The Role of Math Experiences and Personality Traits in Math Anxiety

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A dissertation submitted to the School of Graduate Studies in partial fulfillment of the requirements for the degree of

Doctorate of Psychology, Department of Psychology, Faculty of Science

Memorial University of Newfoundland

May 2014

St. John's, Newfoundland and Labrador

Abstract

Math anxiety has been defined by Richardson and Suinn (1972) as “unpleasant feelings, specifically, those of tension and anxiety that impede an individual’s ability to manipulate numbers and solve math problems in a variety of situations (pg. 551).” Although previous research has investigated the situational factors (e.g., language and symbols used in math) of math anxiety, little research has examined dispositional and environmental factors. The current study assessed both dispositional (i.e., the Big Five Personality traits) and environmental factors (i.e., different kinds of math experiences) associated with math anxiety. A total of 131 undergraduate students (34 males and 96 females; *Mage* = 20.81) completed paper and pencil measures of math anxiety, a personality measure of the Big Five Personality traits, a new measure specifically designed to explore different kinds of math experiences, and measures of general anxiety and test anxiety. Results showed a significant positive relationship between math anxiety and neuroticism, but this relationship became non-significant after controlling for general anxiety and test anxiety. Environmental factors including support in high school, the manner by which math is taught (e.g., giving students plenty of examples), and doing well at math (e.g., having good marks in math) were significantly related to the level of math anxiety experienced by students even after controlling for general and test anxiety. The implications of these findings for better understanding which individuals may be at risk for developing math anxiety are discussed, in addition to the creation of programs and tutorials to decrease math anxiety.

Acknowledgements

Many people offered me their time, guidance, and assistance while I was writing this dissertation and for that I am forever grateful. At this time I would like to extend to them my sincere thanks. My deepest gratitude to Dr. Darcy Hallett for his encouragement, guidance, support, and knowledge, all of which were of great value to the development and completion of this dissertation. Many thanks go to Dr. Sarah Francis and Dr. Jackie Hesson for their invaluable feedback and suggestions. Sincere thanks to Cheryl Fitzpatrick for her assistance in data collection, analysis, and coding. A special thank you to the members of the Research Center for the Development of Mathematical Cognition for their generous feedback and support throughout this process. I would like to thank five special ladies for their continued support, encouragement and friendship over the last four years (*you know who you are*). Thank you to my family and friends who dealt with my complaints and frustrations throughout this process, for never leaving my side, and continually encouraging and supporting my development. The biggest thanks go to my parents who always supported and encouraged me throughout my academic career. Without the guidance and support of all of you, this would not have been possible.

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The Role of Math Experiences and Personality Traits in Math Anxiety

At an early age, almost every individual begins to learn how to count. As we mature and enter school, we begin to learn how these numbers can be manipulated to create what is recognized as math. Math is a subject that is taught from kindergarten to university, and is an important component of our daily tasks (Baloglu & Kocak, 2006). Distinguishing itself from other skills (e.g., language), math is a complex skill that must be taught and cannot be learned from one's environment (Ashcraft & Krause, 2007). Research pertaining to skill development and strategies to improve learning and performance, particularly with respect to math skills, has been growing in response to the 21st century's rapidly evolving technological world. Math skills are essential for increasing individuals' participation in society and their success in everyday life (Maloney, Risko, Ansari, & Fugelsang, 2010). The development of math skills is also critical to ensure continued advancements in science and technology.

Despite its significance for individuals and society, some individuals love math while others despise it. In fact, it is common in today's society to encounter individuals who have a fear of math and numbers. These individuals have what is commonly referred to as math anxiety. Math anxiety is a negative response experienced by some individuals when they are faced with numbers, math, and calculations (Ashcraft & Moore, 2009). Richardson and Suinn (1972) defined math anxiety as "unpleasant feelings, specifically, those of tension and anxiety that impede an individual's ability to manipulate numbers and solve math problems in a variety of situations (pg. 551)." These situations range from those in a classroom setting to those encountered in everyday life (Ashcraft & Moore,

2009). Although the prevalence and incidence of math anxiety is unclear in the literature, anecdotally it appears to be quite common in today's society.

Factors that have been shown to be associated with math anxiety can be grouped into three broad categories, namely: situational, dispositional, and environmental (Baloglu & Kocak, 2006; Byrd, 1982). Situational factors are defined as those that are directly associated with math (Fitzgerald, 1997) including the construct itself (in this case math) as well as variables surrounding the construct (Byrd, 1982). Examples include the language and symbols used in math, the idea that math skills are built upon, and the instructional methods (e.g., rigidity and having only one correct answer). Dispositional factors are personality factors that make an individual more likely to experience math anxiety and can be considered a vulnerability to math anxiety (Baloglu & Kocak, 2006). Finally, environmental factors consist of an individual's previous experiences with and perceptions of math (Baloglu & Kocak, 2006).

Although all of these factors contribute to math anxiety, most research focuses on situational factors while very little attention has been paid to dispositional and environmental factors. The current study will address this gap by contributing toward a better understanding of the dispositional and environmental factors that impact math anxiety. This in turn, will help better identify those individuals who are at most risk of developing math anxiety. In addition, this will inform the development of strategies that could potentially alleviate math anxiety. Although there are many factors that could be considered dispositional (e.g., self-esteem and confidence), the current study will explore the potential relationships between the Big Five Personality traits (neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness) and math

anxiety. Personality factors were chosen as no other research has examined this variable and its potential relationship to math anxiety. Additionally, the current study focuses on the influence of certain kinds of math experiences with math anxiety. This approach necessitated the development of a questionnaire that assessed many different kinds of math experiences. This new questionnaire is a first step in investigating the types of earlier experiences that are associated with later math anxiety.

Prior to turning to the study itself the remainder of this section reviews further background information to help set a context for the current study, while also providing a framework for the understanding of math anxiety. This includes an overview of the literature pertaining to general anxiety, math anxiety, and the limited research regarding dispositional and environmental factors.

General Anxiety

Anxiety is described as "uneasiness, worry, or tension we experience when we expect a threat to our security" (Wagner, 2005; pg. 23). It has three main components namely: cognitive, physiological, and behavioral. The cognitive components are negative thoughts that individuals have about a situation which cause them to worry (Wagner, 2005), the physiological components are the body's reaction to the anxiety-provoking stimuli (e.g., stomach aches, headaches, increased heart rate), and the behavioral components are an individual's reactions to the anxiety-provoking stimuli (e.g. crying, avoidance, poor concentration; Wagner, 2005). The relationship between these components is considered bidirectional, and these components interact with one another to increase anxiety. This may be experienced and expressed by different individuals in various different ways.

Anxious reactions are categorized on a continuum from high to low (Wagner, 2005), with anxiety at both high and low levels being considered maladaptive. High anxiety leads individuals to constantly assess for dangerous situations, causing tension within the individual (Wagner, 2005). There are two major consequences of high anxiety, namely, avoidance of situations that create anxiety and the constant state of worry (Suarez et al., 2009). Furthermore, those who experience anxiety tend to shift their attention onto themselves and their perceived character flaws, while also underestimating their own ability to deal with perceived threatening situations (Suarez et al., 2009). This shift in focus may reinforce negative beliefs by disrupting concentration and performance (Suarez et al., 2009). In comparison, individuals who experience low anxiety tend to be careless and irresponsible as they are not fearful of dangerous situations (Wagner, 2005).

Given the negative implications of anxiety, it is not surprising that research has been carried out to help identify its development and causes. Early research focused on the "Trait and State" model of anxiety proposed by Speilberger (1972; as cited in Isiksal, Curran, Koc Gary & Askun, 2009). Following this model, some expressions of anxiety were thought to be associated with individual "traits" (i.e., personality characteristics and/or differences) that increased an individual's vulnerability to anxiety. Alternatively, other expressions of anxiety were thought to be associated with specific "states" or situations where individuals believe they are facing a dangerous situation causing arousal of the autonomic nervous system and a negative emotional reaction (Isiksal et al., 2009). Research on anxiety has continued to evolve with an increased focus on the impacts and interaction of multiple variables associated with anxiety.

Building on previous research, Barlow (2002) proposed “The Triple Vulnerability Model” of anxiety that incorporates research from a variety of different fields (e.g., cognitive, behavioural, biological, and emotional). This model intended to build a comprehensive theory of the development of anxiety and emotional disorders (Farach & Mennin, 2007). Barlow’s model suggests that the development of anxiety is attributed to an interaction between: (1) a genetic vulnerability; (2) a generalized psychological vulnerability; and (3) a specific psychological vulnerability.

A genetic vulnerability, the first component of Barlow’s model, refers to the idea that individuals’ genetics has a significant impact on their personality traits and temperament, which in turn could be predictors of the development of anxiety (Suarez et al., 2009). To support this assumption, research has been conducted to examine the potential relationship between personality traits, temperament, and anxiety. In particular, this research focused on factors such as an individual's level of cortical arousal and autonomic nervous system reactivity (Eyseneck, 1981 as cited in Suarez et al., 2009); behavioral inhibition, behavioral approach systems, and the flight and fight response (Gray & McNaugton, 1996); and levels of neuroticism/negative affect, and extraversion/positive affect (Clark &Watson, 1991).

Relatedly, research has shown particular traits associated with anxiety that are common in families and have their basis in genetics. Studies have also demonstrated that specific traits, including neuroticism, negative affect, and behavioral inhibition, all contribute to an individual’s vulnerability to develop anxiety (Barlow, 2000). More specifically this research has shown that having a high level of neuroticism and a low level of extraversion places an individual at risk for developing anxiety and other related

disorders (Gershauns & Shere, 1998). However, having a genetic predisposition towards anxiety does not appear to be sufficient to cause a person to develop anxiety (Barlow, 2002).

The second component of the triple vulnerability model is referred to as generalized psychological vulnerability and a diminished sense of control. This component is based on the notion that an individual's sense of unpredictability and lack of control in different situations significantly contributes to anxiety. These variables are associated with negative cognitions and physiological arousal (Suarez et al., 2009). However, there are individuals who attribute this lack of control to transitory external or internal states. These individuals appear to have developed "an illusion of control" (Barlow, 2002). For example, researchers have studied this phenomenon in animals whereby results suggest the development of anxiety and depression in these animals was associated with the predictability and controllability of specific life events such as obtaining food and escaping from pain (Mineka, & Kihlstrom, 1978). Animals were able to endure these events if they had some control over them. Research has also shown the importance of parenting styles in the development of a sense of control in humans. A study conducted by Chorpita, Brown, and Barlow (1998) found that individuals were at an increased risk of developing anxiety disorders if their family environment hindered their ability to develop a sense of personal control. Research suggests that a sense of control is cultivated in children whose parents are responsive in a reliable manner and who allow their children to discover their environment, providing opportunities for learning skills to cope with unpredictable events in a way that is not overbearing or over protective promotes a sense of control (Barlow, 2002).

The third and final component of Barlow's Triple Vulnerability Model is specific psychological vulnerability, which represents an individual's early life experiences. Suarez et al. (2009) indicates that there are three ways in which this vulnerability can develop. First, an individual may develop anxiety after being exposed to an event that was dangerous and caused discomfort; second, an individual may experience a false alarm in a situation which results in the development of anxiety; and last, an individual may have observed another's reaction to a situation or have been told that a situation or object is dangerous.

Barlow's Triple Vulnerability Model reinforces the idea that anxiety is quite a complex construct. Not only is it comprised of a number of components and explained by a number of theories, it also occurs in a number of different situations and settings. In an academic setting there are two situations in particular where anxiety seems to be common: 1) general testing situations, where the resulting anxiety is referred to as test anxiety, and 2) specific situations involving math, where the resulting anxiety is identified as math anxiety (Hembree, 1990). It is only recently that researchers have begun taking an in-depth look at math anxiety as a construct, considering both its causes and consequences.

Math Anxiety

Math anxiety is defined as "unpleasant feelings, specifically, those of tension and anxiety that impede an individual's ability to manipulate numbers and solve math problems in a variety of situations" (pg. 551; Richardson and Suinn, 1972). Although the definition of math anxiety appears straightforward, it can be difficult to distinguish from the related concepts academic (e.g., math) self-concept and math self-efficacy. Academic

self-concept has been defined as “an individual’s knowledge and perception about themselves in academic situations” (pg. 499) and is dependent on self-comparison to others (Wigfield & Karpathian, 1991, as cited in Ferla, Valcke, & Cai, 2009). On the other hand academic self-efficacy has been defined as individuals’ levels of confidence that they are able to effectively complete assigned tasks at the level expected or their sense of being effective in a given situation (Schunk, 1991). Based on these definitions it appears plausible that math anxiety is highly related to and likely inseparable from academic (e.g., math) self-concept and self-efficacy. However, research suggests that these are in fact three distinct constructs (Ferla et al., 2009; Lee, 2009)

Ferla and colleagues (2009) found that while math anxiety, math self-concept, and math self-efficacy were correlated with one another (i.e., math anxiety and math self-concept r = -.65, math anxiety and math self efficacy r = -.24; math self-concept and math self-efficacy r = .37), however, their relationship with other variables differed. Math self-concept was found to be more strongly related to math anxiety, general motivation, and emotions towards math. Comparatively, math self-efficacy was more strongly related to math performance. In another study, Lee (2009) conducted a cross-national comparison of 41 countries to explore the relationship of these three concepts. After completing both exploratory and confirmatory factor analysis, a three-factor model composed of math self-concept, math self-efficacy, and math anxiety emerged. Results were consistent with those found by Ferla and his colleagues (2009).

As noted previously, many researchers assume that math anxiety and general anxiety are comprised of similar constructs. As such, they have used theories of general anxiety to further understand the cause and development of math anxiety. Most of this

research has focused on the “State and Trait” model of anxiety, with most assessing math as a type of “state” anxiety. This research is founded on the belief that math anxiety is a type of state anxiety that manifests itself in situations where individuals come in contact with math (Brady & Bowd, 2005). These situations range from those found in the classroom to those encountered in everyday life (Ashcraft & Moore, 2009). Classroom situations are those that evoke feelings of tension and anxiety and can involve testing, answering questions aloud, or the mere thought of having to do a math problem. Examples of everyday life situations that could bring about those same feelings are trying to calculate a 15% tip on a restaurant bill or calculating the sum of purchases at a store to avoid being overcharged.

Based on previous literature (Ashcraft & Moore, 2009; Brady & Bowd, 2005) it appears as though math anxiety has been thought of as a type of state anxiety. For math-anxious individuals, situations involving math can create an anxious response in an individual’s body (i.e., increased heart rate). For these individuals this response seems to only occur in situations that involve math (i.e., is associated with a particular time and situation). However, there is a gap within the literature regarding personality variables or the impact of “traits” and their potential influence on math anxiety. As such, the potential influence of a personality factor increasing an individual’s vulnerability to math anxiety is being disregarded. Given related research and findings regarding general anxiety (Clark &Watson, 1991; Gershauns & Shere, 1998), it is possible that there is a specific personality characteristic that renders an individual more vulnerable to math anxiety when placed in situations involving math.

Variations in response to math anxiety have also led researchers to question whether math anxiety was composed of multiple components or subconstructs (Wigfield & Meece, 1988). Similar to general anxiety, reactions to math anxiety fall on a continuum, ranging from mild to quite severe. One person might experience little to no reaction in situations involving math, whereas others may experience strong reactions (e.g., crying; Ashcraft & Moore, 2009). The nature of these reactions also varies (e.g., crying when doing simple addition, negative attitude about math, avoidance of math, and possible cognitive biases). Wigfield and Meece (1988) conducted a longitudinal study assessing beliefs, attitudes, and values about math, in sixth through twelfth grade students. They suggested that math anxiety could be divided into two components, namely, a cognitive component and an affective component. The cognitive component involved worry specific to the math task and doing well in addition to self-defeating thoughts about one's ability to perform to one's own expectation (Wigfield & Meece, 1988). The affective component was associated with an individual's emotions, such as feelings of nervousness or negative physiological reactions (i.e. heart racing, sweating) to situations involving math (Wigfield & Meece, 1988). Results of their study suggested that the cognitive component had a strong positive relationship with the importance children place on math, as well as the effort they used in learning math (Wigfield & Mecee, 1988). They also found that the affective component of math anxiety had a strong negative correlation with children's abilities, perceptions, and math performance. In general, individuals who experience high levels of math anxiety take fewer math courses (i.e., avoid math), tend to do poorly in math, have negative attitudes about math, and have distorted negative perceptions of their own math ability (Ashcraft, 2002).

Although slightly dated, Hembree's (1990) 151-study meta-analysis of the literature regarding math anxiety provides a good summary of the literature. This research suggests that individuals who have higher levels of math anxiety have lower math performance, avoid math, take fewer math courses in high school, and show less of a desire and intention to take more math courses in high school and college. It also indicated that individuals who showed positive attitudes toward math had lower math anxiety compared to those who held negative attitudes. Finally, math anxiety was found to be related to both general and test anxiety.

Hembree (1990) also examined the various different treatment studies that attempted to lessen math anxiety. These results suggested that systematic desensitization, in addition to anxiety management training, appeared to be the most successful form of treatment to reduce math anxiety. In contrast, studies that focused on learning math in different ways were ineffective. Congruently, Maloney and Beilock (2012) suggest that the management and treatment of anxiety, by the use of expressive writing and re-framing techniques, have a positive effect on math performance, indicating that when an individual's negative affective and cognitive reactions to math are controlled, an improvement in math performance can be observed. Research in the field of test anxiety has seen an improvement from a B^- to B^+ when individuals have used expressive writing to help control their worries (Ramirez & Beilock, 2011). Similar results have been found with regards to math anxiety (Maloney & Beilock, 2012). Hembree's study did not provide a review of the development of math anxiety nor when it may first be apparent in individuals.

Research regarding the development and continuation of math anxiety is important, as math skills are learned and built upon. Researchers once believed that math anxiety was solely associated with higher-order and more difficult math-related skills (Maloney & Beilock, 2012). Moreover, a commonly held belief was that math anxiety did not appear prior to Junior High School (Ashcraft, 2007). However, research indicates that approximately 16% of individuals report their first negative math experience to have occurred during grades three and four (Jackson, & Leffingwell, 1999). Gierl and Bisanz (1995) conducted a study assessing the development of math anxiety in elementary students, specifically those in grades three and six. Their results indicated that as children got older and moved forward in school, their level of math test anxiety increased. At the same time, older students had more positive attitudes about math than younger students. These findings hold significant implications for future research on math anxiety. Previous research discounted the development of math anxiety and its possible impact on younger children. However, Zakaria and Nordin (2008) suggest that individuals may begin to assess new math situations throughout their education in terms of past negative math experiences. Moreover, these experiences may extend back much earlier in an individual's academic career than commonly believed. Research pertaining to the development and continuation of math anxiety must begin to include a focus on individuals' early learning experiences of basic math skills in elementary school and throughout their academic life. The current study will help address this gap and further our understanding of math anxiety as a persistent or transient subtype of anxiety by assessing math retrospectively during different educational periods.

Research regarding math anxiety has also considered the possibility of a gender difference. This research suggests that when gender differences in math anxiety are apparent they are relatively small, and typically indicate that females may experience higher math anxiety than males (Betz, 1978; Dew, Galassi, & Galassi, 1983). In addition, a small gender difference was found between female attitudes towards math and male attitudes towards math, with females showing a more negative attitude towards the subject (Hyde, Fennema, Ryan, Frost, & Hopp, 1990). However, some researchers have argued that there is a societal belief that math is a male-dominated subject, and as such, females are not encouraged to gain better skills and understanding in this area of study (Singer & Stake, 1986; Levitt & Huttson, 1983; as cited in Hunsley & Flessati, 1988). Due to these beliefs, more males than females take math courses and pursue careers in math-dominated fields (U.S. Department of Education, 2005; as cited in Kiefer & Sekaquaptewa, 2007). These findings have led some researchers to propose instead that societal beliefs about gender differences in math are affecting individuals' attitudes towards math more so than gender differences in math anxiety (Hyde et al., 1990). Due to these inconsistent results, gender differences in math anxiety and math experiences were not examined in the current study.

