and test anxiety may be separate phenomena" (Bailey, G., Cole, K., Hall, L., Holliday, D.C., Kazelskis, R., & Kersh, M.E., Larmon, M., Reeves, C., 2000, p. 144). Benson (1989), as well as Buckley and Ribordy (1982), also found that mathematics anxiety differed from general test anxiety. Hembree (1990) believes that mathematics anxiety is not "purely restricted to testing. Rather, the construct appears to comprise a general fear of contact with mathematics, including classes, homework, and tests" (p. 45). In measuring mathematics anxiety Newstead (1998) said that "test anxiety could not be a dimension of the scale since in this English sample, the pupils' mathematical understanding had not been assessed using standard tests" (p. 67). Differentiating between these two constructs aids in our study so that we can narrow our focus and find an instrument that measures mathematics anxiety specifically. It would seem appropriate therefore to use the MARS (Mathematics Anxiety Rating Scale) instrument for this study.

2.2 MARS Instrument

The instrument that was chosen for use in this study was the Mathematics Anxiety Rating Scale (MARS) developed by Richardson and Suinn (1972). Finding the right instrument is invaluable to ensure that the results are accurate. With regards to mathematics anxiety, Pajares and Urdan (1996) said, "a reliable measure of math anxiety can be valuable for counseling and guidance objectives" (p. 45). It is important to find reviews of the instrument to identify its strengths and weaknesses so when the results are studied, positive conclusions based on the data can be made. As Dew, Galassi and Galassi (1983) said, "MARS does seem to be the more internally consistent measure" (p.445) in comparing the MARS with other instruments that measure mathematics anxiety. In their meta-analysis Capraro, Capraro and Henson (2001) found that "the articles examined in the present investigation demonstrated that the MARS (and its multiple test-length versions) tends to yield high scores with strong reliability across administrations" (p. 383). Hannafin reviewed the MARS and concluded that "this test apparently has little or no competition" (Mitchell, 1985, p. 911). In another review of MARS, McMorris said,

> The eight-page scale has a good format, is easy to read, and is simple to use. The items are very well written, completely lacking in the kind of ambiguity often presented in scales of this kind, and without typographical error. Although many items deal with college or secondary school courses in mathematics, other items range from 'Totaling up a dinner bill that you think overcharged you' to 'Working on an income tax form' (Buros, 1978, p. 899).

The MARS instrument therefore appears to be a very appropriate tool for this study. Other studies (Hendel and Rounds, 1980; Ferguson, 1986) have looked even more closely at the MARS instrument and have found sub-constructs within the overarching construct of mathematics anxiety. These studies describing those sub-constructs are also useful for this study. They are discussed next.

2.3 Sub-Constructs

Frary and Ling (1983) support mathematics anxiety as a unidimensional construct (p. 992). Newtead (1998) also found in her study that "the mathematics anxiety scores were in fact unidimensional" (p. 62). However, there are many other researchers who would contest otherwise. The term mathematics anxiety is, as Hendel and Rounds (1980) point out, "a linguistically ambiguous term that could suggest a pathological response to mathematics per se" (p. 146). Therein lies the dilemma with measuring mathematics anxiety. It is more than likely that when this phenomena is studied, at least a couple of dimensions that fall under the umbrella term of mathematics anxiety are being measured.

Other researchers have also recognized that mathematics anxiety is not a unidimensional construct but rather a multidimensional construct (Hendel, D., & Rounds, Jr., J, 1980, p.139; p. 630; Resnick, H., Segal, S., & Viehe, J., 1982, p. 44; Bessant, K., 1995, p. 342; Kazelskis, 1998). It is important to recognize what those sub-constructs are in order to understand what the data are indicating to the researcher, and, thereafter, to treat mathematics anxiety. Hendel and Rounds (1980) derived two factors from the MARS instrument; mathematics test anxiety and numerical anxiety (p. 145). They believed that MARS is best described "primarily as test anxiety and secondary as anxiety associated with mathematics courses" (p. 142-143). Ferguson (1986) pointed towards a third sub-construct that the MARS instrument measures, abstraction anxiety (p. 149). In that study, Ferguson found that "both factor analysis methods provided strong support to the hypothesis that Abstraction Anxiety is an important factor of mathematics anxiety" (p. 149). Ferguson defined abstraction anxiety as "a factor that reflects anxiety concerning mathematics topics that are at first introduced in the middle grades" (p. 149) and noted "that is the same time when sex differences in mathematics performance begin to arise" (p. 149). This is an interesting connection for this study as the sample examined in this study will most likely become teachers at that level. Sex differences within mathematics anxiety and achievement, another area important to this study, has received a great amount of attention in the literature.

2.4 Differences Between the Sexes

The differences that exist in mathematics ability as well as differences in mathematics anxiety, between males and females, have been studied extensively. While

Hyde (1993) argued that there are no overall gender differences in mathematics performance (Penner, Batsche, Kneff, & Nelson, 1993, p. 240; Hendershot, 2000), she opposes conventional beliefs. Some studies, such as that of Benbow (1988, p. 182), have found males to be more successful; while others have found females to be more successful, but in the majority of the literature reviewed females were found to be more math anxious than males. While "few consistent sex-related differences are found at the primary school level" (Fennema, 1985 p. 304) as noted before, they begin to emerge in the middle grades (Ferguson, 1986, p. 149). Fennema (1985) found that "there is a substantial body of evidence to suggest that by the beginning of secondary school, boys frequently perform better than girls at mathematics" (p. 305) This may be in part attributed to Blumenfeld, Eccles, Harold and Wigfeild's (1993) finding that boys had more positive competence beliefs for mathematics than girls (p. 830). Eccles, Meec,e and Wigfeild (1990), also found that when compared to girls "boys have higher perceptions of their own math ability, higher performance expectancies in math, and stronger intentions to keep taking math" (p. 64). However, as Kimball (1989) found "occasionally, differences exist that favor girls" (p. 198). Moreover, in Kimball's research, she found that "using grades in mathematics classes… when differences are found, they almost always favor girls" (p. 199). Casey, Nuttall, and Pezaris (1997) found that "an item analysis revealed that the majority of items that favored boys required the use of mathematical insight, whereas all the items favoring girls required standard algorithmic solutions" (p. 677). It would seem to be a common belief that females are more successful with familiar mathematical tasks, whereas males are more successful with novel mathematical tasks. Kimball (1989) suggested,

> Perhaps girls do work harder in the classroom because they have less confidence and this lesser confidence is somehow related to their lack of mathematics-related experience. Or perhaps boys find classroom material more boring in comparison to their outside experience, and thus their motivation to perform well in the class is decreased (p. 204).

The largest difference between the sexes with regards to mathematics can be seen in mathematics anxiety. Many researchers have found that females display more anxiety than males when it comes to mathematics anxiety (Tobias, 1980; Dew, Galassi, & Galassi, 1983; Marsh, 1987; Eccles, Meece & Wigfeild, 1990; Felson, & Trudeau, 1991; Flessati, & Jamieson, 1991; Casey, Nuttall, & Pezaris, 1997; Ruben, 1998; Bowd & Brady, 2003). In the review of the literature, only Sandman (1979) found boys to have greater mathematics anxiety than girls. Houghton and Zettle (1998) suggested that it may be more socially acceptable for females than it is for males to admit to experiencing math anxiety (p. 82). This is interesting when contrasted with Felson and Trudeau's (1991) finding that "girls attribute as much mathematical ability to themselves as do boys" (p. 120). However, Flessati and Jamieson (1991) found that "females view the consequences of exhibiting anxiety as more serious, and they also view their mathematical ability as being poorer than it actually is" (p. 311). This lack of confidence is of concern for this study as increasing that confidence may result in lower anxiety scores on the parts of both males and females, although, according to the literature, females may benefit greater with higher confidence in their mathematical ability. Age is another factor that affects mathematics confidence and ability and will be closely considered.

2.5 Age Effect

In the literature, age has been found to have an effect on mathematics anxiety. Hadfeild and McNeil (1994) found that "older students tended to have higher levels of math anxiety" (p. 380). This is an important finding for this study because the sample that we are measuring for mathematics anxiety have all finished at least one degree at the university level and thus are relatively older students. Furthermore, many participants within the sample will probably be considered mature and/or returning students, meaning students who have returned to university after some amount of time and thus will be even older. Hadfeild and MacNeil (1994) discovered that "the age factor indicates that those who are returning students are more likely to have mathematics anxiety" (p. 382). They believed that "this could be due to a lack of confidence, due to either feeling 'rusty', or from a poor background in mathematics" (p. 382). Going into this study, this information can shed light on the sample to be examined and prepare the researchers for why mathematics anxiety may be encountered from subsamples within the sample. Understanding the effect age may have on the sample of this study leads the investigation to look at the background of the sample.

2.6 Background

A person's background may have an effect on their mathematics achievement and their mathematics anxiety. McMorris' (Conoly, 1992, p. 511) review of the MARS noted that mathematics anxiety affects the number of mathematics courses enrolled in among other negative effects. Thus, those with mathematics anxiety are less likely to have greater backgrounds in mathematics, perpetuating their anxiety. Similarly, if one has very little background in mathematics then he/she may be more prone to mathematics anxiety. Cooper and Robinson (1989) found just that. Cooper and Robinson (1989) stated that "a cycle in which a background lacking mathematics leads to anxiety about mathematics, which in turn, leads to mathematics avoidance" (p. 359). This coincides with Lussier's (1996) finding that "subjects with high backgrounds reported higher scores, reflective of less anxiety about mathematics than those with low backgrounds" (p. 830). Thus, those who do have a strong background in mathematics not only appear to have less anxiety about mathematics but also seem to have greater achievement in mathematics. Resnick, Segal and Viehe (1982) found that "math anxiety does seem to be related to academic orientation and math interest. Those students with stronger academic orientations toward and with higher levels of interest in mathematics as measured by the Strong-Campbell Interest Inventory are more likely to have lower levels of math anxiety as indicated by scores on the MARS" (p. 46) Resnick, Segal, and Viehe used the Strong-Campbell Interest Inventory instrument to measure mathematics basic interest, academic orientation and introversion-extroversion (p. 40). It would appear that having a strong background in mathematics can have a positive effect on mathematics performance and a negative effect on mathematics anxiety, lowering levels of math anxiety. This is useful for possible remediation of mathematics anxiety in individuals as it demonstrates that the more familiar an individual with mathematics anxiety becomes with mathematics, the lower their mathematics anxiety should become.

With regard to ethnic background, Fennema, Hyde and Lamon (1990) said ethnicity was not found to be a strong indicator towards mathematics anxiety (p. 148). Ma (1999) also found in her study that "there may not be significant ethnic differences in the relationship" between ethnicity and mathematics anxiety (p. 533). This is important to note for this study since the majority of the sample will come from similar ethnic backgrounds. Any number of outliers that come from a different ethnic background than the majority should not necessarily be seen as representative of that ethnic background.

