A Study of Mathematics Anxiety Amongst Primary Pre-service Teachers enrolled in a Dutch Teacher Training Program

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Abstract

This thesis is about mathematics anxiety of pre-service teachers enrolled in a teacher-training program at a primary school teacher training college (PABO) in the Netherlands, who prepared to become primary school teachers. The main purpose of my research was:

- to investigate if there were any indications of mathematics anxiety in Dutch pre-service teachers enrolled in the study year 2010-2011 in the teacher-training program at the PABO of the Hogeschool van Amsterdam (HvA); If so,
- to find out if there was a relationship between the students’ mathematics anxiety level and their performance in the mandatory mathematical skills test called WISCAT-pabo; and
- to explore if they were able to overcome their anxiety and to perform better in a skills test through training sessions and tutoring by peers.

In addition to the measurement of mathematics anxiety of first-year students and the exploration of the effectiveness of the given support to overcome this anxiety and/or pass the mathematical skills test, I also explored the Pedagogical Content Knowledge of prospective teachers who were further in their teacher-training program regarding the subject of mathematics anxiety. Through workshops with third-year students, I investigated what they knew about mathematics anxiety, whether they recognized it in their pupils (when they are practicing teaching at school), and what they thought one could do about it.
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1 Introduction

Despite its importance and applications in everyday life, mathematics is often considered as a difficult subject. Research has demonstrated that many students have learning difficulties and show poor performance in mathematics. One of the attributed reasons is the anxiety that an individual may have towards mathematics. The following provisionary definition of mathematics anxiety may be used: Mathematics anxiety is a state of a sinking feeling, uncertainty and despair at doing arithmetic and mathematics. Mathematics anxiety is an important factor that affects student achievement and attitude towards mathematics (See, for example, Hembree, 1990). It may for example lead to poor performance and avoidance of mathematics.

Preis and Biggs (2001) described mathematics avoidance and performance as a cycle as illustrated in Figure 1.

![Figure 1](image-url)

**Figure 1.** The cyclic nature of mathematics avoidance and mathematics performance.

In the first phase, the person experiences a negative feeling to mathematics related situations which could be a result of their past negative experiences with mathematics. This leads to the second phase in which the person begins to avoid mathematical situations, followed by phase three which involves poor mathematical preparations, and finally there is phase four characterized by poor mathematics performance. This
cycle becomes repetitive and difficult to break when the math anxious individuals conclude for themselves that they cannot sustain in any math related situations.

Research indicates that mathematics anxiety develops in a child mainly at the elementary school level, at the time that there occurs a shift from concrete to more abstract thinking (See, for example, Jackson & Leffingwell, 1999). It is important that mathematics anxiety is identified in a child as early as possible and that mathematics teachers know how to become aware of mathematics anxiety amongst their pupils and how to deal with it in the classroom. Many causes of teachers’ influence on the development of mathematics anxiety by their pupils have been proposed in the research literature. Some of them are: (a) lack of content knowledge of teachers; (b) attitudes of classroom teachers towards mathematics; (c) the teaching methods; and (d) mathematics anxiety in teachers.

These findings actually triggered my motivation to conduct research about mathematics anxiety. During the two years that I worked as a mathematics teacher in India, I realized that many students showed aversion towards mathematics. As a novice teacher myself, I had no knowledge about mathematics anxiety nor did my fellow teachers at school. It was during my study in the Master of Mathematics and Science Education at the University of Amsterdam that I got more insight in the occurrence of mathematics anxiety and the negative role it plays in the development of a child. I wanted to learn more about it and also about the role that teachers play in this.

As was noted in the previous two paragraphs, mathematics anxiety is not just limited to students, but it can even exist in teachers. According to Williams (1988), mathematics anxiety has its roots in teaching and teachers and has been tied to poor academic performance of students, as well as to the effectiveness of elementary teachers. According to Levine (1993), anxiety for teaching mathematics is a frequent fear of pre-service teachers. Mathematics teaching anxiety may reflect real or perceived knowledge deficits in mathematics content as well as in mathematics teaching skills, memories of past occurrences of mathematics failure or presence of mathematics anxiety in the teacher itself.