The current study builds upon Barlow's Triple Vulnerabity Model of anxiety to help better understand the impact of dispositional and environmental factors on the development and continuation of math anxiety, and potential strategies to help alleviate it. This will help advance the current literature in this area given the findings presented thus far (including the propensity to apply and associate theories of general anxiety with math

anxiety), the complexity of the factors that impact, or are impacted by math anxiety, and the current research gaps.

This approach assumes that the three vulnerabilities theorized in Barlow's Triple Vulnerability Model can be applied to the division of math anxiety into dispositional, environmental, and situational factors. Genetic vulnerability could be interpreted as dispositional factors, and specific psychological vulnerabilities can be interpreted as environmental factors. While not as obvious, generalized psychological vulnerabilities could be interpreted as specific math situations that may provoke a sense of loss of control. It is possible that math's rigidity, use of specific language and symbols, and the belief that there is only one correct answer may result in a sense of loss of control (i.e., the inability to answer questions using our own methods). In any case, Barlow's Triple Vulnerability Model provides support for one of the main contentions of this paper, namely the importance of examining the dispositional and environmental factors associated with math anxiety in addition to the situational factors.

Dispositional Factors

While the focus of the preceding section was to provide a general background regarding math anxiety, the following is meant to delve more specifically into the dispositional factors that potentially affect math anxiety. In order to examine dispositional factors, it is helpful to first return to the distinction between state anxiety and trait anxiety. The majority of individuals who research math anxiety believe it to be a type of state anxiety, as it is shown predominantly when individuals are faced with numbers, math, and calculations (Brady & Bowd, 2005). State anxiety has been defined as "an unpleasant emotional state or condition, which is characterized by activation or arousal of

the autonomic nervous system, which is dependent on time, the situation, and the perception of danger" (Spielberger, 1972, pg. 482; as cited in Isiksal et al., 2009). However, this assumption may not be supported, as research has not examined the relationship between math anxiety and personality traits or Barlow's concept of genetic vulnerability.

Most personality researchers agree that personality traits can be classified into one of the following five domains: neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness (Costa & McCrea, 1992). These five domains of personality are commonly referred to as "The Big Five" of personality. Neuroticism measures one's emotional stability and includes feelings such as fear, guilt, and anger. This is the domain of personality that has been most closely linked with psychological difficulties (Costa & McCrea, 1992). Extraversion is the domain that measures an individual's sociability, activity, and their experience with positive feelings. Openness to Experience measures an individual's imagination, feelings, and values. Agreeableness is a measure of an individual's interpersonal skills. Conscientiousness is a measure of an individual's self-control. Together, these five factors are purported to describe different aspects of human personality.

Previous research has assessed the association of these domains with both general anxiety and test anxiety. The results indicated that the personality trait most closely related to anxiety is neuroticism (Gray, 1982 as cited in Barlow & Craske, 2008). Moreover, some researchers describe neuroticism as a "higher order factor characteristic" of all anxiety disorders (Barlow and Craske, 2008). Interestingly, in the past, the terms

neuroticism and anxiety were often used interchangeably and anxiety disorders were actually labeled neurotic disorders until the 1980's (Clark, Watson, & Minika, 1994).

Although there has been no research examining the potential influence of personality traits on math anxiety, Clark and Watson's (1991) tripartite model of anxiety and depression lend support to the theory that neuroticism may also be associated with math anxiety. Their model suggests that both anxiety and depression share a similar characteristic labeled negative affect, a temperamental variable related to the personality trait of neuroticism. Although anxiety and depression are both characterized by high levels of negative affect, these symptoms' presentations can be distinguished by their levels of two other temperamental variables, namely, positive affect and "autonomic hyperarousal". More specifically Clark and Watson propose that depression has a distinct characteristic of low positive affect, (which can also be described in terms of extraversion), whereas, anxiety has a distinct characteristic of high "autonomic hyperarousal." Research has shown high "autonomic hyperarousal" in math-anxious individuals when placed in situations involving math. Therefore, it seems quite plausible that negative affect, and perhaps by association neuroticism, would also be associated with math anxiety.

Research on the relationship between test anxiety and personality traits also lends support to the theory that neuroticism may be associated with math anxiety. Results of a study conducted by Chamorro-Premuzic et al. (2008) suggest a strong relationship between individuals' levels of neuroticism and their tendency to experience test anxiety as well as a moderate relationship between extraversion and test anxiety. When these two dimensions of personality were taken into account with individuals' core self-evaluations,

their self-evaluations could not explain the test anxiety shown by these individuals. This is significant as it implies that personality variables, specifically those of neuroticism and extraversion, are better predictors of test anxiety than an individual's core self-evaluation.

Further support for this theory is found in studies that have confirmed that math anxiety and test anxiety are related and are similar constructs, and both are comprised of a cognitive and affective component (Dew, Galassi, & Galassi, 1984; Hembree, 1990; Chamorro-Premuzic et al., 2008). Other similarities between test anxiety and math anxiety have been noted: both have a negative influence on performance; both have established relationships with general anxiety; an individual's ability, gender, and ethnicity influence test anxiety and math anxiety the same way; treatment can reduce both test anxiety and math anxiety; and the reduction of both test anxiety and math anxiety have been shown to improve one's performance (Hembree, 1990).

Given the similarity between math anxiety, general anxiety, and test anxiety, and the relationship between personality traits and general anxiety and test anxiety, it seems plausible that there might be a similar relation between personality traits and math anxiety. In other words, there may be personality variables that account for individuals' vulnerabilities to experiencing math anxiety, regardless of their experiences and situational circumstances. It is possible that personality variables may influence an individual's perception of situations involving math, increasing levels of math anxiety. If this were the case, these findings would negate the assumption that math anxiety is purely a form of "state" anxiety. Due to the lack of research in this area, it is too early to define math anxiety as either state or trait anxiety. It may be that there are both state and trait

variables that contribute to math anxiety and as such the relationship is better explained by the Triple Vulnerability Model proposed by Barlow (2002).

To date, no research has examined the impact of the five domains of personality on math anxiety. Therefore, the current study will address this gap in the literature by assessing each of the five facets of personality as defined by Costa and McCrea (1992), and their potential relationship to math anxiety. This knowledge may be useful in helping identify individuals who are more prone to math anxiety and preventing this anxiety from impacting their academic future through the implementation of effective treatment programs. Barlow's model suggests that personality traits alone cannot explain the cause of anxiety. Thus, it is unlikely that personality factors alone will explain the cause and development of math anxiety. For this reason, the current study also assessed the influence of environmental factors on math anxiety.

Environmental Factors

Research into the relationship between math experiences and math anxiety has been limited. Furthermore, the majority of the research conducted in this area exhibits one or more of the following problems: 1) the study only assessed the self-reported experiences of math teachers or pre-service teachers, so their conclusions may not be generalizable outside of these samples; 2) the study did not include a standardized measure of math anxiety and instead asked participants to self-report their level of math anxiety; and, 3) the study focused solely on math-anxious individuals, without considering that the experiences reported by their sample may also be experienced by non-math-anxious individuals. Despite these limitations, the existing literature does give rise to common themes that suggest a relationship between math experiences and math

anxiety. This research provides a strong basis for further research to better understand and identify the nature of these relationships. The main themes that demonstrate the most promise for further research include the relationship between math anxiety and various methods of instruction, levels of support from parents and teachers, negative life events, and math performance. As such, the common themes distilled from the research reviewed below guided the construction of the math experience questionnaire used in this study.

The relationship between math anxiety and math instructional practices has been examined most often in the literature (Harper & Daane, 1998; Jackson & Leffingwell, 1999; Brady & Bowd, 2005). Jackson and Leffingwell (1999) asked 157 pre-service teachers to respond to the following question: "Describe your worst or most challenging mathematics classroom experience from kindergarten through college." In addition to this, they were asked to describe what could have been done to bring about more positive math experiences. Their results suggested a number of behaviors shown by teachers while teaching math to be related to a student's anxiety around the subject. These behaviors include embarrassing students in front of their classmates (e.g., by making negative comments towards them or by making their mistakes known to the entire class), showing signs of gender bias, having a negative attitude, responding angrily when asked for clarification, and showing a lack of understanding for those who needed extra time to grasp difficult math concepts. Jackson and Leffingwell also reported a link between perceived teacher personality types and math anxiety. Individuals who reported higher math anxiety were more likely to report that their teachers behaved in a manner that was hostile, insensitive, impatient, and critical.

Consistent with these findings, Brady and Bowd (2005) found that negative experiences in elementary and secondary school with math instructors was one of two main contributors to math anxiety (the other being the highest level math course taken). Their study examined the relationship between math anxiety, formal math education, attitudes towards math, and past math experiences in a group of pre-service teachers. The findings are noteworthy as participants consistently reported instructional methods were related to their math anxiety, regardless of the fact that the instrument used did not specifically ask about those experiences. Examples of instructional methods that reportedly hindered participants' ability to learn math included teaching at a fast pace that they could not keep up with and being made to feel unintelligent (i.e., when asking for help or stating they did not understand). Brady and Bowd also found that math anxiety and negative math instruction experiences had a great influence over pre-service teachers' confidence in teaching math.

The results of these two studies do not provide conclusive evidence of a relationship between math anxiety and instructional methods. Jackson and Leffingwell (1999) did not use a standardized measure to assess participants' levels of math anxiety; therefore, it is unclear whether math anxiety was truly assessed. Brady and Bowd (2005) used a very narrow measure of math anxiety that focused on participants' levels of enjoyment of math or lack thereof (i.e., whether or not their participants reported that they liked math). They did not examine particular experiences per se. Furthermore, the generalizability of these studies is questionable as the participants in both studies were pre-services teachers. However, Martin (1994) carried out research with college students that also support the idea that instructional factors influence the development of math

anxiety and that having critical teachers (i.e., those that were not supportive) is associated with higher levels of math anxiety.

With the use of interviews, a literature review, and a survey Martin (1994) developed a 180-item questionnaire of experiences, beliefs, and attitudes thought to be related to adult math anxiety. This questionnaire was administered to 320 college students with the goal of better explaining the cause of math anxiety, and supporting the development of teaching strategies to reduce math anxiety. Her results revealed 19 components that predicted which math anxiety group participants belonged to (non-math-anxious, neutral, or math-anxious). These components include, but are not limited to, poor math self-efficacy and negative attitude about math, the perceived value that parents placed on math, instructional methods and teachers' attitudes towards math, and a decrease in math performance. The components related to experience were instructional methods used by math teachers and being chastised in math class due to poor performance. This study provided a good basis for assessing an individual's experience with math and the potential relations to math anxiety; however, it does have some limitations.

As in the case of Jackson and Leffingwell (1999), Martin (1994) did not use a standardized measure for math anxiety. Participants self-identified as being math-anxious, neutral, or non-math-anxious. In addition, it does not appear that any analyses of the relationship between individuals' levels of math anxiety and their personal experiences were completed. Instead, a multiple discriminant functional analysis was used to assess which components were able to differentiate between the three groups of participants. Therefore, it remains unknown whether the individuals who self-reported having high

math anxiety experienced more, less, or the same number of negative and positive math experiences compared to those who reported having low math anxiety.

The literature also includes other research that points to a relationship between math anxiety and a broader range of experiences beyond instructional methods. Schmidt (2005) conducted a qualitative study that examined the experience of college students who suffer from math anxiety. Eight major themes emerged from the results that appeared to be related to math anxiety including: disrespecting, humiliation, and fear-based instruction, disbelieving or abusive parents, turbulent home life and parental conflict, major life transitions, math-me inadequacy and negative self-appraisal, perfectionism, culture and gender, acceptance to hate/flunk math, and respectful and supportive instruction. Similarly, Zoop (1999) examined the causes of math anxiety in adult learners and examined the effects of a treatment program. Participants in this study were a group of eight individuals, selected from a larger sample of 135, who scored high on the math anxiety rating scale. They participated in a number of interviews as well as a math anxiety treatment program. Results indicated a range of potential experiences, related causes, and themes related to math anxiety among her participants. These included specific events in their education, life events (i.e., changing schools and working while attending school), and lack of support. In addition, participants described their math anxiety as negative feelings that they had about themselves.

In both of these studies (Schmidt, 2005; Zoop, 1999), the participants were highly math-anxious. No comparisons were made between the experiences of individuals who suffered math anxiety. In other words, studies such as these cannot rule out that non-math-anxious individuals do not have these same experiences as math-anxious

individuals. Another limitation is that Zoop (1999) failed to compare specific events with scores on the measure of math anxiety; therefore, it is unknown if some of these experiences contributed more to math anxiety than others.

There are a limited number of studies that have included participants with a range of levels of math anxiety. However, those that have been conducted support a relationship between math anxiety and math experiences (Hunsley & Flessati, 1988; Flessati & Jamieson, 1991; Bonnstetter, 2007). Hunsley and Flessati (1988) conducted a study to examine how differential experiences in math might explain the gender difference sometimes seen in math anxiety. More specifically, their aim was to compare the sex role hypothesis with the math experience hypothesis. The sex role hypothesis centers around the belief that math is a male-dominated subject and that females are not encouraged to gain better skills and understanding in this area of study (Hunsley & Flessati, 1988). In contrast, the math experience hypothesis states that it is individuals' math skills and prior experiences that determine the level of math anxiety they will experience regardless of their gender (Hunsley & Flessati, 1988). Similar to the latter hypothesis, it is believed that the individuals who experience the highest levels of math anxiety will be those who have the least math experience, the lowest math grades, and the highest levels of negative beliefs about math (Flessati & Jamieson, 1991). The results provide support for the math experience hypothesis. Differences in math marks and beliefs and experiences about math were found between the non-math-anxious, the moderately math-anxious, and the highly math-anxious group. The only gender difference found was that females reported higher marks in comparison to males. Flessati and Jamieson (1991) subsequently replicated the

findings of this study, providing further support for the contention that past experiences in math are related to the present level of math anxiety.

While these studies considered the relation of math experience to math anxiety, and are two of the few studies that have included individuals with a range of math anxiety, they did not include any analysis of the nature of the math experiences. Instead, experiences were coded as positive, negative, or neutral. Thus, these two studies do not provide any guidance as to what types of experiences are related to math anxiety. Furthermore, these results need to be interpreted cautiously as there appeared to be a large amount of missing data in their sample.

Bonnstetter (2007) also used a range of math-anxious individuals (children in grades four through eight with the lowest and highest levels of math anxiety on the Math Anxiety Questionnaire (MAQ), a standardized measure of math anxiety). Bonnstetter interviewed eleven children with the goal of comparing their levels of math anxiety with what they reported in a previous study in 1999. Bonnstetter found that the same six themes emerged in the 2007 study as in the 1999 study, namely, feelings about self, feelings about math, concepts in math, instructional/learning style, teacher characteristics, and teacher strategies. Individuals who were math-anxious had more negative experiences with regards to the six themes, whereas non-math-anxious individuals had more positive experiences. However, one of the main limitations of this study was the small sample size used. It is difficult to discern whether similar results would be obtained with the use of a larger sample and if the results can be generalized to other populations.

Despite their weaknesses, these studies provide the basis of a better understanding of how personal experiences with math may be related to math anxiety. Although their

different approaches and methodologies resulted in various findings in which may have varying levels of confidence, there are some themes that appear to emerge consistently. First, methods of instruction appear to be related to the development of math anxiety. Research shows that math-anxious individuals consistently report problems with the teaching methods they were exposed to. Second, individuals with high math anxiety commonly report a lack of support by parents and teachers. Third, math-anxious individuals commonly report experiencing negative life events and having negative feelings about themselves and math. Negative life events included changing schools, moving from one house to another, divorce, and mental health issues in the family. Negative feelings about oneself and math included the beliefs that one is not able to do math, that one will always perform poorly, or that math is of no importance. Lastly, performance in math appears to be a variable that influences levels of math anxiety, in that those with lower math grades tend to have higher levels of math anxiety. Due to the fact that four of these themes (lack of support, instructional methods, life events and math marks) continually emerge throughout the literature, the current study focused on assessing the potential relationship of these themes with math anxiety.

Furthermore, these relationships will also be retroactively assessed in three different periods in education (Elementary, Junior High, and High School). As previously mentioned, the majority of research in this area discounts the development of math anxiety and its possible impact on younger children. Researchers initially believed that math anxiety was solely related to more difficult math-related skills (e.g., algebra; Malony & Beilock, 2012) and that math anxiety did not appear prior to Junior High School (Ashcraft, 2007). However, current research indicates that math anxiety is present

in children as young as those in grade one (Ramirez et al, 2012). It is important to distinguish among the development and the continuation of math anxiety, as math is a subject whereby skills are built upon. Asking about math-related experiences during different educational periods could further the understanding of math anxiety as a persistent or transient subtype of anxiety. Moreover, few of the previously mentioned studies used both math-anxious and non-math-anxious participants or conducted analyses directly examining the relationship between these experiences and levels of math anxiety. The current study will address this problem by using a wide range of math-anxious and non-math-anxious individuals with the main focus of the study being to examine the relationship between math-related experiences and the level of math anxiety reported by individuals. As there is no known measure of math experiences that looks specifically at the variables identified above, one of the objectives of the present study is to create a measure that examines these variables. This measure will serve as a stepping-stone for future research.

Research Questions and Hypotheses

Given the research summarized above, this study sought to address the following two questions: (1) Are there personality variables that contribute to the level of math anxiety experienced by university students and, (2) How do past math experiences, specifically those associated with support, instructional methods, negative life events, and math marks, contribute to the level of math anxiety experienced by university students? To address the second of these two questions, a measure designed to assess math experiences was developed. Bearing in mind the outcomes of previous research, five hypotheses were proposed. First, it was hypothesized that individuals with higher levels

of neuroticism will demonstrate higher levels of math anxiety (measured by the Math Anxiety Rating Scale – Short Version) relative to individuals reporting lower levels of neuroticism. Research has supported the notion that neuroticism is a potential contributing factor to the development of general anxiety and test anxiety (Barlow, 2000; Chamarro-Premuzic et al., 2008). Math anxiety, test anxiety, and general anxiety are all related and similar constructs; however, they are not identical. There has been no previous research conducted assessing personality traits and their potential contribution to math anxiety. Therefore, this research question serves to address a gap in the literature, increase the understanding of math anxiety as its own construct, and assess whether there is a dispositional vulnerability associated with math anxiety. Moreover, having a greater understanding of math anxiety as its own construct may help identify those at risk, as well as help with the development of treatment programs.

The second, third, fourth, and fifth hypotheses bear on the role of math experience with math anxiety. Second, it was hypothesized that individuals who perceived having lower levels of support in Elementary, Junior High, and High School would have higher levels of math anxiety compared to those who perceived higher levels of support. Third, it was hypothesized that those individuals who reported more negative experiences with instructional methods in Elementary, Junior High, and High School would have higher levels of math anxiety compared to those who reported fewer negative experiences. Fourth, it was hypothesized that those who reported negative life events in Elementary, Junior High, and High School would have higher levels of math anxiety compared to those who did not report experiencing these events. Last, it was hypothesized that those

individuals who had lower math marks would have higher math anxiety compared to those who had higher math marks. The current study will not be measuring actual obtained math marks, but rather the math marks recalled by the individuals. Research has demonstrated the impact of each of these variables' potential contribution to math anxiety (Bonnstetter, 2007; Brady & Bowd, 2005; Flessati & Jamison, 1991; Harper & Daane, 1998; Hunsley & Flelesa, 1988; Jackson & Leffingwell, 1999; Martin, 1994; Schmidt, 2005; Sheilds 2006; Zoop, 1999;). However, the majority of these studies possessed methodological flaws such as focusing on specific groups of participants that are not necessarily generalizable (i.e., math teachers, pre-service teachers, and adult learners), not including a standardized measure of math anxiety in their study, and focusing solely on math-anxious individuals. It is important to more rigorously assess these variables to gain a better understanding of math anxiety as a construct, to potentially aid with the possible development of interventions, and to aid with possible teaching strategies that may be used to decrease levels of math anxiety.