2.7 Interaction Between Anxiety, Achievement and Attitude

One's anxiety towards mathematics has been found to have an effect on mathematics achievement and is demonstrated in the following studies. Norwood (1994) noted that "the lower the mathematics anxiety level, the higher the achievement level" (p. 252). In addition, Ma (1999) found that "the relationship between mathematics anxiety and mathematics achievement is significant from Grade 4 on" (p. 533) This is significant for the sample in the present study as they will certified to teach from grade 4 to grade 9. Meece and Wigfeild (1988) broke anxiety into two components, cognitive and affective, stating that "worry is the cognitive component of anxiety, consisting of self-deprecatory thoughts about one's performance. Emotionality is the affective component of anxiety, including feelings of nervousness, tension, and unpleasant physiological reactions to testing situations" (p. 210). It is important to understand the make up of mathematics anxiety. Engelhard (1989) found that "subjects with higher levels of math anxiety tend to have lower levels of math performance" (p. 290). Frary and Ling also found that individuals with "higher level of mathematics anxiety tended to receive lower course grades, to have attained lower levels of high school mathematics and to have had lower college grade-point averages" (p. 990). Accordingly, Betz (1978) found "higher achievement in math is related to lower reported levels of math anxiety" (p. 446). Thus, it follows that if one were to decrease those negative feelings as well as those negative thoughts then mathematics anxiety would possibly be decreased. These feelings could be reduced by creating positive feelings towards mathematics. The results from Bessant's (1995) study suggest that favorable attitudes toward mathematics may reduce tendencies towards mathematics anxiety (p. 339). Hembree (1990) also found that "positive attitudes toward mathematics consistently related to lower mathematics anxiety, with strong inverse relations observed for an enjoyment of mathematics and self-confidence in the subject" (p. 38). Munday, Swetnam and Windham (1993) also found that "a positive attitude toward mathematics culminates in higher mathematics achievement" (p. 421). If positive attitudes can reduce anxiety as well as increase achievement, then creating positive attitudes in students taking mathematics classes and courses is imperative to reduce anxiety in those individuals who already suffer from mathematics anxiety and to foster positive attitudes in students from an early age to prevent the onset of mathematics anxiety. Both goals are relative to the sample that will comprise this study since they are both mathematics students and will probably one day teach mathematics to children and adolescents. Preventing the onset of mathematics anxiety in young students can possibly break the cycle of math anxiety since as Hembree (1990) found "like test anxiety, mathematics anxiety seems to be a learned condition more behavioral than cognitive in nature" (p. 45). If the behavior is never learned then it should not emerge. Discovering when and how these behaviors emerge is critical for their remediation.

2.8 When Differences First Begin To Emerge

An important fact emerging from the literature was when sex differences in mathematics began to emerge. As suggested by Fennema (1985), at the elementary level there are no signs of sex differences in mathematics (p. 304). If sex differences in mathematics do not emerge from the beginning of schooling, then it is important to discover when they begin to arise. Fennema, Hyde and Lamon (1990) observed that sex differences "emerge reliably between 13-16 years of age" (p. 139). This would be approximately between the grades of 7 and 10, or rather the intermediate level. Bouffard, Chouinard, Jenkins, and Vezeau (1999) also noted that differences between boys and girls attitudes towards mathematics are greatest during adolescence (p. 185). Iben (1991) noted that "intrinsic motivation to study mathematics is established in the early-middle school years" (p. 148). This is the age group that the sample in this study is preparing to possibly teach and so having this knowledge can be very helpful to those prospective future teachers. Knowing that sex differences arise at a specific time can aid in preparing the curriculum for the pre-service program for those teachers who will deal with that age group. As well, it can help to prepare those teachers who may end up teaching that level prepare for their students. Fennema and Hart (1994) further stated that "girls tend to be less confident than boys of their ability to learn mathematics beginning in middle school" (p. 656). Once again, this is important knowledge for those possible future teachers who will deal with this age group. They can prepare their approach to teaching mathematics to promote confidence in both sexes. Recognizing when sex differences emerge and why they emerge can be a valuable tool in decreasing mathematics anxiety in students. As well, this knowledge is valuable to the pre-service program in preparing future teachers for their students.

2.9 Remediation Through The Pre-Service Program

Many different attempts have been made to aid those with mathematics anxiety (Troutman, 1978; Gillingham and Olson, 1980; Hardeman and Laquer, 1982; Brown and De Bronac-Meade, 1982; Covington and Tiballi, 1982; Eckart and Tracy, 1990; Gardner, 1991; Nevid and Schneider, 1993).The pres-service program is one place that the remediation of mathematics anxiety can begin. The pre-service program is a valuable tool in preparing future teachers to teach mathematics to their future students. In the case of teachers at the J/I level, they are not required to have a background in mathematics and thus the pre-service mathematics instruction course becomes that much more essential. As Munday, Swetnam and Windham (1993) put it, "the tragedy of the situation is that prospective teachers who avoid taking mathematics courses are not as well prepared to teach as they could be" (p. 422). With the amount of attention given to mathematics in the pre-service program, these prospective teachers will likely need to go beyond their course requirements to feel confident in teaching mathematics. Having confidence in what they are teaching is important for teachers. Manouchehri (1998) points out that "having confidence in what they taught and in their knowledge of mathematics was important for all teachers. They generally avoided teaching units they did not feel comfortable with mathematically or those that they did not see as mathematically significant" (p. 282). It would seem that not having the confidence to teach mathematics curricula or having too much anxiety in that regard, is a problem, and that promoting and attempting to instill confidence as well as trying to reduce anxiety in future math teachers should be a focus of the pre-service mathematics instruction course. Lindstrom and Tooke (1998) produced evidence that "evidence that student's mathematics anxiety may be reduced by completing a mathematics methodology course" (p. 137). Betz and Hackett (1981) indicated the need for confidence within mathematics specifically for women as they speculated that

> ...women's lower self-efficacy expectations with regard to occupations requiring competence in mathematics may be due to a lack of experiences of successful accomplishments, a lack of opportunities to observe women competent in math, and/or a lack of encouragement from teachers or parents (p. 409).

Thus further emphasizing the need to promote success and instill confidence in female pre-service teachers. Adams and Holcomb (1986) have already pointed to a need for promoting such positive attitudes when dealing with mathematics (p. 943). Furthermore, Battista (1986) found "that the mathematics anxiety of pre-service elementary teachers can be reduced by a mathematics course" (p. 18). The same can be assumed for a J/I teacher. Battista (1986) further stated that "the quality of mathematics instruction at the elementary school level depends on the preparation of pre-service elementary teachers to teach math" (p. 10), as it does it at the J/I level.

Another important aspect of preparing pre-service teachers for teaching mathematics is preparing them for mathematically anxious students. In doing so, reducing such anxieties in students may become a natural part of teaching mathematics. Reducing those with mathematics anxiety is important, especially for those with greater anxiety, such as females. Females have been found by Campbell and Sanders (1997) to be neglected when it comes to teaching gender equity in the classroom. Campbell and Sanders believe that the "omission of gender equity at the pre-service level means that new teachers may enter the classroom not realizing how their behavior and the educational materials they use may inadvertently harm girls' performance and aspirations" (p. 70). It is critical then that teachers become more sensitive to their own attitudes toward perpetuating stereotypic views of math achievement or careers in the quantitative fields as inappropriate for girls and women (Eccles, Futterman, Goff, Kaczala, & Meece, 1982, p. 343). It would seem that the literature suggests that there is a need to prepare future mathematics teachers at the J/I level by reducing their mathematics anxiety, increasing their knowledge base and instilling confidence in their mathematical ability. Furthermore, there is a need to increase pre-service teachers' ability to teach mathematics in general and specifically to both genders so that equality can be reached. If this does not occur, then the cycle of mathematics anxiety may continue to prevail.

2.10 Creating a New Cycle

In one study a cycle was alluded to that encapsulates the dilemma of not effectively dealing with the mathematics anxiety problem that exists in students. Munday, Swetnam and Windham (1993) stated that "math-anxious teachers convey a negative attitude toward mathematics to students, who in turn take fewer mathematics courses and then proceed to become ill-prepared math-anxious teachers who create more students who are math-anxious with a negative attitude toward mathematics" (p. 422). This statement illustrates the cycle of mathematics anxiety that must be ended. Hadfeild and

McNeil (1994) pointed out that "if elementary teachers are to make instruction more relevant and exciting to their students, they must first overcome any fears or negative attitudes that may have a negative influence on their planning and teaching" (p. 376). Not only is this true for intermediate teachers but it can first be demonstrated in the pre-service mathematics instruction course. It can then be carried into the classroom where it has been found to be successful when the teachers "effectively implement the improved programs" (Hadfeild, O., & McNeil, K., 1994, p. 376). These improved programs are more easily sustained when "teachers had emotional and intellectual support and opportunities for productive growth of their content and pedagogical skills". When this occurred "they more easily and naturally sustained a spirit of reform" (Manouchehri, A., 1998, p. 278). Mathematics reform as a movement has offered change in the way in which mathematics is taught and learned. It involves greater emphasis of hands-on learning through the use of manipulatives. Furthermore, it attempts to make mathematics less abstract and more practical to daily life. Mathematics reform and its strategies can be reviewed in the NCTM Principles and Standards for School Mathematics (2000). Understanding the positive effects of mathematics reform in the classroom can help those future teachers accept its concepts and strategies. By using this information in the pre-service J/I mathematics instruction course, a new fondness for mathematics can be achieved.

CHAPTER 3

Design of the Study

3.1 Methodology

This study was conducted using both quantitative and qualitative measures combined. For the quantitative aspect of the study, the MARS (1972) was used. Eight open-ended questions (which were answered in writing) which followed the MARS made up the qualitative aspect of the study. Together the data was scrutinized for themes pertaining to the research questions.

3.2 Research Design

3.2 (a) Participants.

The participants for this study were those pre-service teachers enrolled in their professional year at the J/I level from the sampled Ontario university. This sample is considered representative of all pre-service J/I teachers in Ontario. All those pre-service teachers enrolled in the J/I mathematics methods course who attended their regular class during the sixteenth week of in class instruction were asked to participate in the study. Of the 183 students enrolled at the J/I level at the sampled university, 149 participated in the study, 132 completed all requirements for the study. Participants ranged from their early 20's to over 40. They were enrolled in either the concurrent education program or the one year program. Participants were taken from all J/I mathematics instruction classes and they were of both sexes, having backgrounds that ranged across all teachable subjects.

3.2(b) Instrument.

Two instruments were used in this study. One instrument was used for the quantitative research and one for the qualitative research. For the quantitative research, the MARS (Suinn, 1972) instrument developed by Dr. Richard Suinn was used. It is a 98-item, Likert format questionnaire with respondents answering by marking the appropriate circle to describe the degree of anxiety that the situation mentioned in each question aroused. Answers ranged from "not at all', "a little", "a fair amount", "much" or "very much". The instrument was scored by giving a value to each question answered with 1 a value for "not at all', 2 a value for "a little", 3 a value for "a fair amount", 4 a value for "much", and 5 a value for "very much". Scores for each question on individual's questionnaires were added up for a total score for each participant.