It is generally assumed that there are several causes of mathematics anxiety, categorized as personal, societal, environmental and pedagogical (See, for example, Trujillo & Hadfield, 1999). My research study focused on the pedagogical aspects and it concerned mathematics anxiety of pre-service teachers enrolled in a teacher-
training program at PABO\textsuperscript{1} in the Netherlands, who prepare to become primary school teachers. Considering the results of previous studies of other researchers, which indicate that teachers transmit their math anxiety to the students, the main purpose of my research was:

- to investigate if there were any indications of mathematics anxiety in Dutch pre-service teachers enrolled in the study year 2010-2011 in the teacher-training program at the PABO of the Hogeschool van Amsterdam (HvA); If so,

- to find out if there was a relationship between the students’ mathematics anxiety level and their performance in a mathematical skills test; and

- to explore if they were able to overcome their anxiety and to perform better in a skills test through training sessions and tutoring by peers.

The mathematics anxiety level was assessed through a self-report instrument taken from the research literature and proven to be suitable for use with primary school pre-service teachers. The mathematical skills test referred to above is WISCAT-pabo\textsuperscript{2}.

The purpose of the WISCAT-pabo was to determine the arithmetic skills and knowledge of the pre-service teachers up to the level of final year at the primary school. This test is mandatory for all Dutch students in the first year of PABO and they must pass this test in order to be allowed to continue the teacher-training program. Because this test is so important for the pre-service teachers, I also explored the test anxiety of students failing the skills test, because this may be an additional factor.

In addition to the measurement of mathematics anxiety of first-year students and the exploration of the effectiveness of given support to overcome this anxiety or pass the skills test, I also explored the pedagogical content knowledge (PCK) of prospective teachers when they are further in their teacher training program. Through a workshop I shared my knowledge and understanding of mathematics anxiety with the student teachers and discussed with them the symptoms, causes, and assessment of mathematics anxiety. In conjunction with the workshop, the pre-service teachers were asked to observe their pupils during a one-week of teaching at school, and report any indications of mathematics anxiety. I also discussed with them their own

\textsuperscript{1} PABO- Pedagogische Academie Basisonderwijs (In Dutch) = Primary school teacher training college.

\textsuperscript{2} WISCAT-pabo is a computerized adaptive testing of the basic arithmetic and mathematics level of first-year PABO students.
observations during their practice teaching sessions and the strategies they would adopt to deal with and overcome math anxiety in their future classrooms.
2 Literature Review and Theoretical Background

In this chapter, I give a short overview of the research literature about mathematics anxiety, test anxiety, and their presence in primary school pre-service teachers. Henceforth, I use the terms ‘math anxiety’ and ‘mathematics anxiety’ interchangeably.

2.1 Mathematics Anxiety

In this section, I review the research literature about the causes, symptoms and measurement of math anxiety. I also look into cognitive aspects of math anxiety and its presence in primary school pre-service teachers.

2.1.1 Definition

Bessant (1995) described mathematics anxiety as a multidimensional concept having both cognitive and affective roots. The cognitive domain contributes to the learning-approach framework for exploring the students’ difficulties in learning mathematics and for linking math anxiety with evaluation of mathematical skills. The affective domain contributes to the framework for examining mathematics affect, attitudes and the larger, more vague concept of anxiety.

A number of definitions of mathematics anxiety can be found in the research literature. They are all related to each other in their main aspects. For example, Richardson and Suinn (1972) described mathematics anxiety as “feelings of tension and anxiety that impair the ability to manipulate numbers and solve mathematical problems in a wide variety of ordinary life and academic situations” (p.551). Similarly, Tobias (1981) characterized math anxious individuals as those who mistrust their problem solving abilities and experience a high level of stress when called upon to use those abilities, particularly in public. Trujillo and Hadfield (1999) defined math anxiety as a state of discomfort that occurs in response to situations involving mathematical tasks that are perceived as threatening to self-esteem. Mathison (1977) defined math anxiety as an irrational fear of mathematics that ranged from a simple discomfort associated with numerical operations to total avoidance of mathematics classes. Ashcraft and Kirk (2001) explained that for example; the claim of statistics students who do poor at an exam that “they become confused,
are unable to focus on the task at hand, or keep thinking about how poor they are at math” is entirely consistent with their major result: “Math anxiety disrupts the ongoing, task-relevant activities of working memory, slowing down performance and degrading its accuracy” (p. 236). According to Ertekin, Dilmac, and Yazici (2009), “anxiety is a state of arousal that surfaces through bodily, emotional, and mental changes an individual experiences when faced a stimulus” (p. 1189). These feelings of anxiety can lead to fear, distress, shame, inability to cope, sweaty palms, nervous stomach, difficulty in breathing, and loss of ability to concentrate (Hembree, 1990; Malinsky, et al., 2006). Other symptoms include tension, nervousness, worrying, edginess, impatience, confusion, fear, and developing a mental block (Pérez-Tyteca, et al., 2009). Therefore the fear of mathematics, also referred to as math anxiety, reflects an internal aversion to any form of mathematical data or fear of working with numbers or equations that interfere with the performance of an individual and inhibit subsequent learning (Kelly & Tomhave, 1985; Hembree, 1990).