Method

Participants

The sample consisted of 131 undergraduate students attending Memorial University (MUN). They were recruited from the Department of Psychology and were enrolled in one of the following three classes: Introduction to Psychology, Research Methods in Psychology for Non-Majors, and Research Methods in Psychology. The sample consisted of 34 males (26%), 96 females (73%), and 1 unknown. The participating students ranged from 18 to 41 years of age (M = 20.81 SD = 3.70). The sample included

107 Caucasian people (81.7%), three Aboriginal people (2.3%), three Indian people (2.3%), one Southeast Asian person (.8%), one Hispanic person (.8%), one Metis person (.8%), three Asian people (2.3%), and seven individuals of unknown ethnicity (5.3%). Participants also differed with regards to the number of years they had attended university; twenty-five individuals were in their first year of university (19.1%), fifty individuals were in their second year of university (38.2%), thirty-four individuals were in their third year of university (26.0%), seventeen individuals were in their fourth year of university (13.0%), and the year of five individuals is unknown (3.8%). The declared major of the participants varied as there were twenty-seven different majors declared. Majors were categorized in terms of arts, sciences, and education. Of the sample twenty-six individuals were declared arts majors (20.3%), forty-one individuals were declared science majors (32.0%), one individual declared a major in education (0.78%), and seven individuals had no major declared (5.47%). Furthermore there were fifty-three declared majors in psychology (41.4%); however, it is unknown if these individuals had declared majors in arts or science.

Measures

All of the measures in this study were administered in paper and pencil format, and were given together as a questionnaire package. These measures include the Math Anxiety Rating Scale – Short Version (MARS-S), the Math Experience Questionnaire (developed specifically for the purposes of this study), the 50-item International Personality Item Pool (IPIP) representation of Costa and McCrae's (1992) five NEO domains (Goldberg, 1999), the Test Anxiety Inventory (TAI), the Penn State Worry Questionnaire (PSWQ), the Beck Anxiety Inventory (BAI), and a demographics

questionnaire. These measures are described below. The purpose of the TAI was to separately measure and control for test anxiety while the purpose of the PSWQ and the BAI was to separately measure and control for general anxiety. The final piece of this section details the development of the Math Experience Questionnaire.

Demographic questionnaire. The purpose of this questionnaire was to gather relevant demographic information on each of the participants for the current study. This questionnaire was composed of short fill-in-the blank questions, assessing the participant's gender, age, ethnicity, and academic information (e.g., year of degree, major, or minor).

Math Anxiety Rating Scale – Short Version (MARS-S Suinn & Winston, 2003). This measure was included for the purpose of measuring the participant's level of math anxiety. The MARS was the first instrument constructed to measure math anxiety (Ashcraft, 2002). It is one of the most commonly used scales to measure feelings of anxiety associated with math (Wigfield & Meece, 1988). The MARS is a 98-item self-report questionnaire that was developed to assess anxious reactions to math during our day-to-day life and academically (Richardson & Suinn, 1972). However, administrators and participants found the 98-item questionnaire long to score and complete. Researchers believed that a shorter form of the MARS was needed to address both of these problems. Therefore, the Math Anxiety Rating Scale, Short Version was created by drawing 30 items from the 98-item version measure. The items were chosen from three factor analysis studies in the literature (Alexander & Cobb, 1987; Alexander & Martray, 1989; Rounds & Hendel, 1980), and had to meet the inclusion criteria of having been an item that was deemed an "important factor" (pg. 169, Suinn & Winston, 2003) in two of the

previously mentioned studies, or was found to have the highest factor loading for one of the factors in one of the previously mentioned studies.

This new short form of the MARS was composed of 30 items, and was comprised of the same two subscales as the long version. The first is the math test anxiety scale, which is associated with feelings of anxiety that individuals face during test situations. The second is numerical anxiety, which occurs when individuals are faced with number and math calculations outside of a testing situation (Rounds & Hendel, 1980). Examples of items include: “taking an examination (quiz) in a math course”, “listening to a lecture in a math course”, “totaling up a dinner bill that you think you were overcharged on”, and “calculating the sales tax on a purchase that costs more than $1.00”. This measure can be administered in an individual or group setting and respondents are asked to rate their level of anxiety on a 5-point Likert scale (not at all, a little, a fair amount, much, or very much). The examiner sums all of the responses together to obtain a total score ranging from 30 to 150, whereby higher scores are indicative of a higher level of math anxiety.

One-week test-retest reliability for college students has been found to be .90, which is quite similar to that of the MARS 98-item measure. When both the MARS-S and the MARS were administered to a college sample and the results compared, correlations were r = -.92 and -.94 when the measures were administered within a week of each other. Additionally, the scores on this measure were negatively correlated with math grades. Furthermore, similar to the longer version of the MARS, the content validity of this measure demonstrated two primary factors: one accounted for 59.2% of the variance and the other accounted for 11.1% of the variance (Suinn & Winston, 2003). Despite the results of the factor analysis, the internal consistency Cronbach’s alpha was .96,

indicating that the items of this measure are highly correlated, and most likely representative of one factor (math anxiety). For this reason, the current study did not separate analyses by the subscales and instead used the overall MARS score to reflect math anxiety. Participants' levels of math anxiety ranged from 30.00 to 148.00 (M=68.17, SD= 18.93), suggesting that this sample represented a range of math anxious and non-math anxious individuals.

International Personality Item Pool (IPIP; Goldberg, 1999). This measure was included to examine the personality characteristics of the participants. The IPIP was created in 1996 and was introduced at the European Conference on Personality. Since this time it has been widely used in research. This measure has been translated into 25 other languages and there are over 80 published studies that have used this measure (Goldberg, 2006). Moreover, as a result of its free cost, its accessibility, the vast number of items (over 2,000), the availability of scoring keys, and its flexibility (i.e., ordering of items, ability to translate easily etc.,) the number of researchers using this measure has increased. The measure can be obtained easily through the IPIP website http://ipip.ori.org/ which contains the psychometric properties of the IPIP scales, the scoring keys, and the total set of IPIP items. Some of the IPIP scales have been developed to mirror constructs measured by scales in "major commercial inventories" such as the five NEO domains (Goldberg, 2006).

Currently around 300 scales have been derived from the approximately 2000 IPIP items. The total number of IPIP items continuously changes with increasing research. Additionally, the IPIP has been successful in mirroring a number of "broad-band-width inventories" including but not limited to; the NEO-PI-R, 16 Personality Factor

Questionnaire, Hogan Personality Inventory, California Psychological Inventory, and Jackson Personality Inventory. For the most part, all of the coefficient alpha reliabilities of these scales match or are higher when compared to the original scales. One limitation of this measure is its lack of normative data and validity indices.

For the purpose of the current study, the IPIP representation of Costa and McCrae's five NEO domains was used. The average coefficient alpha for the IPIP scales is .80, which is a little higher than the .75 average coefficient alpha of the NEO. Coefficient alpha's for each scale are as followed; extroversion .87, agreeableness .82, conscientiousness .79, neuroticism .86, and openness to experience .84 (Lim & Ployhart 2006).

The IPIP's representation of Costa and McCrae's (1992) five NEO domains is a 50-item self-report questionnaire. It measures the five domains of personality, namely, neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness, with each domain being represented by 10 items. Participants are asked to describe themselves honestly by rating each statement on the following 5-point scale: very inaccurate, moderately inaccurate, neither accurate nor inaccurate, moderately accurate, or very accurate. Examples of these statements include; "Am not easily bothered by things", "Find it difficult to get down to work" and "Don't talk a lot".

The Test Anxiety Inventory (TAI; Spielberger, 1980). The TAI is a 20-item self-report questionnaire that was developed to assess individuals' levels of test anxiety. This measure can be administered in an individual or group setting and takes approximately 8 to 10 minutes to complete. It is composed of two subscales, namely, the emotionality scale and the worry scale. Respondents are asked to rate how often they are

troubled with particular symptoms of anxiety during, after, and before a test on a four-point Likert scale (almost never, sometimes, often and almost always). The ratings of the items are summed together to obtain a total score ranging from 20 to 80; higher scores are indicative of higher level of test anxiety. Normative data is available for this measure and is located in the interpretive manual. For the purpose of the current study, only the normative date for college students will be reported. The data is based on 1,449 undergraduate students. The mean level of test anxiety experienced by males in the normative sample is 38.48 with a standard deviation of 12.43. Comparatively, the mean level of test anxiety experienced by females is 42.79 with a standard deviation of 13.70. Two-week and three-week test-retest reliability for a college sample has been found to be .80. Internal consistency has ranged from .61 to .69. The TAI has been correlated with a number of other measures of anxiety. Research has shown a .82 (males), and .83 (females) correlation between the TAI and Test Anxiety Scale. Furthermore a correlation of .73 (males) and .69 (females) has been shown with the Worry and Emotionality Questionnaire -Worry Scale and .77 (males) and .85 (females) for the Emotionality Scale. This measure was included to assess the participants' level of test anxiety, so that it can be controlled for in the statistical analysis. The participants' level of test anxiety as measure by the Test Anxiety Inventory ranged from 20 to 79 (M=22.20, SD= 13.72). Indicating that on average these participants had low levels of test anxiety.

Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger and Borkovec, 1990). The PSWQ is a 16-item self-report questionnaire that was developed to assess an individual's level of worry. The creators of this measure compiled a list of 161 items associated to the variable of worry. This list of items was provided to 337 college

students. The results were analyzed and suggested a number of different factors; one factor accounting for 22% of the variance and other factors accounting for a smaller amount of variance. Following further analysis and item deletion, the remaining 16 items with a total internal consistency of .93 made up the PSWQ. Respondents are asked to rate how typical it is for them to experience worrisome thoughts on a 5-point Likert scale (1-not at all typical of me to 5-very typical of me). The ratings of the items are added together to obtain a total score ranging from 16 to 80 with higher scores indicative of higher levels of worry. The PSWQ has been found to have a high test-retest reliability of .92 and an internal consistency of .94. Moreover, this questionnaire has shown to be successful in differentiating those who have a diagnosis of Generalized Anxiety Disorder (characterized by worry) from those suffering from Post-Traumatic Stress Disorder. Furthermore, the concurrent validity has been assessed by a number of researchers by means of comparing it with other measures of anxiety and has been found to range from .29 to .79 (Therrien & Hunsley, 2012). This measure was included to assess the participants' level of generalized worry. This measure was included (along with the Beck Anxiety Inventory) so that the statistical analyses can assess the variance attributed to math anxiety that is separate from general anxiety. Participants' level of anxiety as measure by the Penn State Worry Questionnaire ranged from 20.96 to 80 (M=54.84, SD= 14.15).

Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988). The BAI is a 21-item self-report questionnaire that was developed to assess an individual's level of anxiety. Individuals are asked to rate how often they are troubled by a symptom during the past month on a 4-point Likert scale (0-not at all to 3-severely, it bothered me a lot).

The ratings of the items are summed together to obtain a score from 0 to 63 with higher scores indicative of higher levels of anxiety. Scores that fall within the 0 to 21 range suggest low anxiety, those that fall within the 22 to 35 range indicate moderate anxiety, and those that are higher than 36 indicate high levels of anxiety. The BAI has an internal consistency of .92 and a one-week test-retest reliability of .75. Research has demonstrated its ability to distinguish between anxious and non-anxious groups, and a moderate correlation with other measures of anxiety has been shown (ranging from .29 to .63). However, this measure also has been shown to be correlated with symptoms of depression (.56 to .65), questioning its discriminate validity. Additionally, this measure focuses primarily on the somatic symptoms of anxiety. This measure was included to assess the participant's level of anxiety; the Penn State Worry Questionnaire was also included to ensure that both the somatic and worry components of anxiety were assessed. Both of these measures were included to test the hypothesis that general anxiety (as defined by somatic and worry components) does not better account for the relationship between math anxiety and the associated variables being examined. The sample's level of anxiety as measured by the Beck Anxiety Index ranged from 0 to 55 (M =17.51, SD=10.90). Indicating that on average these participants had low levels of general anxiety.

Development of the Math Experience Questionnaire

This measure was created specifically for the current study to gain insight into individuals' positive and negative experiences with math. For the purpose of this research, math experience is defined as a personal event or situation, encountered or perceived, involving math. This measure was designed to attempt to measure a variety of personal experiences that an individual may or may not have had in relation to math.

Based on a review of previous literature, four common themes related to higher levels of math anxiety emerged: 1) lack of support; 2) instructional methods; 3) life events; and, 4) math marks. Items for this measure were based on these four themes. Furthermore, items were derived from a literature review of math anxiety including studies that have each attempted to measure an individual's experience with math. Some items were chosen from measures that were created by other researchers (e.g., Zoop, 2006; Schmidt, 2005), and others were written for the purposes of the current study and based solely on the literature. Once a large pool of items was created, a group of individuals (all members of the Research Center for the Development of Mathematical Cognition) examined the items to ensure their clarity, that they accurately reflected the construct that was being examined, that the language was appropriate, and that there were no double-barreled items (e.g., items that were composed of more than one construct, e.g., was your math teacher critical and impatient). A group discussion was had about each item and its purpose. If there were any questions or uncertainties, the item was deleted. The process of reviewing the items with a larger group occurred on a number of occasions. Essentially, this group process assessed the face validity of the measure item by item; assessing the items to determine if they appeared to be measuring the intended variable (i.e., math support, instructional methods, life events, or math marks). The construct validity of this measure was not assessed in this study, as there are no other measures of math experience to which to compare it. However, future studies should examine whether this measure does correlate to measures of related constructs. Additionally, two individuals completed the measure to ensure that there were no items that seemed confusing and to examine the length of time it would take to be completed. The measure is composed of both Likert-

type questions as well as open-ended questions. The measure uses a Likert scale labeled: strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agree (5). In addition to these, a “do not recall” selection was also provided. Open-ended questions were also included to ensure that no vital information was being missed. The final version of the measure has a grade reading level of 7.2, as reported by Microsoft Office.

This measure is a self-report measure composed of 72 Likert items which are rated on a 5-point scale ranging from strongly agree to strongly disagree and 14 open-ended questions (see Appendix D). The 72 Likert items are 24 items repeated three times, where participants were asked to separately reflect on their experiences in Elementary School (Grades 4 to 6), Junior High (Grades 7 to 9), and High School (Grades 10 to12). Questions were based on four general themes: lack of support, instructional methods, life events, and math marks. The Likert items measure one of three themes: 1) Support (items 1, 2, 16, 18); 2) Instructional Methods (items 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 17, 19 and 21); and 3) Math Marks (items 8, 22, 24). Additional items were also added that individually assessed gender-related experiences (items 3 and 15), the use of a calculator when working on math problems (item 20), and the teacher’s attitude about math (item 23). For the most part, the fourteen open-ended questions examined the life events theme, however, there were some open-ended questions that assessed both the support and the instructional methods theme.

Reliability Analyses

Following data collection, each scale was first assessed for its internal consistency. Items were candidates for elimination if they approached near zero or negative item-total correlations and if their elimination increased the internal consistency

of the scale. Although reliability analyses were completed separately for each scale, the objective was for each scale to consist of the same items across all of the different levels of schooling (i.e., elementary, junior high, and high school). The results of these analyses were fairly consistent across the different educational periods for all the dimensions. In the case of the support scale, one item (i.e., “I was frequently left alone to work on math problems”) met elimination criteria for all three levels of schooling and a second item (i.e., “My math teachers were understanding when I asked for help with math”) met these criteria for Elementary School and High School. Given these results, both items were eliminated from all three scales. The resulting two-item scales had an internal consistency of .79 for Elementary School, .78 for Junior High, and .76 for High School.

The instructional scale was originally composed of thirteen items; however, two items (i.e., “My math teacher frequently employed math competitions or games to help with teaching math concepts” and “My teachers frequently asked me to answer questions in front of the class (i.e. on the blackboard, aloud)”) met the elimination criteria for all three levels of schooling. A third item (i.e., My math teachers acted as though what they were teaching was easy to learn”) met these criteria for Elementary School and Junior High School. As a result all three items were eliminated for all three scales. A fourth item (i.e., “My math teachers were critical”) only met the elimination criteria for Junior High and High School, but this item was retained because it did not warrant elimination for Elementary School and the effect of including it for Junior High and High School was negligible. The final ten-item scales had an internal consistency of .84 for Elementary School, .84 for Junior High School and .88 for high school.

In the case of the math marks scale, one item (“My math marks were not up to my expectations”) met the elimination criteria for elementary school. Therefore, it was eliminated on all three scales. The resulting two-item scales had an internal consistency of .91 for Elementary School, .92 for Junior High School, and .93 for High School.

The final version of this measure was composed of 51 Likert items which are based on three themes 1) Support (items 1 and 2,); 2) Instructional Methods (items 6, 7, 9, 10, 11, 12, 13, 14, and 19); and 3) Math Marks (items 8 and 22). In addition, the measure also included items examining gender-related experiences (items 3 and 15), the use of a calculator when working on math problems (item 20), and the teacher’s attitude about math (item 23). No changes were made with regards to the long-answer questions; they remained the same and were used to assess the possible impact of life events on math anxiety as well as adding some extra information with regards to the first three themes.

Subsequent to this analysis, the face validity of each scale was examined to ensure that the remaining items were measuring the intended constructs even after the removal of some items. With regards to the support scale, the items appeared to be measuring perceived supportive characteristics of teachers, namely encouragement and openness to help. Therefore it is possible that this scale may be measuring teacher support specifically. The remaining items on the instructional methods scale appeared to be measuring frequently used teaching strategies; however, there were two items in this scale that appeared to be measuring the teacher’s personality (i.e., patience and criticalness). The math marks scale appeared to assess whether the participants felt as though their marks were higher or lower in comparison to their marks in other subjects.

It is worth noting that the number of items on each scale differs and the construct validity of the measure was not assessed. Moreover, it is unknown whether the items actually comprise the three scales that have been identified, as no formal factor analysis was complete.

Procedure

The primary researcher of the current study forwarded an email to several of the faculty members within the psychology department at Memorial University. This email provided detailed information on the current study and its purpose, along with a request for professors' permission to allow the researcher to enter into their undergraduate class to explain the study to the students in an attempt to recruit participants. Once permission was granted the researcher scheduled a date with the professor to come and explain the study to the students. During the classroom visit the researcher or her assistant read aloud a standardized script (see Appendix A) to the students describing the study and its purpose and answered any questions that arose. At the end of the explanation the researcher or the researcher's assistant informed all students that participation in this study was voluntary and that if they agreed to participate they had the freedom to withdraw at any point in time. Additionally, an email outlining the study was sent to each student in the class along with possible times that they could participate. Students were asked to contact the researcher if they wanted to participate in the study and to identify which time slot they would be attending. Students would arrive at the specified location (classroom, computer lab, and/or research lab) and sign in by providing their name and student number so that they could be given credit for the completion of the study. The number of individuals that participated during each slot varied and was dependent on the

number of individuals that signed up on that given day (range = 1-17, *M* =6.24). During the data collection session the researcher provided the students with the information letter explaining the study and its purpose (see Appendix B). The participants were informed that their participation was voluntary and that they could withdraw from the study at any point without fear of being penalized. After going through the information and agreeing to complete the study, the students were required to sign the consent form.