The MARS has been found to have a test-retest reliability coefficient of 0.78 (Suinn, 1972, p. 2). Furthermore, Suinn (1972) demonstrated an internal consistency reliability coefficient (coefficient alpha) of 0.97 (N=397) for the MARS (p. 2). This demonstrates that the average intercorrelation of the items in the test is quite high. Suinn (1972) "confirms that the test is highly reliable and indicates that the test items are heavily dominated by a single, homogeneous factor, presumably mathematics anxiety" (p. 2). This information aids the focus of the study, signifying that the use of the MARS does in fact measure mathematics anxiety and mathematics anxiety alone.

The second instrument used was an open ended questionnaire comprised of 8 items developed by the researcher. The participants were asked to respond to these questions in pen or pencil in the response booklets that were given to them with the sheet of open ended questions. The responses were analyzed by qualitative means. The response booklets were first coded, then the codes were placed into emergent categories and finally those categories were placed into themes that emerged from the categories.

The two instruments were given to the participants during their regularly scheduled J/I mathematics methods course.

3.2(c) Method.

Data were gathered during the winter term of 2004. Participants were approached during their regularly scheduled J/I mathematics instruction course during their 16th week of in-class instruction. Participants had had only two weeks remaining of in-class instruction prior to their final five week placement of teaching practicum before their degree requirements would be fulfilled. Participants were first given an overview of the study, its instruments to be used, the ethical considerations for participants, and the consent form. Participants were then informed that the study was voluntary and anonymous.

Next, participants were given the instruments, the cover letter attached with the consent form and the response booklets. Participants were asked to complete the consent form prior to beginning the study. Consent forms were collected and time was given for participants to complete the study. There was no minimum or maximum amount of time allotted. The cover letter, consent form, and both instruments can be found in the appendices (p. 81).

3.3 Data analysis

Once the data was accumulated from the MARS instrument and the open-ended questions, each corresponding MARS instrument and response booklets was numbered to provide case numbers. After which, each completed MARS instrument was then analyzed to establish a score following the procedures Dr. Richard Suinn outlined in the instructions for analysis that came with the instrument when it was delivered. These scores were then entered into the Statistical Packages for Social Sciences version 11, (SPSS) along with the descriptive data for each case. The data were then analyzed for levels of anxiety across gender, between gender, academic background, program, course section and age. Cross-tabulations were created to compare mean MARS scores as well as percentiles determined for the same purpose. Also, one way analysis of variance (ANOVA) tests, and independent samples t-tests were used to examine the differences between the MARS scores in light of the different sample descriptors. Lastly, a bivariate correlation analysis was also conducted.

The 8 open-ended questions at the end of the questionnaire were analyzed inductively looking for patterns, similarities and outlying answers that describe the participants' experiences and thoughts. There would be episodes describing situations as they arose. That is, the researcher focused on certain cases that are relevant to the research problem. These episodes describe a more complete picture of the participant's experiences, thoughts and feelings in light of the collective data. Initially, each case in the qualitative data sample was read over as an initial reading so that the researcher could familiarize himself with the entire dataset. Next, a second reading was conducted, during which the researcher coded that dataset. Codes were established based upon reviewing the data and deciding upon appropriate codes. In total, 107 codes emerged from the data. No codes were established prior to the second reading of the complete data set. Following this stage, the researcher created a table with two columns. In the first column was each code that was derived from the data. In the second column, in the same row as the accompanying code, were listed each case that the code appeared in. This was done to facilitate the writing process as a means of reference for the researcher as well as to facilitate the qualitative process. Next, the codes were scrutinized to derive categories. Eight categories emerged from the 107 codes. The categories were carefully studied to find themes. Three themes were discovered. The following themes emerged from the data; (I) the program at the studied university, (II) being a teacher and (III) being a mathematics student. The analysis focused on those themes.

CHAPTER 4

Results

Quantitative Data

Quantitative data was collected using the MARS instrument described in chapters two and three. The shaded sections of each table represent data that is being illustrated, while the white sections are the actual data for the corresponding row and column. In this chapter the data is merely illustrated, chapter five discusses the implications of the data.

In examining the data it is important to understand whom the data represents. Table one gives a detailed description of the sample with regards to participants and MARS scores.

Table 1: Descriptive Statistics by Section

Class Section		YA	YB	YC	YD	YE	Total
Total In Section		31	42	42	37	31	183
Total Participants		23	27	30	31	21	132
Percentage of sample		17.42%	20.45%	22.73%	23.48%	15.90%	100%
Program enrolled in	Concurrent	11	9	7	12	1	40
	One year program	12	18	23	19	20	92
Gender	Male	7	9	8	9	9	42
	Female	16	18	22	22	12	90
Mean MARS Score		200.74	179.78	191.53	183.26	195.33	189.39

Table 1 illustrates the sample in 6 categories. By examining table one it is evident that the sample was dominated by females as they more than doubled the number of males who participated. However, this is not a reflection of a lack of participation but rather a reflection of the number of males and females enrolled at the J/I level. Upon further examination, one can see the same sort of discrepancy for enrollment in program. The number of participants enrolled in the one year program more than double the number of participants in the concurrent program. One statistic that is not represented here but is noteworthy was that 55.3% of all participants listed themselves within the 20 to 24 age interval, and all class sections had a modal age interval of 20 to 24 years of age. This demonstrates that the majority of participants are between 20 and 24 years of age and has implications for the data when it is examined later on in the chapter. Lastly, it should be mentioned that as evident in the table 72.13% (132 participants) of all possible participants completed all necessary information to examine their MARS scores. 149 participants participated in the study, however, 17 cases were dismissed due to incomplete information.

Percentile information for the total sample was examined and compared to the percentile information provided by Dr. Suinn in order to make a comparison between samples. Table 2 compares this study's results with Dr. Suinn's results.

Table 2: Percentiles for MARS Scores from Sample for Current Study
And Percentiles given by Dr. Richard Suinn for MARS

		Percentiles						
		5	10	25	50	75	90	95
Weighted Average (Definition 1) **Current Study** Based on N=132	Score	112.65	120.3	141	184	229	264.1	287.35
Weighted Average (Definition 1) **Dr. Suinn** Based on N=394	Score	-*	140	165	215	255	-*	315

* Denotes a percentile that was not given

Table 2 illustrates the percentile ranks for MARS scores from both the current study and from those that were provided with the MARS instructions when the instrument was purchased. An interesting pattern emerges here. In closely observing the layout of percentiles of the sample in this study, they indicate that the sample in this study have lower MARS scores than the sample that was evaluated by Dr. Suinn (upon purchasing the MARS, Dr. Suinn provided data information concerning the percentiles he found in his sample). The results indicate a lower mean for mathematics anxiety. The significance of this is discussed in the following chapter.

4.1 Class Section and MARS Scores

Class sections were examined with regards to MARS scores in order to determine if there was a significant difference between class sections. Table 3 describes the class sections with regards to their mean MARS scores.

Table 3: Comparison of Class Section and Mean Score on MARS

Class Section	Mean	N	Std. Deviation	Minimum	Maximum	Range
YA	200.74	23	58.418	122	344	222
YB	179.78	27	49.842	110	254	144
YC	191.53	30	58.427	112	348	236
YD	183.26	31	61.497	98	376	278
YE	195.33	21	59.532	126	284	158
Total	189.39	132	57.326	98	376	278

Table 3 illustrates the mean MARS scores from each class section. In examining the table, it is apparent that class section YA had the highest mean MARS score, while YB had the lowest. It is also important to note that YB had the smallest range between highest and lowest MARS score within the class sections, signifying that the participants in YB's class section scored the most similar to one and other. YD experienced the most variation in scores with a range of 278; however, this may also be accounted for by the fact that YD had more participants from its class section that any other class section.

A one way ANOVA test was conducted to see if there was a significant difference between the MARS scores of the class sections. Table 4 shows the results.

Table 4: One Way ANOVA for MARS Scores between Class Sections

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7502.345	4	1875.586	.563	.690
Within Groups	423003.170	127	3330.734		
Total	430505.515	131			

Table 4 illustrates the comparison between the class sections on the MARS scores. The high sig. value, $p = 0.69$ and $F = 0.563$, demonstrate there is no significant difference among the means of the five sections involved, on the MARS scores.

4.2 Age Interval and MARS Scores

Age intervals were examined next in order to compare the age intervals of the participants and their MARS scores. Table 5 shows the descriptives of the age interval groups.

Table 5: Comparison of Age Interval and Mean Score on MARS

Age Interval	Mean	N	Std. Deviation	Minimum	Maximum	Range
20-24	196.78	73	55.697	98	376	278
25-29	182.37	35	63.345	110	348	238
30-34	178.42	12	47.588	106	275	169
35-39	177.50	6	50.749	133	245	112
40 and Over	174.33	6	68.649	112	288	176
Total	189.39	132	57.326	98	376	278

Table 5 illustrates the comparison between the age intervals of the participants and their mean MARS scores. Upon examining Table 5 it is evident that those participants in the sample who were between the ages of 20 and 24 had the highest mean MARS scores and were the more anxious individuals. As seen in Table 5, mean MARS scores for age intervals decreased as age intervals went up. It is also noteworthy to mention that while the 20-24 age interval had the greatest range for MARS scores and accordingly the greatest number of participants, the greatest dispersion can be seen in the 40 and over age interval. This may indicate that the mean MARS score for the 40 and over age interval is not as representative of that sub-sample as it appears given the low number of participants.

Using a graphic representation of the above data can aid in examining possible meanings of this information. Figure 1 illustrates the above data in a graph.

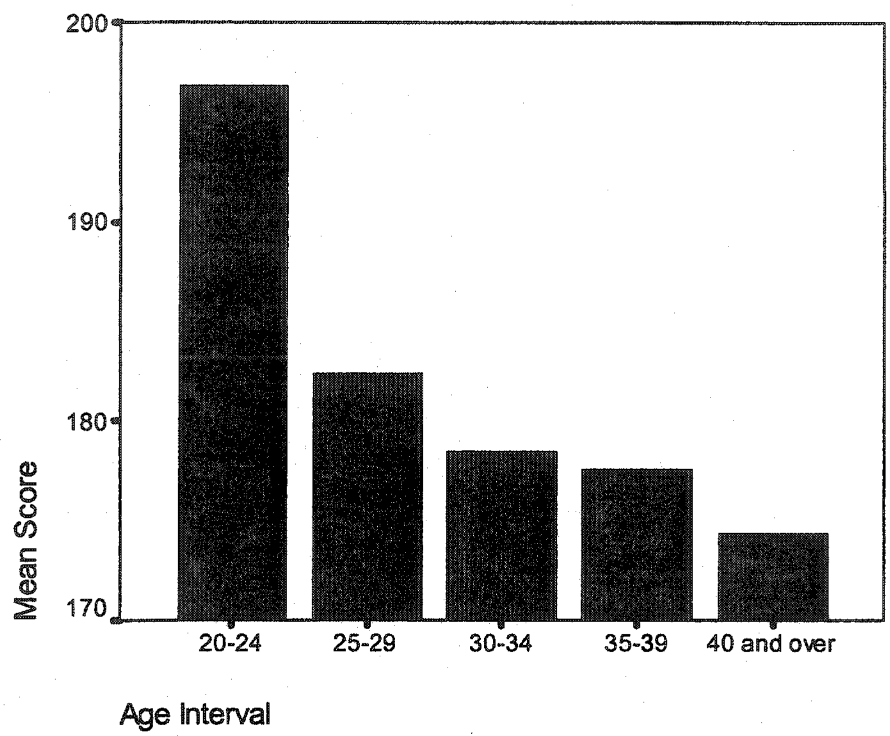

Figure 1: Age and Mean Score on the MARS

Figure 1 is a visual representation of the same data that is found in Table 4. Figure 1 visually illustrates the mean MARS scores for each age interval. As seen in the figure, those participants who are 20-24 years of age have a significantly higher mean MARS score than those participants that fall into all other age intervals. It can also be seen that as age goes up MARS scores decrease. It is, in a sense, a negative correlation relationship.