To sum up all the different versions of the definition of math anxiety, I would say that it is a state of discomfort or fear of working with numbers and solving mathematical problems that leads to an aversion and avoidance of mathematics and any mathematics related situations.

2.1.2 Origin

Trujillo and Hadfield (1999) wrote the following about the origin of mathematics anxiety (p. 219): “According to Hadfield and McNeil (1994) the causes of mathematics anxiety can be divided into three areas: environmental, intellectual, and personality factors. Environmental factors include negative experiences in the classroom, parental pressure, insensitive teachers, mathematics presented as rigid sets of rules, and nonparticipatory classrooms (Dossel, 1993; Tobias, 1990). Intellectual factors include being taught with mismatched learning styles, student attitude and lack of persistence, self-doubt, lack of confidence in mathematical ability, and lack of perceived usefulness of mathematics (Cemen, 1987; Miller & Mitchell, 1994). Personality factors include reluctance to ask questions due to shyness, low self esteem, and viewing mathematics as a male domain (Cemen, 1987; Gutbezahl, 1995; Levine, 1995; Miller et al., 1994).”

According to Ashcraft, Kirk and Hopko (1998), “early reports suggested that mathematics anxiety is a non-intellectual factor, in the sense that it was observed
even in otherwise successful students, which nonetheless had serious consequences for educational and career-related choices” (p. 176). From this, it can then be seen that the origins of negative beliefs and anxiety about mathematics are as diverse as are the individuals experiencing math anxiety.

2.1.3 Cognitive Consequences

From a cognitive point of view, mathematics anxiety has the most pronounced detrimental effect on arithmetical performance when the problems are relatively complex (Ashcraft & Faust, 1994; Ashcraft & Kirk, 2001). Difficulty of material at this level is seen when working with parts of numbers, such as those with two column additions that require carry operations or multiplication problems or memorizing multiplication tables. As the complexity of the problem increases, there is an increased possibility of losing track during calculations. In other words, the disruption of math anxious individuals is attributed to disturbance in working memory processes.

Math anxiety can interrupt and even make everyday activities of an individual difficult, for instance balancing a checkbook, developing a household budget or simply calculating a restaurant bill. In academic settings, math anxiety affects an individual in any school related activities, in classrooms and standardized test taking, resulting in what Ashcraft and Faust (1994) called ‘global avoidance’ (See also, Ashcraft & Ridley, 2005). In other words, math anxious individuals may avoid any mathematics courses or subjects involving mathematics. This may mean that math anxious individuals do not gain competence or mastery of mathematical operations and it may directly influence their performance in mathematics (Hembree, 1990). However, there are some students who suffer from math anxiety and yet study regularly, work hard in the classroom and finish their homework on time but are unable to present what they know because of the math anxiety in them. Some researchers believe that intrusive thoughts and worries about completing mathematical problems may interfere with working memory (Ashcraft & Kirk, 2001) and so they lack the ability to excel or perform well.