Following the completion of the consent form, the participants were asked to complete the questionnaire packet containing the Math Anxiety Rating Scale – Short Version (MARS-S), the Math Experience Questionnaire, the 50-item International Personality Item Pool (IPIP) representation of Costa and McCrae's (1992) five NEO domains (Goldberg, 1999), the Test Anxiety Inventory (TAI), the Penn State Worry Questionnaire (PSWQ), the Beck Anxiety Inventory (BAI), and a demographics questionnaire. The first three measures (the MARS, the Math Experience Questionnaire, and the IPIP) were included to test the primary hypotheses of the study while the last three measures were included so that math anxiety could be examined while statistically controlling for text anxiety (the TAI) and general anxiety (the PSWQ and the BAI). It is important to note that the order of all questionnaires was partially counterbalanced using a Latin square design (there was six different ordering sequences used), to ensure that the order of the questionnaires was not a factor affecting the obtained results. The questionnaire packet took participants approximately an hour to an hour and a half to complete.

Upon completion of the questionnaire packet, participants were given a debriefing form (see Appendix F), were asked if they had any questions, and were thanked for their

participation. To ensure participants' confidentiality all measures were returned to the researcher in a sealed envelope and stored in a locked filling cabinet. Students who agreed to participate in the study were given a 1.5% credit towards their final mark in the course. To ensure that there was no coercion to complete the study, students in the classes who did not wish to participate were given the opportunity to receive the same course credit by writing a summary of a research article. Participants were told that if they wished to see the results of the overall study, they could contact the researcher.

Results

Prior to data analysis, ethnicity, gender, participant major, anxiety as measured by the BAI and PSWQ, test anxiety, and math anxiety were examined for accuracy, missing data, outliers, and distribution. Due to the size of the dataset, descriptive statistics were used to detect cases of data entry error. Missing data in this dataset were treated as missing and were given a specific code. Upon examination, it appeared as though missing data were random and rare. Out of 131 participants, there was one case where gender was missing, two cases where the participant's major was missing, one case of a missing BAI score, and seven cases where ethnicity was missing. These data points were left as missing and casewise deletion was used for all analyses.

One case was a univariate outlier because of its high *z* score ($z = 3.28$) on anxiety as measured by the BAI, and one case was a univariate outlier because of its high *z* score ($z=3.94$) on math anxiety as measured by the MARS. Both of these cases were deleted from the analyses. The normality of the distribution was also examined by assessing the skewness and kurtosis of the above-mentioned variables. Scores on the BAI had a skewness statistic of .838 (*SE*=.212) and a kurtosis value of .256 (*SE*=.422*)* and score on

the PSWQ had a skewness statistic of -.328 (*SE*=.212) and a kurtosis value of -.797 (*SE*=.420). Scores on the TAI had a skewness statistic of .638 (*SE*=.212) and a kurtosis value of -.231 (*SE*=.420) and scores on the MARS had a skewness statistic of .534 (*SE*=.212) and a kurtosis value of .760 (*SE*=.420). Using a guideline that acceptable skewness and kurtosis is within two standard errors of zero, these results indicate that the BAI, TAI, and MARS are all positively skewed. The level of skew, however, was not great, so the data were left untransformed in order to treat the measures as they have in other studies and because skewness at these levels does not have large effects on correlations (Dunlap, Burke, & Greer, 1995). The final scale means and standard deviations are located in Table 1.

Hypothesis One – Dispositional Factors

This study first examined the association of math anxiety and personality variables in order to determine if they contribute to the level of math anxiety experienced by university students.

The relation between math anxiety as measured by the MARS and the five personality variables of neuroticism, openness, conscientiousness, agreeableness, and extraversion on the IPIP scale were assessed first using bivariate correlations. Results showed a significant positive relationship between neuroticism and math anxiety (r = .36, p = .01), but no significant correlation between math anxiety and any of the other personality variables (see Table 2). This correlation implies that as levels of neuroticism increase, so do levels of math anxiety; the higher an individual's level of neuroticism, the higher the level of math anxiety. In order to test the amount of variance in math anxiety accounted for by neuroticism above and beyond general anxiety and test anxiety, a semi-

partial correlation was conducted between neuroticism and math anxiety, while controlling for general anxiety and test anxiety. The result of this analysis was that the relation between neuroticism and math anxiety became non-significant (r = .07, p = .458), suggesting neuroticism does not account for a person's level of math anxiety independent of the influence of general and test anxiety.

Hypotheses Two through Five – Environmental Factors

As previously stated, math experience was measured using both closed-option Likert items and open-ended questions. The Likert-item scales were calculated as described in the Method section. The responses to the 14 long-answer questions were coded and analyzed by the researcher (all codes are listed in Appendix G). In addition, a second coder analyzed a random selection of 20% of the questionnaires. Each coder was given the coding scheme as well as a coding sheet (see Appendix G) and asked to code the questions without any discussion of their results. After both coders completed the coding process, the percentage occurrence agreement was calculated to be 83% (See Table 3 for the percentage occurrence agreement per question). Disagreements between the coders were resolved by discussion. Although this inter-rater agreement does not take into account chance agreement, as would a kappa statistic, the probability of chance agreement is fairly low, as there are a large number of codes for each question. Moreover, the number of different codes for each question is not consistent, which means that the chance agreement would vary from question to question and, therefore, it would not be possible to calculate an overall kappa.

Analyses are described below in separate sections related to each hypothesis. For the long answers, each question was analyzed by comparing differences in math

anxiety between people who answered that particular question one way and those that answered in another way. These analyses first tested the most aggregated code groupings for these questions, but would then follow up with more testing of specific code groupings if the corresponding groups contained at least 10 participants each. This was done even in cases where no significant difference was found with the most aggregated codes in order to examine the possibility of math anxiety differences only existing for more specific codes. Furthermore, because of the multiple tests, an alpha of .01 was used to help control for inflated family-wise Type I error. The alpha level of .01 was chosen as a compromise between two different arguments regarding the appropriateness of using alpha reduction procedures. On the one hand, researchers have traditionally been encouraged to control for Type I error rate by using a Bonferroni method that would divide the overall alpha by the number of tests to be conducted (e.g., Hays, 1988). In this paper, there were 44 statistical tests conducted on the long-answer variables, so a Bonferroni adjustment would result in a per-comparison alpha of .001. Other researchers, however, have argued that reducing alpha in this way greatly inflates Type II error, is not consistently applied across statistical situations, would have drastic consequences for research if it was consistently applied across statistical situations, and in general should not be done (O'Keefe, 2003). In order to account for the possible inflation of Type I error while simultaneously not inflating Type II error to the point that would drastically curtail the interpretability of the data, an alpha of .01 was chosen.[1]

[1] If a Bonferroni adjustment was used no significant results would have been obtained.

Furthermore, as was the case with Hypothesis One, any significant results were followed up to determine if the effects were still significant after controlling for the influence of general and test anxiety.

Math Experience – Support Scale. Bivariate correlations were conducted to assess the relationships between math anxiety as measured by the MARS, and the support dimension of Math Experiences as measured by the Math Experience Questionnaire throughout Elementary, Junior High, and High School. As the correlations in Table 4 demonstrate, Elementary, Junior High, and High School support were in fact significantly related to math anxiety.

Semi-partial correlations were conducted to test whether or not the significant relations between scores on math anxiety and the Elementary School, Junior High, and High School support scale were still present once general anxiety and test anxiety were factored out of math anxiety (see Table 4). These results suggested that only experiences with regards to support in High School were related to math anxiety. Specifically, the results showed a negative relationship between math anxiety and High School support, even when general anxiety and test anxiety has been taken into account.

Open-ended – Support Scale. "*In your past, did anyone (i.e., a teacher, parent, or peer) do something to increase your confidence in your math ability? Please explain."* The responses to this first question were coded to reflect many different reported actions that increased math confidence, such as providing extra help, providing encouragement, being involved in math competitions, or just being kind and caring (see Appendix G). Considering all these actions combined, 87.8% of participants reported that someone did do something to increase their math confidence, whereas 11.5% of participants reported

that they did not have anyone do something to increase their math confidence. Looking at the individual actions, individuals most commonly reported that they received encouragement either from a teacher (29.0%) or from a parent (15.3%). Receiving extra help was also relatively common with 15.5% of the sample reporting they received extra help from a teacher, 13.0% reporting they received extra help from a parent, and 6.1% reporting they received extra help from a tutor. Participants also reported that a teacher's personality (kind, caring, understanding, etc.; 6.1%), being involved or being told they should be involved in enrichment programs (10.7%), being asked to be involved in math competitions or leagues (9.2%), and being asked to tutor others (11.5%) all increased their confidence in math (see Table 5).

Across all reported actions, there was no significant difference in the scores on the MARS for those who did not have anyone do anything to increase their math confidence (n = 15, M = 73.07, SD = 16.09) and those who did have someone do something to increase their math confidence [(n = 115, M = 67.53, SD = 19.30); t(127) = 1.03, p = .305] . In the event that this lack of a result masked differences within this group, this analysis was repeated separately considering those who reported receiving extra help and those who reported receiving encouragement. No significant difference was found between those who reported receiving no extra help (n = 88, M = 65.40, SD = 18.74) and those who reported receiving extra help [(M = 74.00, SD = 18.34); t(127) = 2.44, p = .016]. Furthermore, there was no significant differences found between those who did not receive encouragement (n = 82, M = 69. 79, SD = 18.02) and those who did receive encouragement [(n = 47, M = 65.24, SD = 20.47); t(127) = 1.31, p = .192].

"In your past did anyone (i.e. a teacher, parent, or peer) do something to decrease your confidence in your math ability? Please explain." Participants' responses were coded to reflect various actions that decreased math confidence, such as having a lack of encouragement, praise, support and help, having a math teacher that was unapproachable, or having a teacher become frustrated and angry when teaching math (see Appendix G). Bearing in mind all of these actions combined, 58.8% of participants reported that someone did in fact do something to decrease their math confidence, while 39.7% of participants reported that they did not have anyone do something to decrease their math confidence. Looking at the specific actions, participants most commonly reported that a math teacher who made them feel poorly about themselves (i.e., were belittling, laughed at them; 16.0%) decreased their math confidence, 8.4% of participants reported a lack of encouragement, praise, support, and help, while 5.3% reported having a teacher that was unapproachable. Participants also reported the following as decreasing their math confidence: having a teacher who would become frustrated and angry while teaching math (4.6%), having a teacher who was not concerned for how well people did in math (3.8%), having peers who make fun of them for doing well (3.1%), having friends do better than them (3.1%), other individuals having high expectations of them (2.3%), receiving negative feedback on tests (2.3%), having parents who would become frustrated and angry when teaching math (1.5%), having high expectations for oneself (1.5%), having a teacher who hated math (1.5%), thinking negatively about one's own abilities (.8%), and having peers make fun of those who did poorly (.8%; see Table 5).

Across all reported actions those who did have someone do something to decrease their math confidence had significantly higher math anxiety scores (n = 77, M = 72.66, SD = 17.80) than those who did not have anyone do anything to decrease their math confidence [(n = 51, M = 61.86, SD = 18.40; t(126) = -3.316 p = .001; d = .59]. This effect, however, did not carry over to more specific groupings, as those who reported a lack of encouragement, praise, support, and help (n = *11*, M = 71.36, SD = 20.78) did not differ significantly on the MARS from those who did not report a lack of encouragement, praise, support, and help [(n = 118, M = 68.19, SD = 18.57); t(127) = -.54, p = .593].

Although having an individual do something to decrease math confidence was related to math anxiety, an analysis of covariance was conducted to test if this effect was independent of general anxiety and test anxiety. Once both general anxiety and test anxiety were controlled for, these results became non-significant, F(1,121) = 3.433, p =.066, which suggests that experiences such as these may be more related to general or test anxiety than math anxiety in particular.

"What events at home stand out for you in shaping your feelings about math? Please explain." Participants' responses were coded to reflect various responses of events that shaped participants' feeling about math, most of which related to parental support (e.g., parents' help, parents' encouragement and praise, sibling rivalry, and helping siblings with math, see Appendix G). Considering all of these actions together, 85.5% of participants reported that there were events that stood out for them in shaping their feelings about math, whereas 12.2% reported that there was no event that stood out for them in shaping their feelings about math. Looking at the individual actions, individuals most commonly reported that parents' help (22.9%), parents' encouragement and praise

(16.8%), and having parents or family members that were good at math (16%) stood out as events that helped shape their feelings about math. Participants also reported parents stressing that math was important and to do well (9.2%), parents stressing that is was important to do well overall (7.6%), sibling rivalry (4.6%), helping siblings with math (3.1%), the routine of practicing math (1.5%), and parents who made them feel bad and/or punished them for low marks in math (1.5%) stood out in shaping their feelings about math (see Table 5).

Across all reported actions, there was no significant difference in the scores on the MARS for those who reported having events at home that stood out for them in shaping their feelings about math (n = 112, M = 67.95, SD = 19.66), and those who did not have events at home that stood out for them in shaping their feeling about math [(n =15, M = 67.24, SD = 12.07); $t(125) = -1.37$, $p = .892$]. There was no significant difference in scores on the MARS for those who reported receiving parents' encouragement (n = 22, M = 64.34, SD = 18.90) and those that did not [(n = 105, M = 68.30, SD = 18.90); $t(123) = .093$, $p = .337$]. In addition, no significant difference in scores on the MARS was seen for those who reported having parents who stressed that math was important and to do well (n = 12, M = 70.75, SD = 18.14) and those that did not [(n = 115, M = 67.56, SD = 19.01); $t(125) = -.56$, $p = .580$] , and parents who stressed that it was important to do well overall (n = 10, M = 64.10, SD = 20.18) and those that did not [(n = 117, M = 68.19, SD = 18.83); $t(125) = .655$, $p = .514$]. However, there was a significant difference in scores on the MARS for those who reported receiving no help from their parents (n = 97, M = 71.47, SD = 18.37) and those who reported receiving help from parents [(n =30, M = 56.20, SD = 15.76); $t(125) = 4.11$, $p < .0005$; $d = .89$].

In order to determine the amount of variance in math anxiety accounted for by receiving help from parents above and beyond general anxiety and test anxiety, an analysis of covariance was conducted. These results remained significant once both general anxiety and test anxiety were controlled for; [$F(1,120) = 7.83$, $p = .006$] suggesting that a relationship exists between receiving help from parents and math anxiety, above and beyond general anxiety and test anxiety.

Math Experience – Instructional Scale. Bivariate correlations were conducted to assess the relationships between math anxiety as measured by the MARS and the instructional dimension of Math Experiences as measured by the Math Experience Questionnaire throughout Elementary, Junior High, and High School. These correlations indicated that instructional methods were significantly related to math anxiety during all three defined periods of time (see Table 4).

As before, semi-partial correlations were also conducted to test whether or not the significant relations between scores on math anxiety and the Elementary School, Junior High, and High School instructional methods scales were still present once general anxiety and test anxiety were removed from math anxiety (see Table 4). When general anxiety and test anxiety were controlled, results remained significant where instructional methods were concerned in Elementary and High School, suggesting that the poorer one's instructional methods, the higher one's math anxiety. However, this was not the case for instructional methods in Junior High, as the result did not remain significant once general anxiety and test anxiety were controlled.

Open-ended – Instructional Scale. "*Did your teacher do anything to increase your anxiety about math?"* Participants' responses were coded to reflect a number of

teacher actions that increase math anxiety such as having a teacher that was unapproachable, having a teacher that was angry or frustrated, having a teacher speak about how difficult math was, and having a teacher move through the material too fast (see Appendix G). Taking all of these actions into account, 65.6% of participants reported that a teacher did something to increase their math anxiety, while 29.8% of participants reported that a teacher did not do something to increase their math anxiety. Looking specifically at each action, participants most commonly reported that having a teacher speak about how difficult math was (10.7%) increased their anxiety about math. Furthermore, participants reported having a math teacher who made them feel poorly about themselves (i.e., were belittling, laughed at them; 9.9%), having a teacher who had high expectations (6.1%) and having a teacher who was unapproachable (6.1%). Participants also reported the following actions performed by a teacher: having a teacher who was angry or frustrated (5.3%), having a teacher who placed emphasis on tests and/or doing well on them (3.8%), having a teacher move through the material too fast (3.1%), and being tested on material that was not covered in class (3.1%; see Table 6).

Across all reported actions, there was a significant difference in math anxiety scores for those who did not have a teacher do something to increase their anxiety about math (n = 38, M = 61.50, SD = 16.19) and those who did have a teacher do something to increase their anxiety about math [(n = 86, M = 71.31, SD = 19.53); t(122) = -2.71, p = .008; d = .56)]. In order to determine the amount of variance in math anxiety accounted for by this variable above and beyond general anxiety and test anxiety, an analysis of covariance was conducted. Once both general anxiety and test anxiety were controlled for these results became non-significant; [F(1,117) = 4.88, p = .029] suggesting that having a

teacher do something to increase participants' anxiety about math was not related specifically to their level of math anxiety.

Participants also reported having teachers speak about the difficulty of math. There were no significant differences in scores on the MARS from those who did not report having a teacher speak about how difficult math was (n = 110, M = 69.14, SD = 19.17) and those who did report having a teacher speak about how difficult math was [(n = 14, M = 61.71, SD = 17.29); $t(122) = 1.38$, $p = .170$.] In addition, no significant differences in scores on the MARS were found between those who reported not having a teacher make them feel poorly about themselves (n = 111, M = 67.08, SD = 18.49) and those who did have a teacher make them feel poorly about themselves [(n = 13, M = 78.69, SD = 21.37); $t(122) = -2.12$, $p = .04$].

"Did your teacher do anything to decrease your anxiety about math? Please explain." Participants' responses were coded to encompass many different reported actions that teachers may have done to decrease the participants' anxiety about math, such as giving encouragement, praise and/or support, having weekly math quizzes on material taught, being available for extra help, and providing many examples and practice tests (see Appendix G). Once all of these actions were reviewed collectively, then 71.8% of participants reported that a teacher in their past did in fact do something to decrease their anxiety about math, whereas 24.4% reported that a teacher in the past did not do something to decrease their anxiety about math. Looking at each action individually, participants most commonly reported that they had a teacher who was available for extra help (24.4%), had a teacher who gave encouragement, and either praise, support, or both (22.1%) or had a teacher who explained and/or answered questions until they were

understood (15.3%). Having a teacher who gave lots of examples and/or practice tests was also reported by participants, with 8.4% reporting that they did in fact have a teacher who fit this description. Participants also reported having a teacher make math fun and/or simple (3.1%), doing well in math (2.3%), having a teacher who was patient and/or understanding (1.5%), and having weekly math quizzes on material learned (.8%) all contributed to decreasing their anxiety about math (see Table 6).

There was no significant difference on the MARS for those who reported having a teacher do something to decrease their math anxiety (n = 94, M = 68.15, SD = 19.15) and those who did not have a teacher do something to decrease their math anxiety [(n = 31, M = 65.88, SD = 17.48); $t(123) = -.585$, $p = .560$]. For those who reported the way in which teachers offered help (i.e., being available for extra help, giving plenty of examples, and explaining questions until they were understood), there was no significant difference in scores on the MARS for those who reported having a teacher being available for extra help (n = 32, M = 72.06, SD = 19.60) and those who did not report having a teacher being available for extra help [(n = 94, M = 66.49, SD = 18.64); $t(124) = -1.44$, $p = .152$]. There was no significant difference in scores on the MARS for those who reported having a teacher who gave encouragement, and either praise, support, or both (n = 29, M = 71.34, SD = 17.31) and those who did not have a teacher who gave encouragement, and either praise, support, or both [(n = 97, M = 66.87, SD = 19.40); $t(124) = -1.12$, $p = .267$]. Similarly, there was no significant difference in scores on the MARS for those who reported having a teacher with a kind personality (n = 31, M = 70.84, SD = 16.92) and those that did not report having a teacher with a kind personality [(n = 59, M = 66.95, SD = 19.58); $t(124) = .99$, $p = .323$]. Finally, no significant differences were found for those

who reported having a teacher explain questions until they were understood (*n = 20, M* = 60.10, *SD* = 19.64) and those who did not have a teacher explain questions until they were understood [(*n = 106, M* = 69.38, *SD* = 18.56); *t*(124) = 2.03, *p* = .044].