A bivariate correlation analysis was done to examine whether or not there is a significant correlation between age interval and mean MARS score. The table below displays the output (see Table 6).

Table 6: Bivariate Correlation on Age Interval and Mean MARS Scores

		Age Interval	Score
Age Interval	Pearson Correlation	1	-.132
	Sig. (2-tailed)	.	.130
	N	132	132

While Table 6 does not show a significant correlation (-0.132), it does demonstrate the negative nature of the correlation between the age intervals and mean MARS score. This shows that as age intervals increased, mean MARS scores decreased. This means that the older participants in the study displayed less mathematics anxiety on the MARS than the younger participants.

A one way ANOVA was conducted to see if there was a significant difference among the age intervals' means on MARS scores. Table 7 displays the ANOVA's analysis.

Table 7: One Way ANOVA for MARS Score over Age

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9365.101	4	2341.275	.706	.589
Within Groups	421140.415	127	3316.066		
Total	430505.515	131			

Table 7 illustrates the comparison among the means of the age intervals on the MARS scores. p = 0.589, and F = 0.706 show that in comparing the means of the age intervals on MARS score there is no significant difference. This contrasts that which is seen in Table 5 and Figure 1. The implications of this examination are discussed in the following chapter.

4.3 Program and MARS Scores

The programs that the participants were enrolled (concurrent program or one year program) were then examined to determine if program was a significant indicator for certain patterns in the MARS scores. Table 8 describes the mean MARS scores for both programs.

Table 8: Comparison of Program and Means Score on MARS

Program	Mean	N	Std. Deviation	Minimum	Maximum	Range
One year program	182.35	92	54.926	98	348	250
Concurrent Program	205.60	40	60.106	107	376	269
Total	189.39	132	57.326	98	376	278

Table 8 illustrates the MARS scores for the programs that participants are enrolled in. As seen in Table 8, those enrolled in the concurrent program had a higher mean MARS score (more anxious) than those enrolled in the one year program.

An independent samples t-test was conducted to compare the two programs enrolled in on MARS score. The following, Table 9, represents the output of the t-test.

Table 9 Independent Samples t-test for Programs and MARS Scores

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Score	Equal variances assumed	.008	.927	-2.172	130	.032	-23.25	10.706	-44.433	-2.071
	Equal variances not assumed			-2.096	68.586	.040	-23.25	11.095	-45.389	-1.115

This independent samples t-test indicates that the 92 participants from the one year program had a mean MARS score of 182.35 in the sample, and the 40 participants in the concurrent program had a mean MARS score of 205.60 (Table 8) and that these means did differ significantly at the $p < 0.05$ level of significance (note the outcome: $p = 0.032$). This result indicates that the concurrent program's students possess a significantly higher level of anxiety than that of those at the one-year program. Levene's test for Equality of variance indicates that the variances for both programs did not differ significantly from each other at the $p < 0.05$ level of significance (note the printout of $p = 0.927$). This allows the research to use a slightly more powerful equal variance t-test. However, if Levene's test did show a significant difference, then it would be necessary to use the unequal variance result.

4.4 Gender and MARS Scores

Gender was examined to determine whether or not gender was a significant indicator for MARS score. Table 10 describes both genders with regards to their mean MARS scores.

Table 10: Genders Descriptives on Mean MARS Scores

Gender	Mean	N	Std. Deviation	Minimum	Maximum	Range
Male	178.50	42	47.847	98	275	177
Female	194.48	90	60.830	106	376	270
Total	189.39	132	57.326	98	376	278

Table 10 illustrates a comparison of the gender variable of the participants on their mean MARS scores. Table 10 shows that females demonstrated a higher mean MARS score than did males. Furthermore, females also had a much greater range as to their scores than did males, that is, a larger standard deviation, $s = 47.847$ for males versus $s = 60.83$ for females. Males, consequently, were more similar to one another on the MARS than were females.

The table below further illustrates the difference between males and females with regards to their MARS scores by looking at their percentiles.

Table 11: Percentiles for Males and Females on MARS Scores

			Percentiles						
		Gender	5	10	25	50	75	90	95
Weighted Average (Definition 1)	Score	Male	108.35	118.90	138.75	177.00	218.50	243.20	271.85
		Female	112.55	120.20	141.75	184.50	237.75	280.60	303.70

Table 11 illustrates the percentile ranks for males and females within the sample separately. Table 11 shows the gap between scores becomes greater as percentiles increase. The difference between genders may be explicable in light of Figure 2.

Figure 2 gives a graphic representation of the MARS scores for the females in the sample. It partially illuminates the differences between males and females.

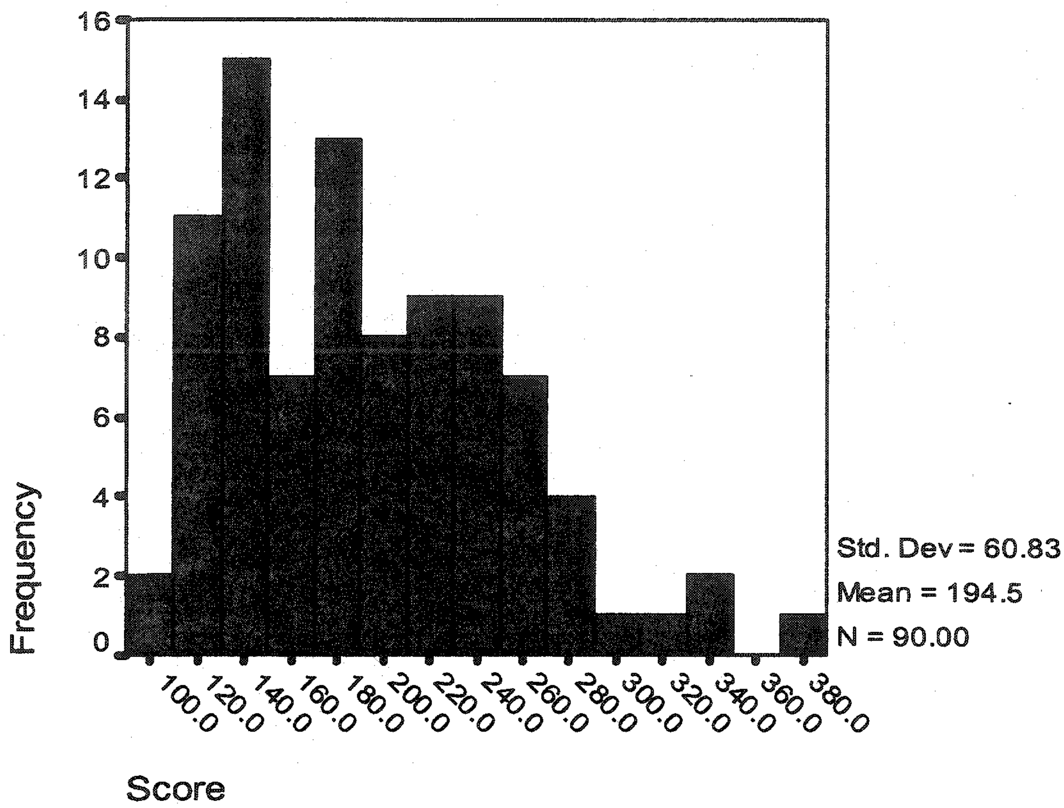

Figure 2: Female MARS Scores

Figure 2 visually illustrates the distribution of MARS scores for all females in the sample. This figure is important for noting the outliers. This histogram for female MARS scores is positively skewed which further isolates the outliers.

An independent sample t-test was conducted in order to compare the genders on their mean MARS scores. Table 12 illustrates the analysis.

Table 12: Independent Samples t-test for genders on MARS Scores

	Assumptions	Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Score	Equal variances assumed	2.512	.115	-1.499	130	.136	-15.98	10.662	-37.071	5.116
	Equal variances not assumed			-1.634	99.974	.105	-15.98	9.779	-35.379	3.423

This independent sample t-test analysis indicates that the 90 females had a mean of 194.48 total points in the sample, the 42 males had a mean of 178.50 (see Table10) total points in the sample, and the means did not differ significantly at the $p < 0.05$ level of significance. (Note the outcome: $p = 0.136$). Levene's test for Equality of Variance indicates variances for males and females do not differ significantly from each other at the $p < 0.05$ level of significance (note the printout of $p = 0.115$). This allows the research to examine a slightly more powerful equal variance t-test. However, if Levene's test did show significant difference, then it would be necessary to use the unequal variance result.

A one way ANOVA test was conducted to further compare the genders and their mean MARS score. Table 13 displays the analysis.

Table 13: One Way ANOVA for MARS Score and Gender

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7310.560	1	7310.560	2.246	.136
Within Groups	423194.956	130	3255.346		
Total	430505.515	131			

The results of the one way ANOVA in Table 13 agree with Table 12 as it reinforces the comparison between the genders on their MARS scores. That is, the Sig. Value $p = 0.136$ of the one way ANOVA test shows that the means of males and females on MARS scores are not significantly different at 0.05 level of significance.

4.5 Teachables and MARS Scores

Participants' teachables and their corresponding MARS scores were examined to investigate whether or not there is a significant difference in the mean scores for the teachable groups.

A comparison of participants' teachables means on MARS scores was carried out in order to find out whether there is a significant difference among the mean scores on MARS. Table 14 shows the descriptive output for the teachable groups.

Table 14: Means of Teachables on MARS Scores

Teachable	Mean	N	Std. Deviation
English	196.86	35	55.973
Mathematics	149.80	5	28.639
Geography	189.67	21	57.176
History	194.45	22	49.853
Physical Education	166.85	13	45.064
Science	156.42	19	42.007
Art	203.00	1	.
French	242.31	13	72.307
Music	240.50	2	26.163
Law	125.00	1	.
Total	189.39	132	57.326

Table 14 describes the teachables groups on the MARS scores. Further, Table 14 shows that participants with Law (125.00), Mathematics (149.80) and Science (156.42) teachables displayed the lowest levels of mathematics anxiety while those participants with Art (203.00), Music (240.50) and French (242.31) as their teachables displayed greater mathematics anxiety. It should be noted however, that only one participant for each Art and Law, listed those as their teachables. Also, only two participants listed Music as their teachables. While this is a notable difference when comparing the number of participants in each group, it is a reflection of the number of J/I students with those teachables.