2.1.4 Presence in Primary Pre-Service Teachers

Math anxiety is widespread among existing primary school teachers and pre-service teachers (e.g., Malinsky et al., 2006; Çatlioglu, et al., 2009; Sloan, 2010). Research suggests that primary school pre-service teachers experience high levels of mathematics anxiety in comparison with other university students (See, for example, Kelly
& Tomhave, 1985; Trujillo & Hadfield, 1999; Vinson, 2001; Bursal & Paznokas, 2006; Swars, Daane & Giesen, 2006). Swetman, Munday and Windham (1993) found that primary school teachers experiencing a high level of mathematics anxiety spent less time on planning and dedicated fewer hours to mathematics related activities. Research by Bush (1981) and Hembree (1990) indicated that math anxiety has implications for teacher practices in mathematics and teachers’ willingness to embrace innovations. Their research revealed that teachers with high levels of mathematics anxiety tend to use more ‘traditional’ and teacher-centered approaches such as lecture based lessons, teaching from the textbooks, rote memorization, and the teaching of basic skills rather than concepts in mathematics. It was found that these teachers devote more time to seatwork, assign the same work to everyone, focus only on whole group instruction, and spend less time toward problem-solving techniques and strategies (cf., Gresham, 2008). In other words, negative attitudes of teachers toward mathematics can have negative impacts on mathematics teaching, with the result that teachers’ math anxiety is transferred to their pupils (Tobias, 1981; Vinson, 2001). Years before, Martinez (1987) has already noted that “Math-anxious teachers can result in math-anxious students” (p. 117). These negative attitudes of teachers are deeply rooted in the teachers’ experience as pupils at school and as students in the teacher-training institute. In a study conducted by Brady and Bowd (2005) with 238 primary pre-service teachers indicated that the confidence of the pre-service teachers in teaching mathematics was related to their mathematics anxiety and their prior mathematics learning experiences at school level. Uusimaki and Nason (2004) also found that for most of the Australian primary pre-service teachers participating in their study, the math anxiety could be attributed to their primary school experiences in learning mathematics. Pre-service teachers enter the teaching profession with relatively stable commitments to their beliefs. According to Smith (1996), these beliefs are often coupled with feelings of alienation and fear in mathematics settings and anxiety about the prospects of teaching it. Consequently, what teachers do in their mathematics lessons reflects their own thoughts and beliefs about the subject (Fernandes, 1995). This is a cause for alarm considering that, teachers who possess medium or high levels of mathematics anxiety may unintentionally transmit their avoidance and fear of mathematics to their students (Wood, 1988).

The implementation of effective instructional practices by a mathematics teacher, such as focus on the process rather than the product (as prescribed by
NCTM), has been linked to the level of mathematics anxiety of the teacher (Bush, 1981; Karp, 1991). Hackworth (1985) phrased it as follows: “The disproportionately large number of mathematically anxious teachers at the elementary school level is often said to influence not only the effectiveness of instruction, but may promote the early onset of mathematics anxiety among students” (p. 8). Some of the possible factors contributing to the anxiety feeling in the pre-service teacher’s are: prior school experiences such as their experiences as a mathematics student, the influence of prior teachers at school and of teacher preparation programs (Raymond, 1997).

The implication of such negative beliefs and negative experiences about teaching and learning mathematics on many primary teacher education students has resulted in the continuity of the math anxiety phenomenon.

**2.1.5 Measurement**

Math anxiety is commonly assessed through self-report instruments. Richardson and Suinn (1972) designed the Math Anxiety Rating Scale (MARS), which is a 98-item self-rating scale test to measure mathematics anxiety of college students. This instrument uses a 5-point Likert scale with questions that test students on their degree of anxiety in a given situation. The statements pertain to the respondent’s everyday life and situations that require them to think and do the tasks mathematically. MARS was once considered as the best available measure of mathematics anxiety with the highest validity and reliability. But the contemporary view (See, for example, Hopko et al., 2003; Bai, 2010; and other references mentioned below) seems to be that MARS has two major shortcomings: (1) it is a test that takes long time to administer and to score; and (2) it was developed with unidimensional representation of negative affect toward mathematics.