One aspect of teaching, however, did show a significant difference. Those who reported having a teacher give plenty of examples (*n* = 11, *M* = 52. 36, *SD* = 12.83) reported less math anxiety than those who did not [(*n = 115, M* = 69.39, *SD* = 18.83); *t*(124) = 2.93, *p* = .004; *d* = 1.06]. In order to test the amount of variance in math anxiety accounted for by having a teacher give plenty of examples above and beyond general anxiety and test anxiety, an analysis of covariance was conducted. These results remained significant once both general anxiety and test anxiety were controlled for; [*F(*1,119) = 7.98, *p* =.006] suggesting that having a teacher give plenty of examples is related to an individual's level of math anxiety.

Math Experience - Life Events. *"How many times did your family move homes when you were a child? During what grades did these moves occur?"* Participants' responses were coded to reflect the number of moves the participants endured and during which grade the moves were made (i.e., Elementary, Junior High, or High School). There were also categories to reflect those who moved prior to Elementary School and those who had moved but did not indicate in what grade (see Appendix G). Examining all of these actions together, 19.1% of participants reported moving during elementary school, 11.6% of participants reported moving during Junior High School, 6.9% of participants reported moving during High School, 18.3% of participants reported moving homes prior to Elementary School, and 6.9% of individuals reported a move, but, did not indicate during which grade the move

occurred. Overall, 51.9% of participants reported never having to move homes, 31.5% of participants reported moving homes once, and 16.2% of participants reported moving homes more than once (see Table 7).

For those who reported that they moved home during Elementary School, there was no significant difference in scores on the MARS for those who reported having moved during Elementary School (*n = 25, M* = 60.06, *SD* = 20.42) and those who did not move during Elementary School [(*n = 104, M* = 68.89, *SD* = 18.58); *t*(127) = .67, *p* = .503]. However, significant difference in scores on the MARS were found for those who had reported moving during Junior High School (*n* = 14, *M* = 83.97, *SD* = 14.37) and those who had not moved during Junior High School [(*n* = 114, *M* = 66.93, *SD* = 18.51); t(126) = -3.38, *p* = .001; *d* = 1.02].

In order to determine the amount of variance in math anxiety accounted for by having moved schools during Junior High School above and beyond general anxiety and test anxiety, an analysis of covariance was conducted. Once both general anxiety and test anxiety were controlled for these results became non-significant [*F(*1,121) = 2.20, *p* =.141], suggesting that moving schools during Junior High School was more related to general and test anxiety than to math anxiety.

These groups were then combined to form those who had not moved (*n* = 68), those who had moved once (*n* = 40), and those that had moved more than once (*n* = 21). There was no significant difference between those who had not moved, who had moved once, and who had moved more than once [*F* (2,126) = 1.84, *p* = .163]. These results suggest that math anxiety was not related to moves made in Elementary, Junior High, or

High School. In addition, the number of moves made did not appear to be related to math anxiety.

How many times did you have to change schools other than the transitions made from Elementary to Junior High and Junior High to High School? During which grades were these moves?" Participants' responses were coded to reflect the number of times the participants moved schools and what grade (i.e., Elementary, Junior High, or High School). There were also categories to reflect those who moved prior to Elementary School and those who had moved schools but did not indicate what grade (see Appendix G). Taking all of these actions into consideration, 17.6% of participants reported moving schools during Elementary School, 13% of participants reported moving schools during Junior High School, 6.1% of participants reported moving schools during High School, 18.3% of participants reported moving prior to Elementary School, and 3.8% of individuals reported moving schools, however, did not indicate during which grade the move occurred. Altogether, 55.0% of participants reported never having to move schools, 30.5% of participants reported moving schools once, and 13.7% of participants reported moving schools more than once (see Table 7).

For those who reported that they moved schools during Elementary School, there was no significant difference in scores on the MARS for those who reported having moved schools during Elementary School (n = 22,M = 71.07, SD = 20.11) and those who did not move schools during Elementary School [(n = 107, M = 67.57, SD = 18.81); $t(127) = -.784$, $p = .435$]. Additionally, no significant differences in scores on the MARS were found for those who had reported moving schools during Junior High School (n =

16, *M* = 77.90, *SD* = 19.58) and those who had not moved schools during Junior High School [(*n* = 113, *M* = 66.79, *SD* = 18.60); t(127) = -2.22, *p* = .028].

"Have you ever had to move to a new school within a school year? If so, in what grade?" Participants' responses were coded to reflect if and when participants had moved to a new school within a school year. Taking all of these actions into consideration, 9.2% of the participants reported moving to a new school within a school year, while 76.3% reported not having to move schools within a school year. Specifically, 0.8% of participants reported moving schools in kindergarten, grades one, four and five; 1.5% of the participants reported moving schools in grade six; 2.3% of the participants reported moving schools in grades two, seven, eight, nine, ten, eleven and twelve; and 4.6% of the participants reported moving schools in grade three (see Table 7).

There was no significant difference in scores on the MARS for those who reported having moved schools within a school year (*n* = 12, *M* = 72. 33, *SD* = 26.04), and those who did not report moving schools [(*n* = 99, *M* = 67.05, *SD* = 18.58); *t(*109) = -.89, *p* = .376]. These results suggest that no relationship exists between moving schools during a school year and math anxiety.

"Did moving schools affect your academic performance in math? Please explain." The responses were coded to reflect if and how moving schools affected the academic performance of the participants such as: Yes, my marks improved, Yes my marks got worse, and Yes it was hard to adjust to new surroundings, teachers, peers, and curriculum (see Appendix G). Of the participants who had moved schools, 31.3% reported that their academic ability had not been affected while 18.3% reported that their academic ability had been affected. Of those who reported that their academic ability was

affected, 5.3% reported that it was hard to adjust to new surroundings, teachers, peers, and curriculum, 4.6% reported that their marks improved, 2.3% reported their marks got worse, and .8% reported that things got worse (see Table 7).

Overall, no significant difference in scores on the MARS was found for those who reported that their academic performance was affected by moving schools (n =24, M = 77.08, SD = 21.82) and those who reported no effects on academic performance [(n = *40*, M = 72.77, SD = 17.60); $t(62) = -.866$, $p = .390$)].

"What events in school stand out for you in shaping your feelings about math? Please explain." Participants' responses were coded to reflect a number of responses of events in school that stood out for participants in shaping their feelings about math, some of which include good math teachers, being asked to take part in competitions, and getting awards (see Appendix G). Bearing in mind all of these actions, 91.6% of participants reported that there were events that stood out in school for them that helped shape their feelings on math, while 5.3% of participants reported that there were not events that stood out in school for them that helped shape their feelings on math. Looking at the individual actions, individuals most commonly reported that good math teachers (17.6%), doing well and/or being confident in their math abilities (13%), and being asked to take part in competitions and/or clubs (12.2%) helped shape participants' feelings about math. Doing poorly or lower than expected in math was also relatively common (11.5%), followed by bad math teachers and getting awards or being nominated for awards in math (8.4%), being in advanced math (6.9%), and the manner in which they were treated depending on which stream (i.e., basic, academic, and advanced math) they were doing (3.1%; see Table 7).

There were no significant differences found in scores on the MARS for those who reported having good math teachers (n = 23, M = 64.37, SD = 14.82) and those who did not [(n = 104, M = 68.90, SD = 19.89); t(125) = 1.03, p = .304] as well as those who reported bad math teachers (n = 11, M = 74.18, SD = 21.04) and those who did not [(n = 116, M = 67.51, SD = 18.90); t(125) = - 1.11, p = .270]. In addition, there were no significant differences in scores on the MARS for those who reported being asked to take part in competitions and/or clubs (n = 16, M = 61.91, SD = 21.39) and those who did not [(n = 111, M = 68.97, SD = 18.68); t(125) = 1.39, p = .168], and those who reported doing poorly or lower than their expectations (n = 15, M = 76.83, SD = 19.56) and those who did not [(M = 66.91, SD = 18.82); t(126) = - 1.91, p = .059].

Moreover, no significant differences in scores on the MARS were found between those who reported doing well and/or being confident in their math ability (n = 17, M = 57.88, SD = 14.78) and those that did not report being confident in their math ability [(n = 110, M = 69.66, SD = 19.26; t (125) = 2.41, p = .017]. Additionally, there were no significant differences in scores on the MARS for those participants who reported receiving awards or being nominated for awards in math (n = 11, M = 56.64, SD = 17.52) and those who did not report receiving awards or being nominated for awards in math [(n = 116, M = 69.17, SD = 18.95); t(125) = 2.11, p = .037].

"Did you have any positive or negative experiences in math-related to your gender? Please explain." Overall, 78.6% of the participants reported having no positive or negative experience related to gender, while 16.85% of participants reported having a positive or negative gender-related experience. Overall, no significant differences were found in scores on the MARS for those who reported having no positive or negative

experience related to gender (*M* = 68.70, *SD* = 20.85) and those who reported having a positive or negative gender-related experience [(*M* = 67.68, *SD* = 17.10); *t*(123) = .21, *p* = .831]. Specifically, results showed no significant differences in scores on the MARS for those who had reported experiencing a negative gender-related experience (*n* = 22, *M* = 67.68, *SD* = 17.10) and those who did not [(*n* = 103, *M* = 67. 92, *SD* = 19.39); *t*(122) = .053, *p* = .958].

"During your time at school did you or a family member experience any major physical or mental health problems?" Overall, 42% of participants reported that during their time at school, they or a family member experienced a major physical or mental health problem, while 55% of participants reported that during their time at school, they or a family member did not experience a major physical or mental health problem. Participants most commonly reported that a family member had experienced a major physical health problem (20.6%). Reporting of personal mental health problems was relatively common (8.4%), followed by family mental health problems (6.9%), personal physical health problems (6.1%), family members experiencing both mental and physical health problems (1.5%), and personally experiencing both mental and physical health problems (.8%; see Table 7).

Overall, there were no significant differences in scores on the MARS for those who reported having personal or familial encounters with mental or physical health problems that occurred during their time at school (*n* = 55, *M* = 71.81, *SD* = 19.44) and those that did not [(*n* = 71, *M* = 65.19, *SD* = 18.53); *t*(124) = -1.95, *p* = .054]. For those who experienced personal mental health problems, no significant differences were found in scores on the MARS for those who reported experiencing mental health problems

during school (n = 11, M = 70.64, SD = 22.31) and those who did not [(M = 67.72, SD = 18.76); t(126) = - .484, p = .624]. As well, there were no significant differences in scores on the MARS for those who reported a family member experiencing physical health problems (n = 27, M = 67.91, SD = 19.09) and those who did not [(n = 101, M = 67.99, SD = 19.09); t(126) = .20, p = .984].

"During your time at school did you or a family member experience substance abuse problems?" Overall, 83.2% of the participants reported not having any personal or familial experiences with substance abuse while 11.5% of participants reported having either personal or familial experiences with substance abuse. Specifically, 1.5% of participants reported personal experience with substance abuse and 6.9% reported that a family member experienced substance abuse problems. For those who reported having personal or familial experience with substance abuse, there were no significant differences in scores on the MARS for those who reported having experience with substance abuse (n =12, M = 75.06, SD = 14.60) and those who did not report having experience with substance abuse [(n = 108, M = 67.31, SD = 19.11); t(121) = -1.51, p = .134]

"Did you experience anything in your personal life that you believe affected your academic ability? Please explain." Responses were coded to reflect many different reported experiences such as substance abuse, interpersonal problems, death of a family member, and lack of self-confidence (see Appendix G). Considering all reported experiences 48.9% of participants reported something had occurred in their personal life that they believed affected their academic ability, while 49.6% of participants reported nothing had occurred in their personal life that they believed affected their academic

ability. Looking at each experience individually, participants most commonly reported mental health problems either personal or familial (9.2%), interpersonal problems (6.9%), and parents' separation or divorce (4.6%) as being things that they believed affected their academic ability. Participants also reported being made fun of by peers (3.8%), having a lack of self-confidence (3.8%), substance abuse (1.5%), death of a family member (1.5%), physical personal or familial health problems (1.5%), and being involved in too many extracurricular activities (1.5%) as events that they believed affected their academic ability (see Table 7).

Overall, there was no significant differences in scores on the MARS for those who reported having something that had occurred in their personal life that they believed affected their academic ability (n = 63, M = 71.49, SD= 19.13) and those who had reported nothing had occurred in their personal life that they believed affected their academic ability [(n =65, M = 64.57, SD = 18.41); $t(126) = -2.09$, $p = .039$]. These results suggest that there is no difference in the level of math anxiety for those who had reported that something in their personal life affected their academic ability and those that did not.

Math Experience - Math Marks. As was the case for the support and instructional scale, bivariate correlations were conducted to assess the relationships between math anxiety as measured by the MARS and the math marks dimensions of Math Experience. As demonstrated by these correlations math marks were significantly and negatively correlated with math anxiety, indicating that as math marks decreased, math anxiety increased.

Semi-partial correlations were also conducted to test the relationships between scores on math anxiety and math marks during Elementary, Junior High, and High School

to assess whether this scale remained significant once general anxiety and test anxiety was removed from math anxiety (see Table 4). When general anxiety and test anxiety were controlled, all three of these correlations remained significant. These results suggest that experiences related to their performance throughout school as measured by the math marks scale of the Math Experience Questionnaire are negatively related to math anxiety, even when general anxiety and test anxiety have been taken into account.

Notably, these are retrospectively recalled math marks that are self-reported and not verified. Therefore, this analysis is assessing the relationship between math anxiety and self-reported retrospective recall of math performance.

Summary of Results

The results of this study are quite complex, as there were many comparisons made between math anxiety and the previously identified variables. The following section highlights the major findings of this study in relation to the research questions.

First, this study examined the relationship between math anxiety and personality variables. A significant relationship was found between neuroticism and math anxiety, but this relationship became non-significant after controlling for general anxiety and test anxiety.

Second, the study assessed environmental factors, specifically previous math experiences related to support, instructional methods, life events, and math marks. With regards to the Likert scales, all of the scales across all of the school periods were negatively related to math anxiety. However, once general anxiety and test anxiety were controlled for, the only scales that remained significantly related to math anxiety included: 1) perceived level of support in High School; 2) instructional methods in

Elementary and High School; and, 3) math marks in Elementary, Junior High, and High School.

Regarding the open-ended questions, most of the reported experiences did not relate to math anxiety. In the support category, reporting that someone did something to decrease math confidence was positively related to math anxiety and, in the instructional category, reporting that teachers did something to increase their anxiety about math was also positively related to math anxiety. Both of these results, however, became statistically non-significant after controlling for general and test anxiety. Moving during Junior High was also related to higher math anxiety, but this also became non-significant after controlling for general and text anxiety. Two types of reported experiences, however, retained their relation to math anxiety even after controlling for general and test anxiety. Specifically, participants who reported receiving help with math from parents and those who reported receiving plenty of examples from teachers reported significantly less math anxiety than those who did not report these experiences.

Discussion

Math anxiety has been defined as negative emotions (e.g., anxiety and tension) that interfere with an individual's math ability (e.g., responding to math problems), in a number of different settings (Richardson and Suinn, 1972). Researchers in the field of math anxiety have categorized factors associated with this construct into three broad categories: dispositional, environmental, and situational. Upon review of the literature there appears to be gaps with regards to both the dispositional and environmental factors. More specifically, no research has assessed the potential relationship between the Big

Five Personality traits and math anxiety, nor the potential relationship between past math experiences and math anxiety.

The purpose of the current study was to assess the potential relationships between math anxiety, personality variables (dispositional factors), and math experience (environmental factors). Specifically, the study was designed to address the following two questions: (1) Are there personality variables (in particular those defined by the Big Five; neuroticism, openness to experience, contentiousness, agreeableness, and extraversion) that contribute to the level of math anxiety experienced by university students and (2) how do past math experiences, specifically those associated with support, instructional methods, negative life events, and math marks contribute to the level of math anxiety experienced by university students? Although personality variables can be examined using existing measures, it was necessary to create a new measure to assess math experience and the four variables that were specifically assessed in this study (support, instructional methods, life events, and math marks). This study proposed five hypotheses regarding the relationships between math anxiety and the previously identified variables in this study. The first hypothesis pertains to personality variables while the following four hypotheses relate to math experiences. The following section will contextualize the results in terms of the current literature and their implications for clinicians, teachers, and future research. Additionally, the limitations of the current study will be reviewed.

Dispositional Factors

The current study examined math anxiety in relation to personality factors. As previously referenced dispositional factors are defined as personality factors that render an individual more prone to experiencing math anxiety. They can be thought of as a

vulnerability to math anxiety (Baloglu & Kocak, 2006). This study served to address a gap in the literature by specifically examining the five facets of personality (i.e., neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness) and the relationship of those facets to math anxiety. It was expected that there would be a relationship between neuroticism and math anxiety given the abundance of research that supports the relationship between neuroticism and anxiety and neuroticism and other psychological difficulties. Neuroticism is the domain of personality that has been most closely linked with psychological difficulties (Costa & McCrea, 1992). It was hypothesized that individuals who had a high level of neuroticism would show a higher level of math anxiety compared to those who did not demonstrate similar levels of these traits. However, the results of the current study did not support this hypothesis.

The results suggested that in this sample, math anxiety, as measured by the Math Anxiety Rating Scale, did not have a relationship with personality variables over and above its relation to general and test anxiety. While the initial results found a relationship between neuroticism and math anxiety, the relationship became non-significant once general and test anxiety were controlled for. The findings of the current study also suggest that neuroticism has a stronger relationship to general anxiety when compared to math anxiety. Additionally, it is also possible that general anxiety and test anxiety may mediate the relationship between neuroticism and math anxiety.

Previous research supports the presence of anxiety in academic situations, specifically those involving testing (test anxiety) and math (math anxiety; Hembree, 1990). Therefore, it is likely that individuals who have higher levels of anxiety in general are more susceptible to be anxious in specific situations such as those involving math and

tests. It is not surprising that the results suggest a stronger relationship between neuroticism and general anxiety, as previous research has strongly supported this view (Barlow & Craske, 2008; Clark, Watson, & Minika, 1994; Kotov et al., 2010). For example, Barlow and Craske (2008) suggest that neuroticism is a "higher order factor characteristic (pg.6)" of all anxiety disorders. Kotov and colleagues (2010) convey the importance of examining neuroticism when assessing personality characteristics and their potential relationship to psychopathology. Finally, in the past it was not uncommon for researchers to use neuroticism and anxiety as synonyms for one another, as anxiety disorders were previously labeled neurotic disorders (Clark, Watson, & Minika, 1994). These points are consistent with the finding of this study that while neuroticism is related to general anxiety, it is not as clearly related to math anxiety. Research suggests a close relationship between anxiety and neuroticism; therefore, it is possible that when general anxiety was statistically controlled for, it eliminated the relationship between neuroticism and math anxiety.