A graphic representation was created in order to clarify the mean MARS scores for the participants who listed each of the teachables. The graphic representation is shown in the figure below (see Figure 3).

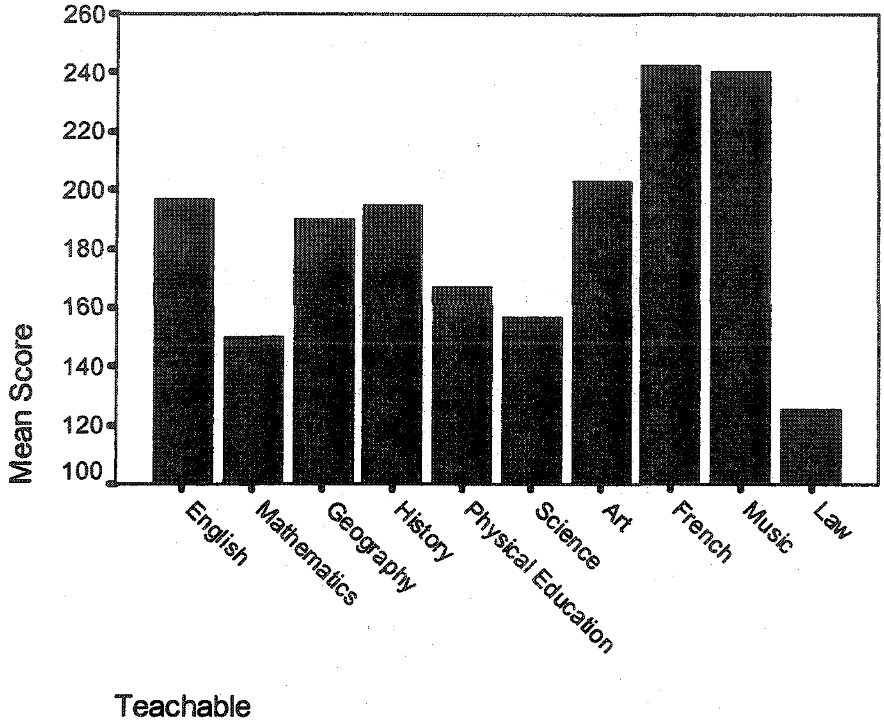

Figure 3: Mean Scores for MARS for the Teachables Groups

Figure 3 visually illustrates much of the same information as in Table 14. This graphic representation of the data further emphasizes the differences between the mean MARS scores of participants for the teachable groups.

A one way ANOVA test was conducted to examine whether or not there is a significant difference between the means of teachables groups on MARS scores. Table 15 shows the ANOVA analysis for the teachable groups.

Table 15: One Way ANOVA for Teachables and MARS Score

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	83572.715	9	9285.857	3.265	.001
Within Groups	346932.800	122	2843.711		
Total	430505.515	131			

Table 15 illustrates the comparison among the means of the teachables on the MARS scores. $p = 0.001$ and $F = 3.265$ show that in comparing the means of the MARS scores amongst teachables that there is a significant difference at 0.01 level of significance. Thus, teachables may be seen as a significant indicator for MARS score.

Qualitative Results

Accompanying the quantitative aspect of this research was a qualitative aspect. Participants were asked to answer 8 open-ended questions in a response booklet. The questions can be found in the appendix D. The goal of the questions was to probe further into the participants' feelings towards mathematics at the J/I level and to explore how they felt those feelings might impact their teaching and those they are likely to teach. Of the 149 participants, 148 completed the qualitative aspect. From the responses 107 codes were found. Those codes were then scrutinized and divided into 8 categories. Finally, three themes were found from the 8 categories. These themes emerged from the participants' responses were the theme of *Being a Mathematics Student*, *Being a Teacher* and *the Program at (the sampled) University*. The following is a report on what was found. The implications of these findings are discussed in chapter five under the discussion and implications section.

4.6 Being a Mathematics Student

Despite only one question dealing directly with being a mathematics student (*How does the way you learned mathematics in school compare to how you are learning to teach mathematics here at (the sampled university)?* the theme of being a math student arose throughout the responses. Participants reflected on feelings towards mathematics, learning preferences, and the need for lifelong learning.

4.6(a) Feelings towards mathematics.

Many participants expressed discomfort and a dislike for mathematics. One female remarked "I do not like math" (case 87). Others were slightly more descriptive in referring to their negative feelings. One participant described how it would affect his attitude saying "I didn't like math as much as some other subjects so I must be able to appear enthusiastic" (case 52). One female was afraid her students would pick up on her feelings towards mathematics saying, "my comfort level I am afraid may demonstrate that I don't like math and that it is a challenge for me" (case 8). She also mentioned that "just at the thought of math I freak out". One male felt that if he did not feel comfortable with mathematics he would try and "avoid the subject or trade it off" (case 93). While few participants expressed an enjoyment of mathematics, there were those who did. One female stated that she had "always liked mathematics" (case 106). A male said "I like math and think it can be fun too with proper preparation and lessons related to real life situations" (case 134). A female said "this J/I math course served to remind me just how much I enjoy learning about math" (case 70) possibly signaling that she had not handled mathematics in such an explicit manner in some time. Not all participants who enjoyed mathematics had felt so their entire life. One female participant found a new liking for mathematics. She said that on her field placement "I found that I like math-this was a surprise" (case 64). The reasons for enjoying mathematics and disliking it can serve to aid in understanding how to make it more enjoyable for all, so that future mathematics students may suffer less from mathematics anxiety, or not suffer at all. This notion is expanded upon in the next chapter.

4.6(b) Learning Preferences.

Throughout the participants' responses they described aspects of their preferred and not as preferred methods of learning. Many described their elementary and secondary mathematics education as a negative experience. One participant said she "learned math in a very boring, textbook type way" (case 16). Another participant described her elementary math education as,

> Scary and stressful, in grade 3 or 4 we had the 'math minute' where you had 1 minute to do 30 multiplication problems. If you answered them all correctly the teacher put a large sticker on your paper. I never got a sticker and to this day I remember the horrible feeling I got in my stomach when the teacher pulled out these 'math minute' activity sheets. Nobody ever explained why math formulas are the way they are (case 28).

Another female echoed these feelings of pressure saying there was a lot of pressure in school before her professional year, (case 82) referring to learning mathematics. One comment made by a male was corroborated by many of the participants, when he said "when I was in school math was rote and without purpose" (case 122). The overwhelmingly preferred method of learning seemed to be when participants felt they were learning in a "more cooperative (manner) and we use manipulatives. It is far better and more user friendly" (case 70). One male expressed the view that he preferred "to find out the reasoning behind the theory; I enjoy the hands on activities. We didn't have much opportunity for this when I was younger" (case 79). One female wrote, in reference to the way in which she was learning mathematics during her professional year, that "the math was more meaningful and the use of manipulative made it easier and a much more enjoyable experience" (case 143). For the majority of respondents there was not only a difference in the way in which they learned mathematics from elementary and secondary school, but a preference as well. The majority of participants preferred the means by which they learned mathematics during their professional year, as seen in the table below and discussed in chapter five.

A table was created to examine the expressed preference of participants with regards to teaching methods. The following was what was found.

Qualitative Table 1: Preferred Teaching Methods

Preferred Teaching Method	Totals
Preferred teaching encountered method during professional year over pre-professional year experiences	43
Did not express preference	74
Did not prefer teaching method encountered during professional year over pre-professional year	8
Did not answer in a way that communicates preference for teaching methods between professional year and prior experiences	23

Qualitative Table 1 is taken from the open ended responses from the participants and differentiates between preferred teaching methods experienced during the professional year and all teaching methods experienced pre-university. As seen above, while the majority did not express their preference, those who did prefer the teaching methods experienced during their professional year were more than 5:1 to those who did not prefer the teaching methods during their professional year compared to their experiences pre-professional year.

4.6(c) Lifelong Learning.

Participants expressed a need for lifelong learning with respect to being a teacher and more specifically to being a mathematics teacher. Some participants suggested that "teacher workshops" (case 2) would be a way of helping teachers through some of the difficulties they perceive as future mathematics educators. One participant wrote that "professional days can be devoted to providing extra information, clarity to math problems, etc, to those J/I teachers (in need of it) – Information that can be used to enhance the classroom experience for students" (case 7). Similarly another participant suggested "training that helps 'to be' teachers be better prepared. This may require one class a week" (case 118). One participant described teaching mathematics as "a learning process for us all" (case 71), accentuating the idea of an ongoing learning process alongside the students. A female said, when encountering difficulties "The only solution that I can think of is going back to when I was in grade 1 and reteaching me everything I learned and everything I need to know in order to teach J/I math" (case 128). Another female felt that it is "important to learn with your students" (case 141). As future teachers of mathematics the participants are prepared to, and are seeking opportunities to be, lifelong learners. Lifelong learning is discussed further in the following chapter.

4.7 Being a Teacher

In studying pre-service teachers, the theme of being a teacher should have been an expected theme to arise. Five of the eight open-ended questions asked the respondent to reflect on certain aspects of being a teacher. They were; *how do you feel your comfort level with mathematics will affect your preparation for math lessons?*; *How do you feel your comfort level with mathematics will affect your teaching of mathematics?*; *How do you feel your comfort level with mathematics will affect the students you teach?*; *Can you perceive any possible difficulties with teaching mathematics at the J/I level? If so, what are they?*; and *If you answered yes to (the last question) in your opinion what are some possible solutions to those difficulties?* The following is a description of responses dealt with participants' preparation, comfort level in the classroom, their concerns as math teachers, and the students.

4.7(a) Preparation.

Preparation was a major, continuous theme throughout nearly all of the responses. 123 of the 148 participants who answered the open-ended questions mentioned preparation during their responses; however, it came up most significantly in reference to being a mathematics teacher. For a significant number of participants (49%), there is a belief that despite any shortcomings the participants may have in their knowledge or their degree of discomfort with mathematics, they can compensate with their preparation. One male described such instances, in a negative correlation, saying, "The more comfortable I am with a topic the less preparing I will do while the less comfortable the more preparing" (case 4). A female expressed a similar view, "Because I am not comfortable with math I'll be very prepared for math lessons. Because I'm nervous with math, I'd want to be prepared and able to cover all the angles" (case 65). Another female echoed those feelings, "I struggle with math and I think I will have to spend a great deal of time trying to grasp and understand the work in the lesson before teaching it to the class" (case 143). Other responses referred to preparation as a means of creating quality lessons for the students' enjoyment and understanding. One female believes that her,

> Comfort level will help me to effectively teach mathematics to my future students. I am quite comfortable with all aspects of it and enjoy finding new ways to approach problems. I think that having that approach will help me to prepare lessons that will be effective. I will have various approaches prepared to accommodate the many learning styles of students. (case 61)

A very small number of participants indicated that their lack of comfort would actually inhibit their ability to prepare quality lessons. One male said "If I feel I don't fully understand, I have trouble deciding how to plan a lesson" (case 133). While one female stated "if I'm not comfortable I will probably stick completely with the textbook" (case 17). Preparation is a central part of being a teacher as is evident in participants' written responses. The need for preparation is detailed in chapter five.