Many researchers have investigated mathematics anxiety using the MARS test, but further studies revealed that there might be more than one underlying construct in math anxiety (cf., Bessant, 1995; Baloğlu & Zelhart, 2007). In order to overcome the above-mentioned shortcomings, researchers started to develop several shorter, multidimensional versions of MARS. For example, Betz’s (1978) Mathematics Anxiety Scale (MAS), adapted from Fennema and Sherman’s (1976) Mathematics Attitude Scale, was set up as a 10-items bidimensional instrument. Items in both positive and negative wordings in MAS were intended to identify the bidimensional affects, positive and negative, toward mathematics. Betz (1978) gave the following
description of MAS: “The scale is intended to assess feeling of anxiety, dread, nervousness, and bodily symptoms related to doing mathematics’’ (p. 442). One of the most recent instruments assessing mathematics anxiety is Hopko et al.’s (2003) Abbreviated Math Anxiety Rating Scale (AMAS), an adapted version of MARS-Revised with only 9 items. Table 2.1 lists some of the most commonly used mathematics anxiety instruments and short versions. Special purpose versions of MARS have been developed for various target groups; they are also included in Table 2.1.

<table>
<thead>
<tr>
<th>Full name</th>
<th>Abbreviation</th>
<th>#items</th>
<th>Reference</th>
</tr>
</thead>
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<tr>
<td>Mathematics Anxiety Rating Scale</td>
<td>MARS</td>
<td>98</td>
<td>Richardson, &amp; Suinn (1972)</td>
</tr>
<tr>
<td>Revised MARS-R</td>
<td>Revised MARS-R</td>
<td>24</td>
<td>Hopko (2003)</td>
</tr>
<tr>
<td>Mathematics Attitude Scale</td>
<td>MAS</td>
<td>12</td>
<td>Fennema &amp; Sherman (1976)</td>
</tr>
<tr>
<td>Mathematics Anxiety Questionnaire</td>
<td>MAQ</td>
<td>11</td>
<td>Wigfield &amp; Meece (1988)</td>
</tr>
<tr>
<td>Mathematics Anxiety Scale</td>
<td>MAS</td>
<td>10</td>
<td>Betz (1978)</td>
</tr>
<tr>
<td>Math Anxiety Scale- Revised</td>
<td>MAS-R</td>
<td>14</td>
<td>Bai et al. (2009)</td>
</tr>
<tr>
<td>Abbreviated Mathematics Anxiety Scale</td>
<td>AMAS</td>
<td>9</td>
<td>Hopko et al. (2003)</td>
</tr>
</tbody>
</table>

Table 2.1. A list of commonly used mathematics anxiety assessment instruments.
2.2 Test Anxiety
In this section, I briefly review the research literature about the definition, origin and measurement of test anxiety, and its relationship with math anxiety.

2.2.1 Definition
Poor performance in any mathematics related tests could not just be attributed to math anxiety, but also to so-called test anxiety. Zeidner (1998) adopted the characterization of the construct of test anxiety from Sieber, O’Neil and Tobias (1977) and defined it as follows: ‘The term ‘Text Anxiety,’ as a scientific construct, refers to the set of phenomenological, physiological and behavioral responses that accompany concern about possible negative consequences or failure on an exam or similar evaluative situation’’ (p. 17). Spielberger and Vagg (1995) defined test anxiety as “the stress associated with examination situations (stress), the subjective interpretation of a test as more or less threatening for a particular person (threat), and the emotional states that are evoked in test situations” (p. 6). Test anxiety is assumed to be more than a dislike of tests and an internal aversion that may interfere with performance (Ball, 1995). However, I do consider test anxiety as a fear for taking tests which arouses in an individual either due to poor preparation for test taking situations or due to the thought of failing in an examination.

2.2.2 Origin
Test anxiety is considered to be a multidimensional construct and is related to the stress associated with evaluative situations (Mandler & Sarason, 1952). In other words, it is the stress experienced by an individual when subjected to tests. There are two types of test anxiety: (1) anticipatory test anxiety, felt when thinking about and studying for a test; and (2) situational test anxiety, felt while taking a test. Arem (1993) identified the following three reasons for test anxiety as: (1) lack of preparation for a test; (2) poor test-taking strategies; and (3) psychological pressures.

A number of researchers have found that there exists a relationship between math anxiety and test anxiety (See, for example, Dew, Galassi & Galassi, 1984). In a study conducted by Bush (1981) he found that, despite a dislike of mathematics or mathematical methods, doing calculations or solving problems rarely caused anxiety. On the contrary, it was preparation for mathematics tests and taking mathematics tests that caused students to react with anxiety. Therefore, Bush contended that math anxiety is no more than subject-specific test anxiety. However, a majority of the
literature that I reviewed on mathematics anxiety and test anxiety asserted that, while the two anxieties are related, they are separate constructs. In the next subsection, I go further into this issue.