Due to the number of similarities found between math anxiety and general anxiety, researchers have used theories of anxiety to further the understanding of math anxiety as a construct. However, much of this research focused on the "State and Trait" theory proposed by Speilberger (1972). Results of the current study did not clarify whether math anxiety can be classified as a type of state anxiety (i.e., "an unpleasant emotional state or condition which is characterized by activation or arousal of the autonomic nervous system, which is dependent on time, the situation, and the perception of danger") or trait anxiety, which has been described as a somewhat consistent individual difference (personality characteristic) increasing an individual's vulnerability to anxiety

(Spielberger, 1972, p.482; as cited in Isiksal, Curran, Koc Gary & Askun, 2009). Researchers have noted that math anxiety may typically occur only when individuals are faced with numbers, math, and calculations (Brady & Bowd, 2005). Results of the current study are consistent with such previous findings suggesting that math anxiety is present only in specific situations. At the same time, math anxiety was strongly related to general anxiety, which research has shown to be highly correlated with neuroticism. This suggests that while math anxiety may occur in specific circumstances, like a type of state anxiety, it also may be more likely to occur in people who are generally more anxious (trait anxiety) and placed in situations that create feelings of discomfort. As such, math anxiety can be argued to be both a form of state anxiety and trait anxiety. For this reason, it might be better to assess math anxiety in terms of Barlow's triple vulnerability model, as opposed to the dated model of state and trait anxiety.

Additionally, these results suggest a difference between math anxiety and test anxiety. Although previous research demonstrated a strong relationship between test anxiety and neuroticism, the results of the current study suggest there is no independent relationship between personality variables and math anxiety. However, it is worth noting that Chamorro-Premuzic and his colleagues (2008) who examined the relationship between test anxiety and personality traits found a relationship between neuroticism and test anxiety, but they did not control for general anxiety. Therefore, it is possible that the relationship they found between test anxiety and neuroticism would no longer be significant once general anxiety has been controlled for. If this were the case, it is possible that both math and test anxiety have no independent relationship with personality variables.

On a final note, it may also be interesting to begin looking at math anxiety as parallel to a specific phobia. The diagnostic criteria for a Specific Phobia as stated in the Diagnostic and Statistical Manual of Mental Health Disorder -5 (American Psychiatric Association, 2013) is as follows; a) marked fear or anxiety about a specific object or situation (e.g., flying, animals, etc.); b) the phobic object or situation almost always provokes immediate fear or anxiety; c) the phobic object or situation is actively avoided or endured with intense fear or anxiety; d) the fear or anxiety is out of proportion to the actual danger posed by the specific object or situation and to the sociocultural context ; e) the fear, anxiety or avoidance is persistent, typically lasting for 6 months or more; f) the fear, anxiety or avoidance causes clinically significant distress or impairment in social, occupational, or other important areas of functioning; and g) the disturbance is not better explained by the symptoms of another mental disorder. Individuals who experience math anxiety may in fact meet diagnostic criteria for a specific phobia. Specifically, it appears as though these individuals experience fear solely related to specific situations (math) and use avoidance as a method of coping with their anxiety (Hembree, 1990). Moreover, research has supported the notion that reactions associated with math anxiety fall on a continuum, and occur in a variety of situations (Ashcraft & Moore, 2009). Furthermore, one can presume that a fear of math would hinder an individual's academic functioning. These individuals may be preoccupied with their feelings of math affecting their performance in school. It is also possible that they become truant from math class or school as they may be avoiding math. Research has previously demonstrated that anxiety management appears to be the most successful form of treatment to reduce math anxiety (Hembree, 1990). Moreover, having control over negative emotions and thoughts

associated with math has been shown to improve math performance (Maloney and Beilock, 2012). If this is the case, examining math anxiety as a specific phobia may help further guide the treatment of these individuals.

Environmental Factors

The second objective of the current study was to examine the relationship between past math experiences and math anxiety. As previously mentioned, environmental factors have been described as an individual's previous experiences and perceptions regarding math that lead to attitudes that evoke math anxiety in relevant situations (Baloglu & Kocak, 2006). Research in this field has found that negative experiences related to four main themes, namely, support, instructional methods, life events, and math marks were associated with math anxiety (Zoop, 1999; Martin, 1994). However, the research is unclear as to which experiences are predictive of math anxiety and which are not. The current study sought to clarify these experiences and their association with math anxiety by specifically examining individuals' experiences related to each of the four themes while in Elementary School (Grades 4 to 6), Junior High (Grades 7 to 9), and High School (Grades 10 to12) as outlined in hypotheses 2 through 5 in the introduction. The development of a questionnaire was necessary in order to assess these four specific themes, as no current measure exists that assessed math experience this way. This new questionnaire can be regarded as a first step in investigating the kinds of earlier experiences that are associated with math anxiety. The psychometric quality of this instrument is questionable as the numbers of items on each scale differs significantly, the construct validity of the measure was not assessed, and no formal factor analysis was

complete. Future research should be dedicated into creating a standardized measure assessing individuals experience with math anxiety.

Lack of Support. The second hypothesis examined in the current study focused on the relationship between math anxiety and perceived level of support. It was hypothesized that individuals who perceived having lower levels of support in Elementary, Junior High, and High School would have higher levels of math anxiety than those who perceived higher levels of support. The results showed that there was a relationship between perceived levels of support and math anxiety, but only for high school students. Furthermore, in the open-ended questions, participants who reported receiving help from their parents with math also reported less math anxiety.

A number of researchers have found perceived level of support to be associated with math anxiety (Jackson & Leffingwell, 1999; Schmidt, 2005; Zoop 1999). Specifically, Jackson and Leffingwell (1999) suggested that the teacher's perceived personality (i.e., hostile, insensitive, impatient, and critical) is associated with higher levels of math anxiety. Moreover, participants of their study who reported they had teachers who responded angrily when asked for clarification and showed a lack of understanding for those who needed extra time to grasp difficult math concepts had higher levels of math anxiety. Similarly, research conducted by Schmidt (2005) and Zoop (1999) suggested that supportive instruction and a lack of support were related to math anxiety.

Contrary to what was expected, the presence of a relationship between math anxiety and lack of support was found solely for perceived level of support in high school. These results suggest that perceived level of support in Elementary and Junior

High School was not related to an individual's level of math anxiety. These unexpected results could be due to the fact that both of these previously mentioned studies utilized very specific samples (i.e., pre-service teachers and individuals with high levels of math anxiety). Moreover, it is unclear if Jackson and Lefingwell truly assessed the participants' level of math anxiety. Furthermore, no comparisons were made between the experiences of individuals who suffered from math anxiety and those who did not. Therefore, one cannot say that non-math-anxious individuals do not have these same experiences.

Additionally, it is possible that the differences seen in the results can be accounted for by the needs of individuals during specific educational periods. For example, individuals may not require as much additional support in Elementary or Junior High math, as it is less demanding compared to High School math. Additionally, it is possible that individuals were receiving adequate support in Elementary and Junior High School. However, this support may have been removed as individuals advanced in education in an attempt to promote independence. It is also possible that as individuals aged they became aware of the social impact that receiving extra help may have and therefore did not ask for or want the help offered. There is no literature that supports these suppositions. However, they would be worthwhile to examine in future research.

Nevertheless, the results of the current study are consistent with some research in this field. Gierl and Bisanz (1995) concluded that as children got older and moved forward in school, their level of math test anxiety increased. Additionally, Baloglu and Kocak (2005) found higher total math anxiety scores for older students when compared to younger students. This is consistent with the need for higher level of support in High

School. Furthermore, the belief of some researchers that math anxiety did not appear prior to Junior High School also supports these results (Ashcraft, 2007).

Similar to general anxiety, it is possible that individuals who experience math anxiety may shift their attention onto themselves and their perceived character flaws. Furthermore, they may also underestimate their own ability to deal with perceived threatening situations (Suarez et al., 2009). These thoughts may lead individuals to believe that they require or lead them to want a higher degree of support. Moreover, it is possible that as a result of the degree of difficulty with math and the belief that math anxiety increases with level of education, higher levels of support are offered in higher grades (i.e., High School). Previous research has not examined perceived support in younger individuals; therefore, it is unknown how this research would compare. It is important for future research to examine in more detail the relationship between levels of math support received during Elementary and Junior High School and math anxiety as it could potential shed light onto the development of math anxiety, and its possible impact on younger children.

The current study also assessed the relationship between support and math anxiety with the use of open-ended questions. The open-ended questions provided space for the participants to reflect openly on their different experiences with math while also covering materials that could not be asked by close-ended questions. The majority, namely 87.8%, of participants, reported that someone did do something to increase their math confidence, whereas 11.5% of participants reported that they did not have anyone do something to increase their math confidence. With that being said, there were no significant differences between these two groups of participants. A little over half of participants reported that

someone did in fact do something to decrease their math confidence. Although those who reported having someone do something to decrease their math confidence had significantly higher math anxiety compared to those who did not. Once general anxiety and test anxiety were controlled for, these results became non-significant, suggesting that these results could not solely be accounted for by math anxiety, but also general and test anxiety.

Participants were also able to state a number of teacher variables that they believed to be associated with their levels of math anxiety, however, no significant differences between these variables were found during the analyses. This is surprising as previous research conducted by Jackson and Lefingwell (1999) suggested that teachers who were insensitive, impatient, hostile, and critical were related to higher levels of math anxiety. Moreover, Schmidt (2005) found that disrespecting/humiliation and fear-based instruction were associated with math anxiety.

It is also possible that individuals who are anxious in general interpreted others' actions in a more negative manner, in turn increasing levels of math anxiety. Research has shown that individuals who experience anxiety tend to view and pay closer attention to events they perceive as being negative, while also focusing on perceived threatening situations for a longer period of time (Hertel & Brozovich, 2010). Additionally, anxious individuals tend to view unclear events or situations as being negative (Hertel & Brozovich, 2010). Therefore, it is plausible that individuals who experience math anxiety and general anxiety perceive math situations and individuals who teach math as more negative, thereby increasing math anxiety. However, once general anxiety is controlled for, the impact of these distorted perceptions may also be controlled for, eliminating their

impact on math anxiety. These perceptions may be more related to general anxiety as opposed to math anxiety.

There was one group that did demonstrate a difference in math anxiety even after controlling for general and test anxiety. In response to the question about what events at home shaped their feelings about math, those who responded that they had parents who helped them with their math reported less math anxiety than those who did not report this help. It is interesting that this difference was evident in the data given that other kinds of parental support (e.g., parental praise and encouragement, parents stressing the importance of math) did not relate to a difference in math anxiety. Furthermore, it is worth noting that this one significant result was a positive event, in the sense that the presence of parental help was associated with less math anxiety. In other words, parental help in math could possibly be a protective factor in the development of math anxiety.

Instructional Methods. Instructional methods is perhaps the variable that has been the most researched in terms of its impact on an individual's level of math anxiety (Harper & Daane, 1998; Jackson & Leffingwell, 1999; Brady & Bowd, 2005). It was the second math experience theme examined in the current study. It was hypothesized that individuals who reported more negative experiences with instructional methods in Elementary, Junior High, and High School would have higher levels of math anxiety compared to those who reported fewer negative experiences. The results showed that although instructional methods in both Elementary and High School did have a negative relationship with math anxiety, this relation was not significant at the Junior High level. These results are mostly consistent with studies conducted in this area.

Most, if not all, studies that have examined instructional methods have found that poorer instructional methods have a positive relationship with math anxiety (i.e., the poorer the instruction, the higher the level of math anxiety). Previous research has identified a number of instructional methods that are related to math anxiety including: embarrassing students in front of their classmates, showing signs of gender bias, having a negative attitude, responding angrily when asked for clarification, showing a lack of understanding for those who need extra time to grasp difficult math concepts, teachers teaching at a fast pace which was too difficult to follow, and being made to feel unintelligent when asking for help or stating they did not understand (Jackson & Leffingwell, 1999; Brady & Bowd, 2005). Nevertheless, the general pattern of results from the current study and existing literature suggests that teachers should be aware of the impact that these types of instructional methods have on math anxiety in their students.

Noteworthy, three items assessing instructional methods in the current study were dropped from the measure as a result of decreasing reliability. It is possible that experiencing these types of instructional situations reflected in these items (e.g., asking students to answer questions in front of everybody) may have a different relation to math anxiety compared to other instructional situations that were included in the newly developed measure.

Results from the open-ended questions differed from the Likert question in that they did not provide as much support for the hypothesis. More than half of participants reported that a teacher did something to increase their math anxiety, while 29.8% of participants reported that a teacher did not do something to increase their math anxiety. However, there were no significant differences in math anxiety scores between these two

groups. Additionally, no significance was found between those who reported each individual variable (i.e., teacher was unapproachable, teacher was angry or frustrated, and the teacher spoke about how hard math was) and those who did not and their level of math anxiety. At the same time, 71.8% of participants reported that a teacher in their past did do something to decrease their anxiety about math, however, once again there was no significant difference between these groups with respect to levels of math anxiety. These results were somewhat surprising given that Bonnstetter (2007), Jackson and Leffingwell (1999), and Brady and Bowd (2005) found that teacher characteristics were related to the level of math anxiety experienced by the participants. Differences seen may be a result of the differing sample sizes in the comparison groups.

Interestingly, while none of the other reported teacher actions were related to math anxiety, those who recalled having a teacher give plenty of examples had significantly lower math anxiety compared to those who did not. This is interesting as one of the main components for the treatment for anxiety disorders is exposure (Craske & Barlow, 2008). Exposure is a technique whereby individuals face their fears, in an attempt to disprove their belief about the situation (Wagner, 2005). Exposure helps individuals habituate to the feelings of anxiety, eventually decreasing anxiety in specific situations (Wagner, 2005). Research has supported the use of anxiety management techniques to help with the reduction of math anxiety (Hembree, 1990). Furthermore, math performance has been shown to improve with the use of techniques that help individuals control negative emotions and thoughts associated with math (Maloney & Beilock, 2012). Therefore, it is possible that teachers who provide plenty of examples to their students are unknowingly using exposure, a commonly used technique for the treatment of anxiety. These teachers

are exposing their students to their fears (math) and unknowingly helping them habituate to their anxiety about the subject.

This result is helpful because, rather than admonishing teachers for helping to create math anxiety, it identifies possible ways that teachers may able to help decrease math anxiety. Moreover, it is consistent with and supported by existing literature regarding the treatment of math anxiety.

Life Events. Life events, the third math experience theme examined in the current study, were also assessed in terms of their possible impact on math anxiety. It was hypothesized that individuals who reported negative life events in Elementary, Junior High, and High School would have higher levels of math anxiety compared to those who did not experience these events. The results showed that there was no significant relationship between negative life events and level of math anxiety.

The first life event that was considered was the disruption caused by having to move during schooling years. Significant differences in levels of math anxiety were found for those who had reported moving during Junior High School and those who had not moved during Junior High School, but moves during Elementary School or High School were not related to math anxiety. However, once general anxiety and test anxiety were controlled for, moving during Junior High also became non-significant. Interestingly, while this suggests that moving schools is not predictive of the level of math anxiety experienced by participants, it may be related to the level of general anxiety. Junior High coincides with the transition into adolescence, which in itself causes much confusion and changes in physical appearance and emotional well-being. These changes could result in self-doubt that could transfer into academics. For this reason, Junior High could be a

more vulnerable time, compared to Elementary and High School, where moving schools may bring about difficulties that could lead to increased general anxiety as well as math anxiety. These results differ in comparison to those of Zoop (1999) who found a relationship between moving schools and math anxiety. The participants in Zoop's study, however, were adult learners who all had high math anxiety, and Zoop also did not consider the role of general and test anxiety. Moreover, she did not assess moves during different educational periods.

When participants were asked about events at home that stood out for them in shaping their feelings about math, 85.5% of participants reported that something had shaped their feelings about math. Specifically, those individuals who had not received help from their parents had higher levels of math anxiety compared to those who did not. These results appear to be consistent with those of Schmidt (2005) who found that disbelieving or abusive parents were related to higher math anxiety. Moreover, these results show the importance of having parents or guardians who are supportive.

Participants were also asked if they believe that something in their personal life affected their academic abilities. Of the participants, 48.9% reported something had occurred in their personal life that they believed affected their academic ability, but they did not differ in terms of math anxiety from those who did not report having something in their life that affected their academic abilities. Participants were additionally asked about events in school that may have shaped their feelings about math. The majority of participants stated that there were events that stood out, but, again, there was no significant difference in math anxiety between those that had events stand out and those who did not. Lastly, participants were also asked about personal and familial mental

health and substance abuse, however, neither showed a relationship with levels of math anxiety.

Results of the current study were not consistent with research conducted by Schmidt (2005) and Zoop (1999). Both of these researchers suggested that life events (including disbelieving or abusive parents, turbulent home life and parental conflict, major life transitions**,** changing schools, and working while attending school) were related to math anxiety. Differing results may be seen as a function of different samples being used, but also due to social desirability (i.e., participants not being forthcoming about their experiences).

Math Marks. In addition to perceived level of support, instructional methods, and life events, math marks and its relationship to math anxiety was also examined. This was the fourth and final math experience theme assessed in the current study. It was hypothesized that individuals who had lower math marks would have higher levels of math anxiety compared to those with higher math marks. Consistent with previous research, the results indicate that math marks were negatively associated with math anxiety during all three time periods.

The current study shows that individuals who have a poorer grade in math will typically experience higher levels of math anxiety, which comes as no surprise. In fact, this variable had the strongest relationship with math anxiety compared to the others. Noteworthy is the fact that the current study did not explicitly examine individuals' math marks, they are retrospectively recalled, self-reported and not verified. Therefore, these results are assessing the relationship between math anxiety and self-reported retrospective recall of math performance.

These results are consistent with previous research (Schmidt, 2005; Hunsley & Flessati, 1988). However, what is uncertain is whether the anxiety is causing the poor math marks, or the poor math marks are causing the anxiety. This question would be difficult to examine, as it is possible that math anxiety is interfering with concentration and memory when learning math, but it is also possible that poor marks could decrease an individual's confidence in math, in turn creating math anxiety. This question cannot be answered by the current study, but would be a worthwhile topic for future research.

Implications

One of the identified goals of this study was to address a gap in the literature with regards to math anxiety. Specifically, the gap related to the relationship between dispositional and environmental factors and math anxiety. This study helps clarify the relationship between math anxiety and personality traits, suggesting that personality traits are not directly related to math anxiety. No other research has assessed the Big Five Personality traits and their relationship with math anxiety. Therefore, further research is required to corroborate these results.

Furthermore, this study assessed the environmental factors specifically those of support, instructional methods, life events and math marks and their relationship with math anxiety. This is the first study to assess specifically these four variables in relation to math anxiety, and has served to enhance the literature in this field. Particularly, this study demonstrated the importance of support from teachers and parents where math is concerned, as well as the importance of support in High School. This is helpful as it may serve as a manner of prevention or reduction of math anxiety. Moreover, the importance of "good" instructional methods was shown. Specifically, a teacher who provided plenty

of examples decreased participants' level of math anxiety. Future research in this area should assess further what variables are considered to be "good" instructional methods that alleviate math anxiety. This information is invaluable and it could lead to the implementation of improved instructional methods into the school system, perhaps reducing math anxiety in the process. Results also indicated that math marks were negatively related to math anxiety, suggesting the poorer one's math marks are, the higher their level of math anxiety will be. Overall, the results of this study can be considered the first step in addressing a large gap within the literature of math anxiety.

This study may also provide useful information for individuals working in both the educational and potentially the mental health systems. With regards to the educational system, it is important for teachers to be aware of variables that contribute to math anxiety in an effort to help with its reduction and prevention. Moreover, it is important for teachers to be able to recognize when or if their students are experiencing math anxiety so that the proper interventions can be put in place (i.e., strategies for anxiety management). Individuals working in mental health may also benefit from further information with regards to math anxiety to be able to effectively create treatment programs for those who are affected by this specific anxiety.