4.7(b) Comfort level in the classroom.

Participants described their various comfort levels in the classroom. Responses ranged from nervous to very comfortable. Many respondents (18%) described feelings of being uncomfortable teaching mathematics. As one female wrote,

> I feel that I may do more direct teaching with math than any other subject. I may rely on the textbook more often even though I want the lessons to be interesting. I see the potential for math to be interesting/hands-on but I am still nervous to apply it (case 49).

The participant is referring to the 'hands-on' approach her instructor used throughout the J/I mathematics instruction course. Another female believes that her "comfort level will make me a bit uneasy teaching math. I don't want to confuse the students but I would be sometimes uncertain of what I am doing" (case 92). A male wrote, "I am not confident with the new ways of teaching math. I am comfortable with doing math, but I don't know if I can teach it" (case 117). The new ways of teaching that the participants was referring to were those practiced and demonstrated by the instructor for the J/I mathematics instruction course. Despite these cases demonstrating a lack of comfort teaching mathematics, there were a greater number of cases (30%) of participants who do feel comfortable teaching mathematics and they described its effect. One male felt that,

> If I am relaxed, I will be open to suggestion from my students, thus increasing their progress. As well, if I am not nervous, my attention can focus on students (as opposed to my nerves) and I will create a better learning environment. Finally, a high comfort level will instill confidence in the student (case 20).

A female reported that she "already taught math in my placement" and "I felt very comfortable and the students performed well on the unit" (case 100). Another female as well said "to be comfortable teaching mathematics is very important. The students look to the teacher for the answer, not just the answer to questions but answers to their anxiousness" (case 104). Students' answers seem to be of particular importance as evident in the following.

4.7(c) Students Questions.

One phenomenon that arose within the theme of being a teacher related to students asking the teacher questions. For many this was a focal point. One participant sees her comfort level as beneficial when dealing with students questions saying that

> I think because I am comfortable with math, teaching math will be easier for me. I think that when you have the background

> knowledge on what you're teaching you'll be less anxious when students ask questions (case 40).

A female echoed these thoughts saying "because I feel comfortable with mathematics, I think it will positively affect my teaching of it. I will be able to answer students' questions without getting flustered and confused" (case 61). Not all participants feel positive when it comes to students' questions. Many participants seemed unnerved at the thought of student's questions. One female said "when I am not confident I go faster through the lesson, I engage the students less for fear they will challenge me" (case 125). Another female believes that her "students will be affected (by her comfort level) because I won't be able to answer their questions if they are difficult and students will probably not have a chance to work on more difficult, higher level questions" (case 128). The ability to answer students' questions seems particularly important to the sample and is given further attention in the chapter five.

4.7(d) Participants' teaching concerns.

Aside from answering students' questions, participants expressed other concerns with being a mathematics teacher at the J/I level and offered possible resolutions. Many did not have any concerns (31%), saying that they did not have any concerns and perceived no difficulties in teaching mathematics at the J/I level. Participants gave similar responses when discussing a lack of concerns, saying things such as "I don't foresee any difficulties in teaching J/I math" (case 22), "I am pretty confident that math will be the least of my problems while I adjust to teaching" (case24), "no, I don't think it will be difficult" (case 57) and "at this point, no (referring to concerns teaching mathematics at the J/I level)" (case 106). While many did not have any concerns, there was a large number of participants (69%) who do have concerns about teaching mathematics at the J/I level. One female wrote that "some kids just don't understand and its often hard to find the words to explain it so that they do understand" (case 55). Another typical concern was put forth by another female saying, "I'm worried about not understanding a concept myself!!" (case 65). Another concern put forward was "the availability of manipulatives. The overall expense of running hands on activities" (case 21). This concern is grounded in the literature as Richardson and Sherman (1995) stated "Teacher use of manipulatives may be hampered by availability or lack of materials" (p. 35). Some participants found particular mathematics strands to be of concern as well. For example, one participant said "possibly algebra, I found it difficult" (case 33).

Despite the many concerns participants mentioned, they still offered multiple solutions to aid them through their difficulties. Solutions such as, (a)"Teach in ways that can be understood and enjoyed by all ability levels, group work with a mix of ability levels could help also" (case 28), (b)"Having a math mentor" (case 45) was another solution offered, (c) the use of "a lot of games and hand-on activities to help students learn the material" (case 140) was another suggestion by a male, and one female listed several solutions for difficulties encountered in the classroom, such as (d) "giving one on one time for students who need it, encouraging them, have math be fun, not intimidating and practice and research different teaching styles" (case 131). Finally, another suggestion made to counter difficulties in the classroom took a proactive approach by making suggestions to the bachelor of education program saying, "I do feel that covering a broader amount of material would help. More classes would also help. Covering the re-occurring topics throughout the J/I curriculum may be a start", (case 92). Such cases imply changes to the program at the university and are discussed in 4.8. Participants offered many quality solutions to possible difficulties encountered while teaching J/I mathematics. These solutions are discussed in the chapter five.

4.7(e) The Students.

The participants displayed a genuine concern for their future students, focusing on their success and their needs. In referring to the participants comfort and knowledge of the discipline, one participant said, "If I do not know what I am talking about or am a little unsure of some concepts, the students needs will not be met" (case 32). Another participant expressed her concern for the students saying 'hopefully my students will gain confidence in their abilities to do math" (case 58). One participant felt that her ability to relate to the students would serve to help them, saying "I'll probably be able to relate to students who have difficulty with math and I will be able to find alternate teaching methods or accommodations to help these students" (case 99). Another participant felt that she doesn't "like math at all and am concerned with my knowledge about it. I worry that I wouldn't be able to help students understand concepts properly" (case 46). The participants demonstrated a concern for their students' needs and success. These concerns are examined further in chapter five.

4.8 The Program at the University

The program at the University was a natural theme in the participants' responses as three of the eight questions asked directly about the participants' experiences there. The professional year program is comprised of an in-class component of 18 weeks (two 9 week sessions at the beginning of each term) and a practicum component of 10 weeks (two 5 week sessions at the end of each term). The questions that dealt with the program at the university were, *do you feel your comfort level has changed since the beginning of the J/I mathematics instruction course in September 2003? If so, how (please elaborate)?*; *How does the way in which you learned mathematics in school compare to how you are learning mathematics here at Lakehead?;* and *What do you feel is a necessary amount of time to prepare J/I for their work as mathematics instructors? And why?* In the responses that follow, these questions seemed directly affected by the program at the University. Participants reflected on such subjects as their in-class as well as practicum experiences, the curriculum which they studied, attitude transference, and their recommendations to the program.

4.8(a) In Class Experiences and Comfort Level.

Many students (70%) reported that their in-class experiences had an effect on their comfort level. For a small fraction (7%) of the sample, their in-class experiences decreased their level of comfort. One male (case 31) said, "My comfort level with math since September has decreased (at least in this class)". He went on to say "things are not explained well and the atmosphere is generally tense. Not only that, but too few areas in math have been covered" (case 31). A female echoed similar feelings. She (case 36) felt "more confused then when I started out. I was more comfortable when I started." Yet another respondent from that section gave similar comments, saying "I'm more nervous now, I like simple memorized formulas and do not like trying to explain why in many ways" (case 42). This type of concern is not completely uncommon as Norwood (1994) stated in her study that most of the students were not interested in knowing the answer to 'why' in mathematics, they were only concerned with getting the 'right' answer (p. 252). However, these types of cases are infrequent in the sample, with the majority of this fraction coming from one class section. However they are significant for the focus of this study. More participants felt that their in-class experiences did not affect their comfort level. This was the case for one male who wrote, "My comfort level has always been good in math" (case75). Many participants with similar feelings made such replies as, "I feel that my comfort level has not changed, however I have learned some interesting new approaches" (case 20) or when asked if their comfort level has changed simply replied "No" (case125). For the vast majority of participants (63%), their in class experiences aided them to feel more comfortable with mathematics. One female noted in her response that her "comfort level has increased greatly since I started this course, I now understand how to teach math and make it interesting and understandable in a practical way" (case16). Another female said "my comfort level has improved dramatically, I have been shown interesting ways to demonstrate concepts as well as using a cross-curricular component, math doesn't always have to be confusing or overwhelming" (case 28). A male in his late thirties said he is "more comfortable, I now know of more, and simpler ways to explain some principles, postulates and theorems" (case 52). One female who said her comfort level had been increased mentioned that "the slow pace of the course can be dull at times but I understand the concepts discussed and I know how to teach them" (case 1). All of these findings are significant. Their implications are discussed in the chapter five.

A qualitative table was created to examine participants' expressed change in comfort level over the course of their professional year. The following was what was found.

Qualitative Table 2: Degrees of Change in Comfort Level

Comfort Level	Number of Participant that Reported Behavior
Comfort Level Increased Positively High	21
Comfort Level Increased Positively Moderately	42
Comfort Level Increased Positively Low	30
Comfort Level Affected High	-
Comfort Level Affected Moderately	1
Comfort Level Affected Low	1
Comfort Level Has Not Been Affected	40
Comfort Level Increased Negatively High	3
Comfort Level Increased Negatively Moderately	3
Comfort Level Increased Negatively Low	4
Did not answer in a way that transmitted their comfort level with or without any change	4
Total	149

As can be seen in examining qualitative table 2, the majority of participants expressed an increase in comfort level over the course of their professional year with the majority of those participants expressing a moderate degree of positive change in their comfort level.

4.8(b) Practicum Experiences and Comfort Level.

Participants also described their practicum experiences as affecting their comfort level. As one female (case 100) said, "I already taught math in my placement and I felt very comfortable and the students performed well on the unit". Another female commented, "since doing my first placement and teaching a lot of mathematics, I feel comfortable teaching that particular grade level (grade 8)" (case 136). This was the case with another female who echoed the previous statement saying,

> I think my comfort level has gone up, mostly because I taught all the math in my placement, I survived and the class (which had low test scores) mostly passed my unit test, so I felt I'd been successful teaching the class! (case 123).

Practicum experience in teaching mathematics seemed to positively affect the participants' comfort level. This notion is expanded upon in the next chapter.

4.8(c) Mathematics Curriculum within the Program.

Participants reflected on the curriculum within mathematics that they studied during the in-class part of their professional year. Some felt that there was not enough curriculum covered during the mathematics instruction course. A female commented in reference to her confidence that "there are 4 other strands that we neglected and so I don't think I'll be as comfortable" (case 3). Another female felt "that we didn't really cover all that much" (case 9). One female pointed out that "I have not learned a lot about teaching J/I math, but from what we have done, I have learned more of the meaning and the basic principles behind formulas, etc, which I did not learn in school" (case 71). Finally, a female made the comment that "there is so much content to cover! Need more time. I would love to see more strands covered." (case 41). Other participants wrote generally about the curriculum that was studied. One male made the comment that "Throughout the J/I course, I have learned the basics and can build off of them if I need to" (case 82). A female in her early twenties said "we just cover a few topics and it is basically a review" (case 115). Another female wrote that "We're learning how to teach math in a much more practical way. We're being taught how to explain concepts and formulas instead of just asking students to memorize them" (case 48). All of these types of responses have implications for the program which are discussed in the next chapter.