2.2.3 Cognitive Consequences
Liebert and Morris (1967) considered two components of test anxiety: worry and emotionality. Worry is a cognitive concern associated with performance and consequences of performance, while emotionality refers to physiological reactions evoked by stress. In their research, Liebert and Morris found that the worry component was negatively related to test performance, and that there was little or no relationship between emotionality and performance. Dew, Galassi and Galassi (1983) also investigated the relationship between math anxiety and test anxiety, in particular, the worry and emotionality components of test anxiety. Over 700 university students completed in their study the Mathematics Anxiety Rating Scale (MARS), the Fennema-Sherman Mathematics Anxiety Scale (MAS), the Sandman Anxiety Toward Mathematics (ATMS), and the Test Anxiety Inventory (TAI). In their investigation whether or not the math anxiety scales measured a construct distinct from test anxiety (worry and emotionality), they found that the math anxiety measures were more closely related to one another than to test anxiety. Therefore, Dew and colleagues (1983) concluded that the two constructs are not the same, but related.

2.2.4 Measurement
Test anxiety is commonly assessed through self-report instruments. Mandler and Sarason (1952) designed the first instrument called the Test Anxiety Questionnaire. It originally consisted of 42 questions, but it was revised by the authors into 37-items rating-scale format. The Test Anxiety Questionnaire is divided into three sections: (1) group intelligence tests; (2) individual intelligence tests; and (3) course examinations.

One of the most popular test anxiety instruments is the Test Anxiety Scale. The original scale, developed by Sarason (1958) consisted of 21 true/false items, which had been rewritten from the Test Anxiety Questionnaire. Sarason and Ganzer (1962) later presented a 16-item Test Anxiety Scale, which correlated .93 with the 37-item scale developed by Samson, Pederson and Nyman (1968). The factor analysis of the Test Anxiety Scale revealed two factors: (1) worry; and (2) emotionality. Liebert and Morris (1967) hypothesized and found an inverse relationship between
worry and performance expectancy and no relationship between emotionality and performance expectancy. The instrument that they used, the Worry-Emotionality Questionnaire, is a 10-item scale made up of Test Anxiety Questionnaire items, which were modified to refer to the participant’s immediate feelings. Five of the items form the Worry Scale, with the remaining five items forming the Emotionality Scale. Participants respond to the items on a 5-point Likert scale.

More recently, Spielberger and colleagues (1978) developed the Test Anxiety Inventory (See also, Spielberger, 1980). They used items from the Test Anxiety Scale and items written by the authors to measure worry and emotionality. Participants respond to the items on a 4-point scale, and the Test Anxiety Inventory yields an Emotionality and Worry score as well as a Total Test Anxiety score. Worry is the cognitive component of anxiety, while emotionality is the affective and behavioral component. Here, worry is characterized as concern about one’s performance, one’s perceived lack of competence (failure) and one’s comparison to others. Emotionality is characterized by one’s reaction to a situation, particularly one’s reaction to a test. The Test Anxiety Inventory total correlates .82 for males and .83 for females with the Test Anxiety Questionnaire. Spielberger and colleagues (1978) presented standard deviations and reliability coefficients as well as correlations between Test Anxiety Inventory scores and grades, study skills, and other measures of anxiety.
3 Research Questions

After reviewing the literature on math anxiety and its presence in the pre-service teachers, I wanted to first investigate if there were any indications of mathematics anxiety in Dutch pre-service teachers starting with their teacher-training program. Research studies have reported a strong correlation between the math anxiety of an individual with that of their performance in mathematics test. Therefore, I wanted to explore whether math anxiety of first year students had an influence on their performance in the first WISCAT-pabo test. Only students who failed the first WISCAT-pabo test and students who wanted to score a better mark attended the training sessions conducted by the staff of HvA. I was also interested to see if this group of first year student teachers were test anxious and whether test anxiety had an influence in their performance of the first WISCAT-pabo test. In addition, I wanted to investigate if the first year student teachers who failed in the first WISCAT-pabo test found the training sessions and the peer tutoring given to them beneficial enough to perform better in the second test, and also if it helped them in reducing their math anxiety level. Apart from the first year teachers, I was also keen to explore the Pedagogical Content Knowledge (PCK) of the third year pre-service teachers in the PABO regarding math anxiety, as they were taught a lesson on Special Education Needs in their Didactics course, at the same time of my research. I wanted to find out if these students were aware of symptoms of math anxiety and if they were able to identify it in their pupils.