Limitations and Future Directions

This study, like all research, has its limitations. First, the measure used to assess Math Experience was created for this study, and was not validated prior to its use. Although the face validity of this measure was supported in the present study, it has not yet been assessed for construct and content validity. However, the researcher did create this measure using previous research in the field as well as collaboration with other

researchers. The current measure was also organized around four themes (support, instructional methods, life events, and math marks) derived from the literature currently available on this topic. Furthermore, the researcher examined items of other measures that assessed math experience in somewhat of a similar fashion, and some of these items or variations of these items were then used in the current measure. Additionally, this measure was reviewed by members of the Research Center for Development of Mathematical Cognition to ensure the clarity and relevancy of the items. Reliability analysis was completed to ensure that the scales were adequate (i.e., had moderate internal consistency). Nevertheless, the measure used could have impacted the results found in this study. In future research, it would be important to extensively validate this measure (e.g., assess the construct and content validity), follow closely the research on scale development (e.g., Clark, & Watson, 1995), increase the number of items in each scale by having a large item pool, and discuss the measure with other researchers whose area of interest is similar.

Secondly, the participants in this study were all university undergraduates. One can presume that these students varied in math anxiety and math ability, but it seems likely that math ability, and perhaps even math anxiety, was less variable than it would be in the general population. Further research is needed to examine if these results would generalize to other adults, especially those with lower math skills.

Thirdly, the current study asked participants to reflect on past experiences. It is possible that due to the passage of time and faulty memory, individuals might have reported their experiences inaccurately. Moreover, it is possible that individuals could have distorted memories in relation to their past math experiences. Both current and past

levels of anxiety can impact the manner in which an individual thinks about and remembers situations. Specifically, anxious individuals have a tendency to recall and perceive information in a negative manner. Anxious individuals are prone to attend more negative events regardless if positive things occurred, and are prone to perceive situations which are unclear in a negative threatening manner (Aikins & Craske, 2001). Therefore, one can see how information recalled by anxious individuals may be unknowingly reported in a distorted manner.

It is also possible that social desirability could have played a part in their responses, meaning that individuals may have responded to the questions in the manner in which they thought was desired by the researcher. Therefore, future research in this field should include a measure of social desirability to be able to assess its impact on the obtained results.

The area assessing previous math experiences and their impact on math experience is relatively understudied. Future research should focus on either refining the measure of math experiences presented in this study or creating a new one. Moreover, conducting research and controlling for specific instructional methods may help with the prevention and treatment of math anxiety as this research could provide insight into which instructional methods prove to be the most beneficial. Longitudinal studies examining levels of math anxiety throughout individuals' schooling may also help with the development of prevention and treatment plans. Furthermore, it may also be interesting to examine the relationship that math anxiety has with other types of academic challenges, such as learning disabilities.

Conclusions

Findings from this study suggest that personality variables may not be directly related to math anxiety. However, it appears as though some previous math experiences may be related to the levels of math anxiety experienced by individuals. Some of these findings are consistent with those found in other studies, however, others were surprising. Specifically, the finding that an individual's recalled and self-reported math marks were related to math anxiety was not surprising, as most of the research indicates that an individual's performance in math is indeed related to math anxiety. Moreover, the relationship between math anxiety and support and instructional methods was different across different periods of schooling. However, this study was not able to provide details as to why these variables were related to math anxiety during these specific times. The results of the open-ended questions were quite surprising as many of the results were non-significant (with the exception of having a teacher provide many examples and receiving the help of parents). The results assessing other variables (i.e., the teacher's personality, teaching at a fast pace, receiving encouragement) were not consistent with the literature.

This study emphasizes the importance of researchers beginning to assess math anxiety in terms of more recent literature concerning anxiety. Barlow's triple vulnerability model is one of the more recent theories of anxiety; this theory proposes that a genetic vulnerability, a generalized psychological vulnerability, and early learning experiences all come together to contribute to the development of anxiety. The three vulnerabilities in Barlow's model of the development of generalized anxiety appear to be quite similar to the three broad categories of math anxiety: situational, dispositional, or environmental factors proposed by Baloglu and Kocak (2006). The dispositional and

environmental factors assessed in this study seem to correspond nicely to the genetic vulnerability, specifically that of personality traits and temperament, and the specific psychological vulnerability discussed by Barlow. On the other hand, situational factors (which were not examined in this study) appear to be similar to the generalized psychological vulnerability identified by Barlow.

Finally, this study also provides some insight into the individuals who are at higher risk for math anxiety, specifically, those who are doing poorly in math have lower levels of support and who experienced poorer instructional methods. Having this knowledge could aid teachers' and parents' understanding into the math anxiety experienced by their children. Additionally, it could help with the creation of programs and tutorials that would best assist these individuals achieve higher grades in math, while also serving to decrease their math anxiety. The research presented here furthers this cause and it is hoped that future research will further it even more.

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Table 1

Participants' Mean Scores and Standard Deviation on the Math Anxiety Rating Scale – Short Version (MARS-S), the Test Anxiety Inventory (TAI), Beck Anxiety Inventory (BAI), and the Penn State Worry Questionnaire (PSWQ)

	Mean	Standard Deviation
MARS-S	68.17	18.93
TAI	22.20	13.72
PSWQ	54.84	14.15
BAI	17.51	10.90

Table 2

Correlations between Math Anxiety, Test Anxiety, and General Anxiety as measured by the Beck Anxiety Inventory and Penn state Worry Questionnaire and five personality scales namely; Openness, Conscientiousness, Agreeableness, Extraversion, and Neuroticism (N=129).

	Math Anxiety	Openness	Conscientiousness	Agreeableness	Extraversion	Neuroticism	Test Anxiety	Beck Anxiety Inventory	Penn State Worry Questionnaire
Math Anxiety	1	-							
Openness	.07	1	-						
Conscientiousness	-.08	.03	1	-					
Agreeableness	-.10	.06	.34**	1	-				
Extraversion	.02	.24**	.30**	.20*	1	-			
Neuroticism	.36**	-.01	-.30**	-.34**	-.33*	1	-		
Test Anxiety	.65**	-.04	-.15	-.15	-.16	.44**	1	-	
Beck Anxiety Inventory	.57**	.07	-.16	-.03	-.10	.37**	.61**	1	-
Penn State Worry Questionnaire	.40**	-.01	.05	-.01	-.11	.60**	.49**	.53**	1

* p<.05
** p<.01

Table 3: Interrater Percentage Occurrence Agreement Per Open-ended Question

Open-ended Question	Interrater Percentage Occurrence Agreement Per Open-ended Question
In your past did anyone (i.e., a teacher, a parent, or a peer) do something to increase your confidence in your math ability? Please explain.	66.7%
In your past did anyone (i.e., a teacher, a parent, or a pier) do something to decrease your confidence in your math ability? Please explain.	91.2%
What events at home stand out for you in shaping your feelings about math	74.2%
Did your teacher do anything to increase your anxiety about math?	64.9%
Did your teacher do anything to decrease your anxiety about math	79.2%
How many times did your family move homes when you were a child? During what grades did these moves occur?	100%
How many times did you have to change schools other than the transitions made from Elementary to Junior High and Junior High to High School. During which grades were these moves?	100%
Have you had to move to a new school within a school year? If so, in what grades?	83.3%
Did moving schools affect your academic performance in math? Please explain.	78.0%
What events in school stand out for you in shaping your feelings about math? Please explain.	76.3%
Did you have any positive or negative experiences in math related to your gender? Please explain.	92.3%
During your time at school did you or a family member experience any major, physical, or mental health problems?	88.6%
During your time at school did you or a family member experience substance abuse problems?	100%
Did you experience anything in your personal life that you believe affected your academic ability?	100%

Table 4

Correlations between Math Anxiety and three dimensions of Math Experience in Elementary School, Junior High School, and High School; Support, Instructional Methods, and Math Marks (N=129).

	Math Anxiety	Math Anxiety Controlling for General and Test Anxiety
Support Elementary School	-.19*	-.126
Support Junior High School	-.19*	-.11
Support High School	-.30**	-.30**
Instructional Methods Elementary School	-.30**	-.21*
Instructional Methods Junior High School	-.23**	-.13
Instructional Methods High School	-.23**	-.24**
Math Marks Elementary School	-.45**	-.42**
Math Marks Junior High School	-.52**	-.41**
Math Marks High School	-.48**	-.42**

* $p<.05$
** $p<.01$

Table 5

Participants' Top Three Responses on the Support Scale Open-ended Questions

Open-ended Question	Top Three Responses		
In your past did anyone (i.e., a teacher, a parent, or a peer) do something to increase your confidence in your math ability? Please explain.	Encouragement from a teacher (29%)	Receiving extra help from a teacher (15.5%)	Encouragement from a parent (15.3%)
In your past did anyone (i.e., a teacher, a parent, or a pier) do something to decrease your confidence in your math ability? Please explain.	Having a math teacher who made them feel poorly about themselves (16%)	Lack of encouragement, praise, support, and help (8.4%)	Having a teacher that was unapproachable (5.3%)
What events at home stand out for you in shaping your feelings about math?	Parents' help (22.9%)	Parents' encouragement and praise (16.8%)	Having parents or family members that were good at math (16%)

Table 6

Participants' Top Three Responses on Instructional Scale Open-ended Questions

Open-ended Question	Top Three Responses		
Did your teacher do anything to increase your anxiety about math?	Having a teacher speak about how difficult math was (10.7%)	Having a math teacher who made them feel poorly about themselves (9.9%)	Having a teacher who had high expectations (6.1%)
Did your teacher do anything to decrease your anxiety about math?	Having a teacher who was available for extra help (24.4%)	Having a teacher who gave encouragement, either praise, support, or both (22.1%)	Having a teacher who explained and/or answered questions until they were understood (15.3%)

Table 7

Participants' Top Three Responses on Life Events Scale Open-ended Questions

Open-ended Question	Top Three Responses		
How many times did your family move homes when you were a child? During what grades did these moves occur?	Elementary School (19.1%)	Junior High School (11.6%)	High School (6.9%)
How many times did you have to change schools other than the transitions made from Elementary to Junior High and Junior High to High School. During which grades were these moves?	Prior to Elementary School (18.3%)	Elementary School (17.6%)	Junior High School (13%)
Have you had to move to a new school within a school year? If so, in what grades?	Grade 3 (4.6%)	Grades 2, 7, 8, 9, 10, 11, and 12 (2.3%)	Grade 6 (1.5%)
Did moving schools affect your academic performance in math? Please explain.	It was hard to adjust to new surroundings, teachers, peers, and curriculum (5.3%)	Marks improved (4.6%)	Marks got worse (2.3%)
What events in school stand out for you in shaping your feelings about math? Please explain.	Good math teachers (17.6%)	Doing well and/or being confident in their math ability (13%)	Being asked to take part in competitions and/or clubs (12.2%)
During your time at school did you or a family member experience any major, physical, or mental health problems?	A family member had experienced major physical health problems (20.6%)	Personal mental health problems (8.4%)	Family mental health (6.9%)
Did you experience anything in your personal life that you believe affected your academic ability?	Mental health problems, either personal or familial (9.2%)	Interpersonal problems (6.9%)	Separation or divorce (4.6%)

Appendix A

Script for reading to the classes

Script for reading to the classes

We are here to ask for volunteers for our research study concerning math anxiety. The purpose of this study is to examine the potential relationship between math anxiety and math experiences, as well as, assessing the potential relationship between math anxiety and personality traits. If you agree to participate in this study, you will be asked to fill out a number of paper and pencil questionnaires. If you decide to participate, we would ask for approximately an hour to an hour and a half of your time. To thank you for participating in this study you will be given a 1.5% increase to your course grade. However, if you do not wish to participate in this study you will be given opportunity to receive the same course credit by writing a summary of a research article.

There is minimal risk involved in the participation of this study. However, there is the potential for you to become fatigued and/or frustrated from completing the questionnaire packet. In addition it is possible for you to become anxious about the thoughts of completing this study, as Math is an anxiety-provoking topic for some individuals.

I would like to emphasize that your participation in this study is completely voluntary and if you wish to terminate your participation at any time you may do so without any consequences.

I will not pass around a sign-up sheet. If you wish to participate you should write down your name along with your contact information (phone number or email address) and you will be contact to set up a time where you can complete the study. If you have any about the study feel free to ask.

Thank you

Appendix B

Consent Form

Feelings About Math
Department of Psychology
Memorial University of Newfoundland

Title: Feelings About Math

Researchers: Krystle O'Leary, PsyD Candidate (Clinical)
Department of Psychology SN2051
Memorial University
St. John's, NL, Canada, A1B 3X9
Phone: 864-7698
Email: k.oleary@mun.ca

Supervisor : Dr. Darcy Hallett, Assistant Professor
Department of Psychology
Memorial University
St. John's, NL, Canada A1B 3X9
Phone: 709-737-4871 Fax: 709-737-2430
Email: darcy@mun.ca

You are asked to take part in a research project titled "Feelings About Math"

This form is a part of the informed consent process. It will give you some information regarding what the research project is about and what your participation will involve. Please read the below information carefully, if you have any questions please feel free to ask the researchers.

Participation in this study is voluntary and if you wish to withdraw at any point in time there will be no negative consequences.

Purpose of study: The current study seeks to examine the potential relationship between math anxiety and math experiences, as well as, assessing the potential relationship between math anxiety and personality traits.

What you will do in this study: If you agree to participate in this study, you will be asked to fill out a demographics questionnaire along with five other questionnaires one that will measure different aspects of your feelings about math, your experiences with math, your feelings about tests in general, as well as feelings and opinions about your general worldview.

Length of time: This research project should take approximately and hour to an hour and a half.

Possible Benefits: You will receive a 1.5% increase to your course grade for participating in the study. This will be offered through a subject pool system. However, if you do not wish to participate in this study you will be given opportunity to receive the same course credit by writing a summary of a research article. Please ask either of the researchers listed above if you want to know more about this option.

Possible risks: There is minimal risk involved in the participation of this study. However, there is the potential for you to become fatigued and/or frustrated from completing the questionnaire

packet. In addition it is possible for some people to become anxious about the thoughts of completing this study, as Math is an anxiety-provoking topic for some individuals.

Confidentiality: Your names will not appear on any forms aside from the consent form or be documented in any reports. Throughout the research study you will be identified by an identification number, and referred to by this number for the remainder of the study. Availability of the questionnaires will only be given to those who are directly involved with the research experiment, and they will be asked to sign an undertaking of confidentiality.

Storage of Data: All forms will be stored in a locked filling cabinet only accessible to the researchers involved in this study. All information will be destroyed upon the completion of the study

Questions: If at any time you have any question regarding the research please do not hesitate to ask. If you would like more information contact;

Source of Assistance:

University Counseling Centre
Location: 5th Floor University Centre, UC-5000
Memorial University of Newfoundland
St. John's, NL A1C 5S7
Phone: (709) 864-8874 Fax: (709) 864-3011
Hours of operation: 9:00 to 5:00, Monday to Friday

Math Help Centre
Location: Mathematics (Henrietta Harvey) Building, HH-3015
Instructor: Mr. Gerry O'Rielly,
Purpose: Aid students in learning the material in Math 1050, Math 1051, Math 1090, and Math1000
Hours of Operation**:** 10:00 to 4:00, Monday to Thursday, 9:00 to 1:00 Friday

Mathematics Learning Center
Website: http://www.mun.ca/mlc/home/

The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research and found to be in compliance with Memorial University's ethics policy. If you have ethical concerns about the research (such as the way you have been treated or your rights as a participant), you may contact the Chairperson of the ICEHR at icehr@mun.ca or by telephone at 737-2861".

Feelings About Math
Department of Psychology
Memorial University of Newfoundland

I _____, agree to participate in the current study. I have read the information letter provided and am aware of whom to contact in the event that I have any questions or concerns. I understand that my involvement in this study is voluntary and I am able to withdraw my participation at any time with no fear of penalty or consequences to me.

_____	_____
Date	Participant Signature
_____	_____
Date	Researcher Signature

Appendix C

Demographic Questionnaire

Demographic Questionnaire

Your responses to the following questions are important to the success of the current research study. It is necessary that you respond as accurately as possible. All responses will remain confidential and anonymous and they will be used for demographic purposes only.

1. Please indicate your sex: Male Female

2. What is your Birthday: _____
(Day/Month/Year)

3. What is your ethnicity: _____

4. What Elementary School did you go to: _____

5) What Junior High School did you go to: _____

6) What High School did you go to: _____

7) What year at MUN are you

- ☐ First Year
- ☐ Second Year
- ☐ Third Year
- ☐ Fourth Year
- ☐ Other (please specify) _____

5. What is your Major: _____

6. What is your Minor: _____

Appendix D

Math Experience Questionnaire

Math Experience Questionnaire

Elementary School (Grades 4 to 6)

Instruction: Please think back to your math teachers in Elementary School and indicate how strongly you agree with the following statements. If you chose the do not recall option please chose another that best reflects your memory of the experience.

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*	*Do Not Recall*
1. My math teachers encouraged me to do well in math	☐	☐	☐	☐	☐	☐
2. I could turn to my teachers when I needed help understanding math concepts	☐	☐	☐	☐	☐	☐
3. My math teachers seemed to favor boys over girls	☐	☐	☐	☐	☐	☐
4. My math teachers acted as though what they were teaching was easy to learn	☐	☐	☐	☐	☐	☐
5. My math teachers were kind	☐	☐	☐	☐	☐	☐
6. My teachers taught math too quickly for me to grasp the important concepts	☐	☐	☐	☐	☐	☐
7. My teachers tried to make math fun	☐	☐	☐	☐	☐	☐
8. My math marks were lower compared to other subjects	☐	☐	☐	☐	☐	☐
9. My teachers encouraged me to try new methods to solve math problems	☐	☐	☐	☐	☐	☐
10. My math teachers frequently had us work through math problems in groups	☐	☐	☐	☐	☐	☐
11. My teachers taught math rules without teaching the theory behind them	☐	☐	☐	☐	☐	☐

		Strongly Disagree	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***	***Do Not Recall***
12.	My math teachers were patient	☐	☐	☐	☐	☐	☐
13.	My math teachers ensured that they explained the terminology they were using	☐	☐	☐	☐	☐	☐
14.	My teachers tried to connect math to everyday life	☐	☐	☐	☐	☐	☐
15.	My math teachers had higher expectations for boys than girls	☐	☐	☐	☐	☐	☐
16.	My math teachers were understanding when I asked for help with math	☐	☐	☐	☐	☐	☐
17.	My teachers frequently asked me to answer questions in front of the class (i.e. on the black board, out loud)	☐	☐	☐	☐	☐	☐
18.	I was frequently left alone to work on math problems	☐	☐	☐	☐	☐	☐
19.	My math teachers were critical	☐	☐	☐	☐	☐	☐
20.	My math teachers frequently allowed us to use a calculator when working on math problems	☐	☐	☐	☐	☐	☐
21.	My math teacher frequently employed math competitions or games to help with teaching math concepts	☐	☐	☐	☐	☐	☐
22.	My math marks were higher compared to other subjects	☐	☐	☐	☐	☐	☐
23.	It was obvious that my teachers did not like math	☐	☐	☐	☐	☐	☐

		Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*	*Do Not Recall*
24.	My math marks were not up to my expectations	☐	☐	☐	☐	☐	☐

How many math teachers did you have during Elementary School?

Junior High School (Grades 7 to 9)

Instruction: Please think back to your math teachers in Junior High School, indicate how strongly you agree with the following statements. . If you chose the do not recall option please chose another that best reflects your memory of the experience.

		Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*	*Do Not Recall*
1.	My math teachers encouraged me to do well in math	☐	☐	☐	☐	☐	☐
2.	I could turn to my teachers when I needed help understanding math concepts	☐	☐	☐	☐	☐	☐
3.	My math teachers seemed to favor boys over girls	☐	☐	☐	☐	☐	☐
4.	My math teachers acted as though what they were teaching was easy to learn	☐	☐	☐	☐	☐	☐
5.	My math teachers were kind	☐	☐	☐	☐	☐	☐
6.	My teachers taught math too quickly for me to grasp the important concepts	☐	☐	☐	☐	☐	☐
7.	My teachers tried to make math fun	☐	☐	☐	☐	☐	☐
8.	My math marks were lower compared to other subjects	☐	☐	☐	☐	☐	☐

		Strongly Disagree	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***	***Do Not Recall***
9.	My teachers encouraged me to try new methods to solve math problems	☐	☐	☐	☐	☐	☐
10.	My math teachers frequently had us work through math problems in groups	☐	☐	☐	☐	☐	☐
11.	My teachers taught math rules without teaching the theory behind them	☐	☐	☐	☐	☐	☐
12.	My math teachers were patient	☐	☐	☐	☐	☐	☐
13.	My math teachers ensured that they explained the terminology they were using	☐	☐	☐	☐	☐	☐
14.	My teachers tried to connect math to everyday life	☐	☐	☐	☐	☐	☐
15.	My math teachers had higher expectations for boys than girls	☐	☐	☐	☐	☐	☐
16.	My math teachers were understanding when I asked for help with math	☐	☐	☐	☐	☐	☐
17.	My teachers frequently asked me to answer questions in front of the class (i.e. on the black board, out loud)	☐	☐	☐	☐	☐	☐
18.	I was frequently left alone to work on math problems	☐	☐	☐	☐	☐	☐
19.	My math teachers were critical	☐	☐	☐	☐	☐	☐

		Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*	*Do Not Recall*
20.	My math teachers frequently allowed us to use a calculator when working on math problems	☐	☐	☐	☐	☐	☐
21.	My math teacher frequently employed math competitions or games to help with teaching math concepts	☐	☐	☐	☐	☐	☐
22.	My math marks were higher compared to other subjects	☐	☐	☐	☐	☐	☐
23.	It was obvious that my teachers did not like math	☐	☐	☐	☐	☐	☐
24.	My math marks were not up to my expectations	☐	☐	☐	☐	☐	☐

How many math teachers did you have during Junior High School?

High School (Grades 10 to 12)

Instruction: Please think back to your math teachers in High School, indicate how strongly you agree with the following statements. . If you chose the do not recall option please chose another that best reflects your memory of the experience.

		Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*	*Do Not Recall*
1.	My math teachers encouraged me to do well in math	☐	☐	☐	☐	☐	☐
2.	I could turn to my teachers when I needed help understanding math concepts	☐	☐	☐	☐	☐	☐
3.	My math teachers seemed to favor boys over girls	☐	☐	☐	☐	☐	☐

		Strongly Disagree	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***	***Do Not Recall***
4.	My math teachers acted as though what they were teaching was easy to learn	☐	☐	☐	☐	☐	☐
5.	My math teachers were kind	☐	☐	☐	☐	☐	☐
6.	My teachers taught math too quickly for me to grasp the important concepts	☐	☐	☐	☐	☐	☐
7.	My teachers tried to make math fun	☐	☐	☐	☐	☐	☐
8.	My math marks were lower compared to other subjects	☐	☐	☐	☐	☐	☐
9.	My teachers encouraged me to try new methods to solve math problems	☐	☐	☐	☐	☐	☐
10.	My math teachers frequently had us work through math problems in groups	☐	☐	☐	☐	☐	☐
11.	My teachers taught math rules without teaching the theory behind them	☐	☐	☐	☐	☐	☐
12.	My math teachers were patient	☐	☐	☐	☐	☐	☐
13.	My math teachers ensured that they explained the terminology they were using	☐	☐	☐	☐	☐	☐
14.	My teachers tried to connect math to everyday life	☐	☐	☐	☐	☐	☐
15.	My math teachers had higher expectations for boys than girls	☐	☐	☐	☐	☐	☐

		Strongly Disagree	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***	***Do Not Recall***
16.	My math teachers were understanding when I asked for help with math	☐	☐	☐	☐	☐	☐
17.	My teachers frequently asked me to answer questions in front of the class (i.e. on the black board, out loud)	☐	☐	☐	☐	☐	☐
18.	I was frequently left alone to work on math problems	☐	☐	☐	☐	☐	☐
19.	My math teachers were critical	☐	☐	☐	☐	☐	☐
20.	My math teachers frequently allowed us to use a calculator when working on math problems	☐	☐	☐	☐	☐	☐
21.	My math teacher frequently employed math competitions or games to help with teaching math concepts	☐	☐	☐	☐	☐	☐
22.	My math marks were higher compared to other subjects	☐	☐	☐	☐	☐	☐
23.	It was obvious that my teachers did not like math	☐	☐	☐	☐	☐	☐
24.	My math marks were not up to my expectations	☐	☐	☐	☐	☐	☐

How many math teachers did you have during High School?

Instruction: Please indicate how strongly you agree with the following statements.

	Question	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***	***Not Applicable***
1.	My mother/female caregiver encouraged me to do well in math	☐	☐	☐	☐	☐	☐
2.	My father/male caregiver encouraged me to do well in math	☐	☐	☐	☐	☐	☐
3.	My parents/guardians would react negatively when I performed more poorly than expected in math	☐	☐	☐	☐	☐	☐
4.	I was rewarded and/or praised for doing well in math	☐	☐	☐	☐	☐	☐
5.	My parents/guardians had high expectations for me in math	☐	☐	☐	☐	☐	☐
6.	I was teased by my peers for my math ability	☐	☐	☐	☐	☐	☐
7.	My peers thought of me as someone who was good at math	☐	☐	☐	☐	☐	☐
8.	I had nowhere to turn when I needed help with math	☐	☐	☐	☐	☐	☐
9.	My mother/female caregiver believed that math was important for my future	☐	☐	☐	☐	☐	☐
10.	My father/ male caregiver believed that math was important for my future	☐	☐	☐	☐	☐	☐
11.	I believed math was important for my future	☐	☐	☐	☐	☐	☐

	Question	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***	***Not Applicable***
12.	Society seemed to value math	☐	☐	☐	☐	☐	☐
13.	My parents/guardians became frustrated when helping me with math	☐	☐	☐	☐	☐	☐
14.	I was confident when doing math	☐	☐	☐	☐	☐	☐

Instruction: Please answer the following questions as accurately and honestly as possible.

1. In your past did anyone (i.e. a teacher, parent, or peer) do something to increase your confidence in your math ability? Please explain.

_____

_____

_____

_____

_____

_____

_____

_____

2. In your past did anyone (i.e. a teacher, parent, or peer) do something to decrease your confidence in your math ability? Please explain.

_____

_____

_____

_____

_____

_____

3. Did your **teacher** do anything to increase your anxiety about math? Please explain.

4. Did your **teacher** do anything to decrease your anxiety about math? Please explain.

5. How many times did your family move homes when you were a child? During what grades did these moves occur (Elementary School, Junior High School or High School)?

6. How many times did you have to change schools other than the transitions made from elementary to junior high school and junior high to high school? During which grades were these moves made?

7. Have you ever had to move to a new school within a school year? If so, in what grades?

8. Did moving schools affect your academic performance in math? Please explain.

9. What events at home stand out for you in shaping your feelings about math? Please explain.

10. What events in school stand out for you in shaping your feelings about math? Please explain.

11. Did you have any positive or negative experiences in math-related to your gender? Please explain.

12. During your time at school did you or a family member experience any major physical or mental health problems?

13. During your time at school did you or a family member experience substance abuse problems?

14. Did you experience anything in your personal life that you believe affected your academic ability? Please explain.

_____

_____

_____

_____

_____

_____

_____

_____

Appendix E

International Personality Item Pool

International Personality Item Pool

Describe yourself as you generally are now, not as you wish to be in the future. Describe yourself as you honestly see yourself, in relation to other people you know of the same sex as you are, and roughly your same age. So that you can describe yourself in an honest manner, your responses will be kept in absolute confidence. Indicate for each statement whether it is: Very Inaccurate, Moderately Inaccurate, Neither Accurate Nor Inaccurate, Moderately Accurate, or Very Accurate as a description of you.

		Very Inaccurate	***Moderately Inaccurate***	***Neither Accurate Nor Inaccurate***	***Moderately Accurate***	***Very Accurate***
1	Am not easily bothered by things	☐	☐	☐	☐	☐
2	Tend to vote for conservative political Candidates	☐	☐	☐	☐	☐
3	Find it difficult to get down to work	☐	☐	☐	☐	☐
4	Make people feel at ease	☐	☐	☐	☐	☐
5	Am often down in the dumps	☐	☐	☐	☐	☐
6	Believe in the importance of art	☐	☐	☐	☐	☐
7	Am not interested in abstract ideas	☐	☐	☐	☐	☐
8	Feels comfortable with myself	☐	☐	☐	☐	☐
9	Do not enjoy going to art museums	☐	☐	☐	☐	☐
10	Don’t talk a lot	☐	☐	☐	☐	☐
11	Would describe my experiences as somewhat dull	☐	☐	☐	☐	☐

		Very Inaccurate	*Moderately Inaccurate*	*Neither Accurate Nor Inaccurate*	*Moderately Accurate*	*Very Accurate*
12	Am always prepared	☐	☐	☐	☐	☐
13	Have a sharp tongue	☐	☐	☐	☐	☐
14	Am the life of the party	☐	☐	☐	☐	☐
15	Rarely get irritated	☐	☐	☐	☐	☐
16	Seldom feel blue	☐	☐	☐	☐	☐
17	Shrink my duties	☐	☐	☐	☐	☐
18	Feel comfortable around people	☐	☐	☐	☐	☐
19	Have a good word for everyone	☐	☐	☐	☐	☐
20	Believes that others have good intentions	☐	☐	☐	☐	☐
21	Tend to vote for liberal political candidates	☐	☐	☐	☐	☐
22	Dislike myself	☐	☐	☐	☐	☐
23	Carry out my plans	☐	☐	☐	☐	☐
24	Carry a conversation to a higher level	☐	☐	☐	☐	☐
25	Have frequents mood swings	☐	☐	☐	☐	☐
26	Make friends easily	☐	☐	☐	☐	☐

		Very Inaccurate	*Moderately Inaccurate*	*Neither Accurate Nor Inaccurate*	*Moderately Accurate*	*Very Accurate*
27	Do not like art	☐	☐	☐	☐	☐
28	Make plans	☐	☐	☐	☐	☐
29	Waste my time	☐	☐	☐	☐	☐
30	Know how to captivate people	☐	☐	☐	☐	☐
31	Suspect hidden motives in others	☐	☐	☐	☐	☐
32	Am very pleased with myself	☐	☐	☐	☐	☐
33	Get chores done right away	☐	☐	☐	☐	☐
34	Accept people as they are	☐	☐	☐	☐	☐
35	Cut others to pieces	☐	☐	☐	☐	☐
36	Am skilled in handling social situations	☐	☐	☐	☐	☐
37	Enjoy hearing new ideas	☐	☐	☐	☐	☐
38	Don’t like to draw attention to myself	☐	☐	☐	☐	☐
39	Get back at others	☐	☐	☐	☐	☐
40	Do just enough work to get by	☐	☐	☐	☐	☐
41	Have little to say	☐	☐	☐	☐	☐

		Very Inaccurate	***Moderately Inaccurate***	***Neither Accurate Nor Inaccurate***	***Moderately Accurate***	***Very Accurate***
42	Don't see things through	☐	☐	☐	☐	☐
43	Respect others	☐	☐	☐	☐	☐
44	Have a vivid imagination	☐	☐	☐	☐	☐
45	Insult people	☐	☐	☐	☐	☐
46	Often feel blue	☐	☐	☐	☐	☐
47	Keep in the background	☐	☐	☐	☐	☐
48	Panic easily	☐	☐	☐	☐	☐
49	Pay attention to details	☐	☐	☐	☐	☐
50	Avoid philosophical discussions	☐	☐	☐	☐	☐

Appendix F

Debriefing Form

Thank you for taking the time to participate in this study. Your participation was greatly appreciated!

This study examined the potential relationship between math anxiety and math experiences, as well as, assessing the potential relationship between math anxiety and personality traits.

What is Math Anxiety?

Math anxiety has been defined as unpleasant feelings, specifically, those of tension and anxiety that impede an individual's ability to manipulate numbers and solve math problems in a variety of situations. These situations range from those in a classroom setting to those encountered in everyday life. Factors that influence math anxiety can be placed into one of three broad categories; situational, dispositional, or environmental factors. Situational factors are factors that occur instantaneously and are directly linked with the stimulus. Math dispositional factors, on the other hand, are essentially personality factors, which each individual brings to the situation at hand, that make them more likely to experience math anxiety. Environmental factors consist of an individual's previous experiences and perceptions regarding math that lead to attitudes that evoke math anxiety in relevant situations.

Very little research has investigated the dispositional and environmental factors of math anxiety. Therefore the goal of the current study was investigate both dispositional and environmental factors associated with math anxiety. Specifically, this study explored both math anxiety and its possible relations to math experiences and personality traits. In order to gain insight and to answer the research question five questionnaires were administered; The Math Anxiety Rating Scale (MARS; *Suinn and Winston, 2003*) which was used to measure levels of math anxiety, the Math Experience Questionnaire (Appendix A) which was used to assess individuals math experiences the 50-item IPIP representation of Costa and McCrae's (1992) five NEO domains (Goldberg, 1999) which was used to examine personality variables, the Test Anxiety Inventory (TAI; *Spielberger, 1980*) which was used to measure levels of test anxiety, the Penn State Worry Questionnaire (PSWQ; *Meyer, Miller, Metzger and Borkovec,1990*) which was used to measure levels of worry, the Beck's Anxiety Inventory (BAI; *Beck, Brown, Epstein, & Steer, 1988*) which was used to measure levels of anxiety. The data collected will be analyzed to determine if math experiences are associated with levels of math anxiety, as well as establish if there is a relationship between personality variables and levels of math anxiety.

Articles for further reading:

Hembree, R.(1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education, 21*(1), 33-46.

If you have any further questions, please contact:

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Appendix G

Coding Scheme

Question # 1: In your past did anyone (i.e. a teacher, parent, or peer) do something to increase your confidence in your math ability? Please explain.

1	No
2.1	Extra help from teachers
2.2	Extra help from parents
2.3	Extra help from tutors
3.1	Encouragement, Support, or Praise from teachers
3.2	Encouragement, Support, or Praise from parents
3.3	Encouragement, Support, or Praise from tutors
4	Teachers personality (Kind, Caring, Understanding, Want students to do well)
5	Being involved or being told you should be involved in an advanced or enrichment program
6	Being asked to be involved in Math competitions or leagues
7	Being asked to tutor others
8	Other

Question #2: In your past did anyone (i.e. a teacher, parent, or peer) do something to decrease your confidence in your math ability? Please explain.

1	No
2	Lack of encouragement, praise, support and help
3	Math teacher was unapproachable
4	Math teacher made me feel poorly about myself (i.e. Made me feel stupid, were belittling and/or laughed at me)
5	Math teacher was not concerned for how well people did
6	Thinking negatively about one's own abilities
7.1	Peers made fun of those that did poorly
7.2	Peers made fun of me because I did well
8.1	Parents would become frustrated and angry when teaching me math
8.2	Teachers would become frustrated and angry when teaching me math
9	My teacher hated math
10	My friends did better than me
11	There was negative feedback on tests when I got it back
12.1	I had high expectations for myself
12.2	Others had high expectations for me
13	Other

Question # 3: Did your teacher do anything to increase your anxiety about math? Please explain

1	No
2	Teacher was unapproachable
3	Teacher was angry or frustrated
4	Teacher spoke about how difficult math was
5	Emphasis placed on test and/or doing well on them
6	Teachers moved through material too fast
7	Testing on material that was not covered in class
8	My teacher had high expectations
9	Math teacher made me feel poorly about myself (i.e. Made me feel stupid, were belittling and/or laughed at me)
10	Other

Question # 4: Did your teacher do anything to decrease your anxiety about math? Please explain.

1	No
2	Teacher explained and/or answered question until they were understood
3	Encouragement, Praise, Support
4	Weekly math quiz's on material learnt
5	Teacher was patient and/or Understanding
6	Teacher made math fun and/or simple
7	I did well in math
8	Teacher was available for extra help (i.e. they were helpful, gave tutorials)
9	Gave lots of examples and/or practice tests
10	Other

Question # 5: How many times did your family move homes when you were a child? During what grades did these moves occur (Elementary School, Junior High School or High School)?

1	None
2	Elementary School
3	Junior High School
4	High School
5	Moved however, it was prior to elementary school
6	Moved however, no grade was indicated

Question # 6: How many times did you have to change schools other than the transitions made from elementary to junior high school and junior high to high school? During which grades were these moves made?

1	None
2	Elementary School
3	Junior High School
4	High School
5	Moved however, it was prior to elementary school
6	Moved however, no grade was indicated

Question # 7: Have you ever had to move to a new school within a school year? If so, in what grades?

1	No
2	Kindergarten
3	One
4	Two
5	Three
6	Four
7	Five
8	Six
9	Seven
10	Eight
11	Nine
12	Ten
13	Eleven
14	Twelve

Question # 8: Did moving schools affect your academic performance in math? Please explain.

1	No
2.1	Yes, my marks improved
2.2	Yes, my marks got worse
2.3	Yes, it was hard to adjust to new surroundings, teachers, peers and curriculum
2.4	Yes, things got worse
2.5	Yes, other

Question # 9: What events at home stand out for you in shaping your feelings about math? Please explain.

1	None
2	Parents help
3	Parents encouragement and praise
4	Sibling Rivalry
5	Parents stressing that math was important and to do well
6	Parents stressing that it was important to do well overall
7	Routine of practicing math
8	Helping siblings with math
9	Parents made me feel bad and/or punished me for low marks in math
10	Having parents or family members that were good at math
11	Other

Question # 10: What events in school stand out for you in shaping your feelings about math? Please explain.

1	None
2	Good math teachers (i.e. teachers that are encouraging, supportive and helpful)
3	Bad math teachers
4	The manner in which you were treated depending on what stream you were doing (advanced, academic or basic)
5	Being asked to take part in competitions and/or clubs
6	Doing well and/or being confidant in my math abilities
7	Getting awards or being nominated for awards in math (i.e. winning math competitions)
8	Being in advanced math
9	Doing poorly or lower then my expectations in math
10	Other

Question # 11: Did you have any positive or negative experiences in math-related to your gender? Please explain.

1	None
2	Positive
3	Negative

Question # 12: During your time at school did you or a family member experience any major physical or mental health problems?

1	No
2	I experienced Mental health problems
3	I experienced physical health problems
4	I experienced both
5	I experienced neither
6	My family experienced Mental health problems
7	My family experienced physical health problems
8	My family experienced both
9	My family experienced neither
10	Other (i.e. Deaths)
11	Yes, however, no specifics given

Question # 13: During your time at school did you or a family member experience substance abuse problems?

1	No
2	Yes I experienced substance abuse problems
3	No I did not experience substance abuse problems
4	Yes my family experience substance abuse problems
5	No my family did not experience substance abuse problems
6	Yes, however, no specifics given

Question # 14: Did you experience anything in your personal life that you believe affected your academic ability? Please explain.

1	None
2	Substance abuse
3	Mental health problems (personal or family member)
4	Interpersonal Problems
5	Physical health problems (personal or family member)
6	Transitions from high school to university
7	Being made fun of my peers
8	Parents separation or divorce
9	Death of family members
10	Lack of self confidence
11	Too many extra circular activities
12	Other