4.8(d) Teacher-Student Interaction within the Program.

Many participants reflected on how the professor affected them within the program. A male wrote that "(the university) has been a good place to learn how to teach math because the teacher provides a good comfort level to the class, whereas in school I always thought my math teacher was too intimidating" (case 75). A female echoed a similar comment, saying "the instructor doesn't intimidate students or make them feel inadequate, he explains things thoroughly" (case 13). Another male felt that the professor "has made me feel comfortable in going into the classroom and teaching" (case 18). The professor and his/her approach seem to have a distinct effect on the students' comfort level in the classroom. This theme is further examined in chapter five.

4.8(e) Participants Suggestions for the Program.

As individuals who have experienced the education program, participants offered their opinion on the program. Participants offered their suggestions to maintain, as well as to change facets of the program based on their needs and experiences. Many respondents (48% as measured by the number of sessions per week participants suggested) felt that the program was effective and should maintain its approach in educating pre-service teachers in J/I mathematics instruction. One female, felt that "one session per week is adequate because that is what is devoted to other subjects and I feel each subject should be equally represented" (case 12). Another female said, "I believe one session a week is adequate time because there is not a lot of time available in a pre-service schedule to fit more. As long as there is a more than adequate professor the one session per week is perfect" (case 104). Others felt overwhelmed by the mathematics curriculum and desired more in-class instruction. As one male suggested, "shorter, daily classes would be better to prepare. A week between classes is too long" (case 81). A female also felt she required "two sessions per week as there is so much to cover and we really need a variety of methods for teaching differing aspects of math" (case 70). One female described the need for more time in J/I mathematics instruction saying "there should be more time spent each week for math instruction. At least three-2 hour sessions per week to cover all aspects of what is expected in math curriculum and new teaching methods and tools" (case 148). Some felt that mathematics is very important and pre-service teachers required more time or more classes because of this. Repeated by several participants were comments similar to, "2 sessions per week, math is too important to be given too little time" (case 52). One female said, "2 sessions per week at least, I think most people need to be reminded how to do most of the J/I concepts unless they are math majors, more time would allow for the teaching of more concepts" (case 28). One female suggested different types of classes saying, "there are some student teachers who love math and have no problems with it and others who struggle and need more instruction, maybe a remedial class, or extra classes available" (case 89). The participants' suggestions will be reflected upon in the discussion and implications in chapter five.

CHAPTER 5

Discussion, Implications and Conclusion

5.1 Discussion

The results of this study support much of the literature on mathematics anxiety and mathematics anxiety remediation and can also aid in structuring pre-service mathematics instruction courses so that they serve as both a treatment for mathematics anxiety and guidance for future teachers who may encounter mathematics anxiety in their classrooms.

5.1(a) The Sample

The sample was taken from the population of J/I pre-service teachers enrolled in their professional year of the education program at an Ontario university. 72.13% of all possible participants enrolled in the J/I program at the university completed the MARS (refer to table 1) and 80.87% answered the open-ended questions. The discrepancy is a result of not all participants completing all aspects of the MARS. Despite missing nearly 28% of possible participants from the J/I program for the quantitative questionnaire and nearly 20% for the qualitative questionnaire, it is noteworthy to mention that of all possible participants only one actually opted not to participate, the others simply were not present in the class at the time that the study was conducted. This may have had an effect on the results, as those who did not attend those classes may have a degree of mathematics anxiety which may have lead them to avoid attending those classes. It should also be mentioned that as the in-class portion of the second semester was coming to a close, participants may have not attended due to other concerns such as completing assignments for deadlines in other classes. These are possible reasons for the 24 possible participants who were absent during those days the study was conducted.

Of the participants, the majority is between 20 and 24 years of age (55.3%), with decreasing numbers of participants as age intervals went up. Despite the participants enrolled in the one year program more than doubling the number of participants enrolled in the concurrent program, 92 to 40 (see Table 1), it seems possible that a significant number of those participants enrolled in the one year program enrolled directly after obtaining their undergraduate degree. This is significant when considering means of predicting mathematics anxiety in participants and will be discussed later on in the chapter.

It is significant to note that the participants in this study scored relatively lower on the MARS than the participants who make up Dr. Suinn's (the creator of the MARS instrument) data (see Table 2). This may point to the sample's treatment they received from the J/I mathematics instruction course and its professor. As reported in the qualitative findings, the majority of the sample examined in this study experienced a decrease in mathematics anxiety over the duration of the J/I mathematics instruction course. Furthermore, aspects of that course were credited by participants as negatively affecting their degree of mathematics anxiety. That is to say, aspects of that course aided to lower many participants' levels of mathematics anxiety. Battista (1986) made a similar interpretation in his findings saying, "The higher a pre-service teacher's initial level of mathematics anxiety, the greater the reduction in anxiety during a methods course" (p. 17) Given that knowledge, it is important to examine the qualitative data for any explanations as to what aided to lower participants' mathematics anxiety. Such an examination of the qualitative data was done and the results of which are accounted for in the qualitative report while their significance is discussed later on in this chapter. Discovering predictors of mathematics anxiety, as well as means of remediation was the purpose of this study and what was found is discussed below.

5.1(b) Class Section

In table 2 the mean MARS scores for each section are shown to be relatively close. Class sections were not found to be an influencing factor on MARS scores - as demonstrated in the One Way ANOVA test in Table 3 ($p > 0.05$). This is a significant finding as it may demonstrate that participants in all class sections probably endured similar experiences and received similar treatment from the professor of the mathematics instruction course. Thus any changes in participants' mathematics anxiety over the duration of the mathematics instruction course were most likely not the result of different treatments. All participants were subject to a similar treatment, from the same professor. With this understanding, narrowing down what factors were involved in the reduction of the participants' mathematics anxiety and the increase in their comfort level is needed.

5.1(c) Age

The age of the participants may or may not point to an influencing factor for MARS scores. The sample was dominated by participants aged 20 to 24 years of age who accounted for over half of the complete sample (see Table 4). While Table 5 demonstrates a comparison between age and MARS score, the difference may be accounted for by the discrepancy between numbers of participants represented in each of the age intervals. There were 73 participants aged 20 to 24, 35 participants aged 25 to 29, 12 participants that were aged 30 to 34, and only 6 participants each in the 35 to 39, as well as the 40 and over age interval. The findings in this study contradict those of Hadfeild and McNeil (1994) who found that "older students tended to have higher levels of math anxiety" (p. 380). In this study, older students had the increasingly lowest mean MARS scores, despite making such comments as one male in his late thirties did, when he said "It has been a long time since I took any mathematics courses" (case73). The one way ANOVA test for MARS scores for the age intervals (see Table 6) indicates that there does not appear to be a significant difference between the two factors ($p > 0.05$). However, when looking at figure 1 it would appear that age has an effect on MARS scores. In examining figure 1 it appears that as participants age, mathematics anxiety decreases. Although this contradicts the literature (Betz, 1978, p. 447), it does seem plausible as many of the questions in the MARS refer to common, everyday applications of mathematics such as "Playing cards where numbers are involved, like poker or blackjack" (question 60 in appendix C) or "Reading a novel with many dates in it" (question 20 in appendix C). These applications of mathematics, for participants that are older, would be more likely to have been encountered more often, making them possibly more familiar with them and thus less anxious about them, as opposed to younger participants who may not have encountered such situations as frequently.

5.1(d) Program Predictor

All participants were in their professional year in the faculty of education but came from two possible programs, the one-year program or the concurrent program. The number of participants in the one-year program more than doubled the number of participants enrolled in the concurrent program, 92 versus 40. As can be seen in Table 7 of chapter 4, there does not appear to be much difference between programs enrolled in and mean MARS scores. However, when examining table 8 in chapter 4, one can see that through the independent sample t-test, a sig. value of 0.032 was found which indicates that program is a significant predictor for MARS score. Furthermore, it appears as though participants in the concurrent program suffered more from mathematics anxiety than their counterparts enrolled in the one year program. This seems odd in light of several participants, enrolled in the concurrent program, responses regarding a particular mathematics course (case 33) during their first year of university. All the participants who mentioned this course did so in a positive light, making comments that it helped them to prepare to teach mathematics. Program may be a significant factor for predicting MARS scores. However, the responses made regarding previous courses would make it appear as though the program is less of a significant predictor than mathematics experience. Some participants in the concurrent program had taken previous mathematics courses and this may be a more significant indicator of reduced mathematics anxiety than the program enrolled in itself. Participants in the one year program did not mention previous courses. However, this may have been a factor for them as well. Lussier (1996) confirms the assertion that the stronger the background in mathematics, the lower that individual's mathematics anxiety score will be. In Lussier's study, "subjects with high backgrounds reported significantly higher scores, reflective of less anxiety about mathematics than those with low backgrounds" (p. 830). This finding may also be significant for age and mathematics anxiety. As mentioned previously, participants who are older may have a stronger background in the common applications of mathematics and thus score less anxious on such questions. Background in mathematics appears to be a significant factor for predicting mathematics anxiety or the lack thereof.

5.1(e) Gender

Throughout much of the literature on mathematics anxiety and gender, females have been found to have greater anxiety than males (Casey, Nuttall & Pezaris, 1997, p. 674; Felson & Trudeau, 1991, p. 120; Flessati & Jamieson, 1991, p. 311). This study proved to have similar findings. However, the difference was very small (refer to table 8) and may point to what Fennema, Hyde and Lamon found in 1990, that "the magnitude of gender differences has declined over the past three decades" (p. 149). In this study males and females were found to differ only minimally with regards to mean MARS score (see Table 11 and 12), thus not a very significant factor for predicting mathematics anxiety. Houghton and Zettle (1998) also had similar findings noting that "while female participants reported slightly higher levels of math anxiety as assessed by the MARS, this difference was not statistically significant as had been expected" (p. 83). This may also be attributed to the decline in gender differences. Female participants in this study more than doubled the males (see Table 9), which may have had an influence on their overall MARS mean. When considering the data in figure 2, one can see that five participants scored significantly higher on the MARS than the rest of the female sample. This clearly affects the overall female mean and may have had an effect on Table 10 in chapter 4, which illustrates the percentiles of each sex with regards to MARS scores. With an equal male representation gender may be found to be even less of a predictor for mathematics anxiety within the sample. While this data moderately supports the literature that says females have greater tendencies towards mathematics anxiety, it does not illuminate any new findings on the matter. The only possible implication of the data may be that if genders were equally represented then differences in MARS scores may be proven to be insignificant more so than they already are and thus possibly suggest that with treatment for mathematics anxiety, gender differences may cease to exist, although more research would have to be conducted to affirm this statement.