To sum up, I intended to answer in my research study the following research questions:

1. Does the standardized math anxiety tests indicate the existence of math anxiety amongst first year elementary pre-service teachers when they enter the teacher-training program?

2. Is there a correlation between students’ results on the first math anxiety test and their performance in the first WISCAT-pabo test?
3. For those students who participate in the training sessions after the first WISCAT-pabo test (those who failed and those who wanted to improve their test score) and take the test anxiety test, what are the students’ results on the math anxiety test and the test anxiety test? Are there correlations between the three test results?

4. How do results on the second WISCAT-pabo test compare with results of the first WISCAT-pabo test for those students who take the training sessions and the peer tutoring?

5. How do results on the second math anxiety test compare with the result of the first math anxiety test for those students who take the training sessions and the peer tutoring?

6. What pedagogical content knowledge about mathematics anxiety do third year pre-service teachers have?
   (a) Did they observe mathematics anxiety amongst their pupils during their teaching practice sessions?
   (b) If so, what instructional strategies did they think of and/or have they used in their lessons in order to deal with their pupils’ anxiety.
4 Research Design and Methods

In this chapter I give a detailed description of the school setting in which my research took place and also describe the quantitative and qualitative research instruments that I have used to collect the data. I also discuss the design of my workshop for third-year pre-service teachers. In the following subsections, I outline the description of how the research instruments have been used to answer the research questions and the methods I have used to analyze the data. In the last section I give the timeline of the activities as planned in my research.

4.1 School Setting

The research took place at the primary school teacher training college, PABO, at the Hogeschool van Amsterdam (HvA). Like in any PABO in the Netherlands, the focus in their mathematics lessons was not so much on learning the discipline itself, but more on learning to teach arithmetic and basic mathematics at primary school level in accordance with the Realistic Mathematics Education (RME) approach. Along with their lessons, the pre-service teachers had practice teaching sessions in Dutch schools in and around Amsterdam. At the beginning of the semester, the pre-service teachers had to take the online skills test called WISCAT-pabo, which tests their mathematical knowledge up to the level of Group 8 mathematics. This test is nationwide administered and scored by CITO. The test contains 40 questions in four domains, namely: (1) mental arithmetic; (2) basic operations; (3) fractions, ratios, percentages; and (4) measuring and geometry. The first 15 questions in this test are of the same level of difficulty for all the candidates. Based on their performance and scores of these 15 questions, the computer adjusts the level of difficulty from the 16th question onwards according to the ability level of the student. The results of this online test are obtained from CITO within 2 hours after submission of all tests. If a candidate clears the test with 103 points then (s)he has obtained enough points for the first year. If a student passes the test with 125 points then (s)he has scored enough points for 3 years and may become a peer tutor. If a candidate fails in the first round of the test then (s)he

3 In the Dutch system of schooling, Group 8 is the last year in the primary level (age group: 11-12 yr.).
4 CITO, the Central Institute for Test Development based in the Netherlands, is one of the world’s leading testing and assessment companies.
must reappear for an exam in the second semester failing which (s) he appears for the re-test towards the end of the first year. During this period, the student teachers are given special attention and individual tutoring on elementary mathematics by the teaching faculty and also by peers of the HvA. The student teachers must pass the WISCAT-pabo test at some moment during the first year in order to be able to continue their education in the teacher training program.

The participants of my research study were 108 first-year pre-service students and some third-year students of the 4-year teacher-training program. Of the 108 participants, (87) were females and (21) were males and they were of the age group 17-24 years. The participants had different educational backgrounds. There was one group of about 30 older people (doing the program on a part time basis) who were not fresh out of secondary school but had to take a break in their careers for various personal reasons.