5.1(f) Teaching Orientation

As illustrated in Table 14, there is a significant difference between the teachables and their MARS scores. However, like much of the other data, this may be accounted for by the lack of equal representation of participants that listed their teachables (see Table 13). This becomes much more plausible when figure 3 is examined. In examining figure 3, what may have been expected from each of the teachables holds true. With the exception of the outlier, Law (with only one representation), those with mathematics as their teachables had the lowest mean MARS score. Second were those who had science teachables, third were those with physical education teachables. Mathematics and science backgrounds are commonly understood to employ the use of mathematics extensively and thus those with such backgrounds would be more familiar with mathematics and thus less anxious regarding mathematics. Those with physical education as their teachable may have scored so low as kinesiology, the discipline in which physical education teachers often have their degrees, employs the use of mathematics. Thus they would be more familiar with mathematics. The three teachables that had the highest mean MARS scores from lowest to highest were art (notably an outlier with only one representative), music and then French. All of the aforementioned could have been preconceived as having high MARS scores due to the lack of mathematics needs in those disciplines. Teachables is another area in which mathematics background can be implied. On the mean, those participants with teachables in fields that required the use of mathematics in their undergraduate degrees scored lower (signifying less mathematics anxiety) than those that did not come from such a background. This may be because they are more familiar and thus more comfortable with mathematics.

5.1(g) Comfort

Throughout the qualitative data, participants' level of comfort was discussed extensively. Respondents related their feelings of comfort to their preparation in teaching J/I mathematics, their level of stress, and their students' needs. Some participants felt that their level of comfort would affect not only their preparation, but also their teaching of mathematics as well. It follows that a teacher who is less comfortable with his or her preparation for a class will in turn be less comfortable teaching the students. The participants related their level of comfort to their knowledge of mathematics. Many expressed that they would need to do a lot of preparation and review in order to understand the mathematics material they will be teaching. This has implications for the pre-service program since the pre-service program has been identified to affect mathematics anxiety (and thus comfort) as well as participants' knowledge of the mathematics curriculum. It is important for future teachers to have a suitable degree of knowledge within the disciplines they will be teaching. Having that knowledge has been identified in participants' responses to affect their comfort level when teaching. Future teachers comfort level to teach a discipline is regarded as important by the participants as students needs will not be met if teachers are not comfortable with what they are teaching. Furthermore, it was a common belief among participants that their own comfort level would transfer to the students they teach. As Munday, Swetnam and Windham (1993) put forth, teachers can pass on positive or negative attitudes which can affect students' motivation to learn (p. 421). This makes it imperative for teachers to have very low or no anxiety towards mathematics in order to end the cycle of mathematics anxious teachers creating mathematics anxious students.

5.1(h) The Program

The education program and specifically the professional year program have been identified to be instrumental tools in eliciting a change in comfort in the participants of this study. Those with stronger backgrounds in mathematics, whether that be an undergraduate program with required courses involving the use of mathematics, or any other type of background where the use mathematics was needed or endured, displayed lower levels of mathematics anxiety. With this knowledge in mind, concurrent programs may consider increasing the number of required mathematics courses prior to the student's professional year. Furthermore, it may be suggested that the requirements for application to the one year program at the Faculty of Education should involve a greater degree of mathematics background than is required at present. Requiring pre-service teachers to have a greater background in mathematics may ensure that less mathematically anxious teachers both enter their professional year and eventually enter the profession. Aside from altering requirements prior to the professional year, there are significant factors that should be noted that the participants of the study reflected on that aided in decreasing their level of mathematics anxiety. In reflecting on their past, the vast majority of participants expressed a preference for the way in which they were taught mathematics during their professional year in the J/I mathematics instruction course as opposed to the way in which they were taught previously, citing a distinct difference. This being said, the most notable difference between the two was that in the J/I mathematics instruction course there was a de-emphasis on rote learning. The use of manipulatives was emphasized through practice and in theory. Participants reflected on hands-on activities that were enjoyable and made the learning fun. The participants also reflected on the atmosphere within the classroom describing it as light and not stressful. Newstead (1998) made the point that "it can be expected that such an approach which includes a more personal process-oriented teaching method emphasizing understanding rather than drill and practice will reduce anxiety" (p. 55). Participants described past mathematics instruction classes and courses as a stressful experience. Participants also made note of how the mathematics instruction was made much more relevant during their J/I mathematics instruction course. This helped to make math less abstract and more relevant to daily life. These types of descriptions should be noted as they were a factor in decreasing participants' levels of mathematics anxiety. Furthermore, a large amount of participants made the suggestion that they would recommend and would have liked to receive more frequent mathematics instruction classes, citing the vast curriculum and preparation for teaching of that discipline as reasons for doing so. It follows that if pre-service teachers have already experienced a decrease in their levels of mathematics anxiety (as illustrated in qualitative Table 2 in chapter 4) and are calling for an increase in their required in-class mathematics instruction, then doing so may aid to eliminate cases of mathematics anxiety or decrease them to levels that are insignificant. The methods in which the J/I mathematics instruction course were taught, not only serve as directions for teaching pre-service teachers, but also as directions for elementary and intermediate school children as well. If pre-service teachers can experience their mathematics anxiety decreased in part by what was described, then it is possible that the onset of mathematics anxiety can be offset or nullified if teaching practices follow such methods as guidelines. Those methods which were demonstrated by the professor of the J/I mathematics instruction course and are outlined in the NCTM (2000).

5.1(i) Lifelong Learning

Participants spoke of an atmosphere of lifelong learning in their reflections and beliefs about teaching mathematics. Suggestions involved the use of professional days as time for their own mathematics education, as well as courses that teachers could take in order to maintain and ameliorate their ability to teach mathematics in a meaningful manner to J/I students. While professional days are often devoted to ameliorating the profession of teaching, these direct calls to mathematics instruction describe a need. Implementing such suggestions would not only benefit those teachers just beginning their careers and just becoming familiar with the mathematics curriculum but they would also benefit those in-service teachers who have been teaching for years and are not comfortable to teach in another fashion other than the traditional rote teaching style. Continuous education for all disciplines can only benefit the profession. However, continuous education for a discipline in which recognized anxieties exist can also aid to decrease those anxieties and allow teachers to teach in a more meaningful manner for both student and teacher.

5.2 Implications

The present study has many implications for educating future and in-service teachers. These were discussed (in the discussion section). Suggestions for further research and research practice have evolved out of analyzing the data.

5.2(a) Implications for Further Research

Another suggestion for further research would be a study involving a pre-treatment test involving the MARS and post-treatment test using the MARS. Although the qualitative data suggests that the J/I mathematics instruction course and its professor did serve as a means of remediation for mathematics anxiety, more specific data could be obtained from a pre and post-test using the MARS accompanied by an open-ended questionnaire to further illuminate the experiences of the participants that decreased their mathematics anxiety.

A suggestion that comes out of the use of qualitative data is that it would be beneficial to conduct an in-depth qualitative study that follows a small number of J/I pre-service teachers over the course of their professional year. This would further examine their anxieties as well as that which aided to decrease their anxieties.

5.2(b) Implications for Research Practice

One of the most obvious suggestions when measuring mathematics anxiety in pre-service teachers, would be to account for past experience with regards to university courses taken that involve the use or study of mathematics, experience during work that dealt with the use of mathematics, and high school mathematics courses taken. These may be strong predictors for mathematics anxiety in J/I pre-service teachers as mathematics experience has been a predictor for mathematics anxiety in other studies.

On a similar note, asking participants to describe the length of time between their last university course and their professional year in the faculty of education would be significant. This would determine if time away from schooling is a factor in determining mathematics anxiety, as those who were older in this study displayed a lower mean MARS score than those that were younger.

One difficulty that disrupted evaluating the data from the MARS instrument was the lack of equal representation from the different groups that participated. These were gender, pre-service teachers' teachables, programs enrolled in and age groups. If these population descriptors could be controlled then it would increase the validity of the results. Conducting a similar study on a larger scale, such as province-wide, may dissolve these discrepancies.

An implication for further research that evolved out of the use of age intervals was that it may be more significant to have participants list their actual age and then analyze the data from those or group them into smaller age intervals. The use of five year age intervals may have been too large.

5.3 Conclusion

Mathematics anxiety continues to persist throughout the teaching profession. It seems to be perpetuated by teachers who are anxious towards mathematics inadvertently inflicting it onto their students. It is a cycle of students who become anxious towards mathematics through their schooling, continuing on and becoming teachers who are anxious towards mathematics and pass on that anxiety to their students.

With such an influence, it is important for teachers not to pass on their anxieties to students. Teachers can relieve their mathematics anxiety by increasing their comfort with mathematics. This is why the pre-service programs offered in faculties of education have and should continue to make the relief of mathematics anxiety a priority.

The results of this study illustrate that measures are being taken to alleviate mathematics anxiety. However, more can be offered to extinguish this problem. The findings of this study identify areas for improvement as seen through both the quantitative data and the qualitative data. These improvements are not drastic changes to what is already in place but simple revisions that will guide future teachers towards a less stressful and more enjoyable teaching career in teaching mathematics. For teachers at the primary, junior and intermediate levels, such ameliorations to their programs are especially beneficial as they will likely have to teach mathematics at some point during or possibly throughout their careers.

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Appendices

Appendix A

Cover Letter

You have been asked to participate in a master's thesis. Your participation is strictly voluntary. The following is a questionnaire that probes students' feelings towards mathematics. It is aimed at gauging students' perceptions of mathematics, of teaching and learning mathematics and also their perceptions of the J/I program.

- All questionnaires that are filled out are completely confidential.
- No information will be used to identify the participants of this study other than to recognize them as J/I students in the 1 year Bed program and final year students of the concurrent education program.
- The results as well as the questionnaires will be kept on file in the faculty of education at Lakehead University for any verification needed.

The results will also appear in the thesis report to be completed by Matthew Koeslag. You are not obliged in any manner to fill out the questionnaire or continue once you have begun if you find any situation uncomfortable. Filling out this questionnaire will in no way affect your marks or relationship with the professor conducting the J/I math course. Your responses are greatly appreciated!

Thank you for your time and effort,

Matthew Koeslag
Master's of Education Graduate Student
Lakehead University

Dr. Medhat Rahim
Thesis Supervisor

Appendix B

Consent Form

I, ________________________________ (please print your first and last name) a pre-service student in the faculty of education at Lakehead University have read and understand the cover letter for the study on pre-service teachers' feelings toward mathematics and agree to complete the questionnaire and participate in the study.

I am aware that I am not obliged to complete the questionnaire and may withdraw my participation at any time.

I understand that completing the questionnaire will in no way affect my standing in the J/I mathematics course that I am taking.

I am aware that there are no perceived risks in participating in this study.

____ ____________________

Participants Signature Date

Appendix C

Appendix D

Questions :

1. How do you feel your comfort level with mathematics will affect your preparation for math lessons?
2. How do you feel your comfort level with mathematics will affect your teaching of mathematics?
3. How do you feel your comfort level with mathematics will affect the students you teach?
4. Do you feel your comfort level has changed since the beginning of the J/I Mathematics Instruction course (in September, 2003)? If so, how (Please elaborate)?
5. How does the way you learned mathematics in school compare to how you are learning to teach mathematics here at Lakehead?
6. What do you feel is a necessary amount of time to prepare J/I teachers for their work as mathematics instructors? (one session per week; two sessions per week, etc…) And why?
7. Can you perceive any possible difficulties with teaching mathematics at the J/I level? If so, what are they?
8. If you answered yes to #7, in your opinion what are some possible solutions to those difficulties?

Appendix E