4.2 Quantitative Research Instruments
All first year students of the teacher-training program were invited to complete a standardized test on mathematics anxiety. I used a combination of two standardized tests. The main reasons for combining two existing short math anxiety tests instead of developing my own test were: (1) to be able to compare my results with results from research literature; and (2) to reduce as much as possible the potential dependence of results on the choice of a particular test (I expected that the results for both tests would correlate). The math anxiety tests were used as pretest (before the first WISCAT-pabo) and posttest (before the second WISCAT-pabo, after training sessions and peer tutoring). Math anxiety of a student was tested once or twice, depending on whether the student passed the WISCAT-pabo test already at the first time or not. The math anxiety tests were administered before the first and second WISCAT-pabo test, respectively.

In addition, I also used a test anxiety inventory to assess the test anxiety of participants. The test anxiety test was also obligatory for those pre-service teachers present at the training sessions. Since there was no provision to conduct math anxiety and test anxiety tests in a digital format, the two instruments were administered through pencil and paper.
Since existing research (see, for example, Dew et al., 1984) suggests both positive and negative relationship between mathematics anxiety and test anxiety, my research study was planned in such a way that it would allow to:

1) distinguish math anxiety from test anxiety according to standardized tests;
2) explore existence of math anxiety and/or test anxiety in pre-service teachers enrolled in primary teacher training program.

For better understanding of the above mentioned quantitative research instruments, I will explain in detail the structure of the mathematics anxiety rating scale and the test anxiety inventory in the following subsections.

4.2.1 Mathematics Anxiety Rating Scale

For the mathematics anxiety test, I combined two short standardized math anxiety tests, which have been used in previous studies to measure math anxiety in college students of large sample size. The two scales were chosen on the basis of their use in the literature and relevance to this particular study. The two tests used were Mathematics Anxiety Scale (MAS see Appendix B) and the Abbreviated Math Anxiety Scale (AMAS see Appendix C). There were two main reasons for this combination of tests for my target group:

1) to see that the results of the two standardized tests to measure mathematic anxiety are similar (i.e. the identified math anxiety level should ideally not depend much on the instrument used)
2) to check if the two tests are correlated with the math skills test (WISCAT-pabo) as a separate test and as a combination.

My hypothesis is that the choice of math anxiety test does not influence too much the identified level of math anxiety.

The Mathematics Anxiety Scale (MAS), adapted from Fennema and Sherman’s (1976) Mathematics Attitude Scale, consists of 10 items on a 5-point Likert scale. The first five items are worded positively and the next five are worded negatively. Test takers have to rate from five possible choices: strongly agree, agree, neutral, disagree and strongly disagree. I assigned the following numeric values to the positively phrased questions: strongly disagree=5, disagree=4, neutral=3, agree=2, and strongly agree=1. I assigned the following numeric values to the negatively phrased questions so that high scores indicate a positive attitude: strongly disagree=1,
disagree=2, neutral=3, agree=4, and strongly agree=5. In this way, the Scores range from 10 to 50 and higher the score, the higher is the level of math anxiety.

The Abbreviated Math Anxiety Rating Scale (AMAS), an adapted version of MARS-Revised with only 9 items is also a 5-point Likert type scale ranging from 1 (low anxiety) to 5 (high anxiety). Test takers must choose from the five possible choices and I assigned the following value for the choices: not at all=1, a little bit=2, a bit=3, fairly much=4, very much=5. The total score represents the summation of the 9 items. Since my test was a combination of the MAS and AMAS the range of the scores for the 19 questions varied from 19 to 95. The higher the score, the higher the level of math anxiety.

4.2.2 Test Anxiety Scale

In order to find out if the participants were test anxious, the Test Anxiety Inventory (TAI), which was developed by Charles Spielberger (1980), was used. It is a self-report inventory, commonly used to measure test anxiety and it consists of 20 items. In addition to measuring the overall anxiety level in test situations, the TAI subscales assess worry and emotionality as major components of test anxiety. The description of the sub-scales, number of items and example items of the Test Anxiety Inventory is given below. See Appendix D for the Test Anxiety Inventory questionnaire.

<table>
<thead>
<tr>
<th>Sub-scales</th>
<th>Scope</th>
<th>No.of items</th>
<th>Example items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotionality</td>
<td>Behavioral or physical reactions to testing situations such as fear, nervousness and physical discomfort</td>
<td>8</td>
<td>2. While taking examination I have an uneasy upset feeling</td>
</tr>
<tr>
<td>Worry</td>
<td>Cognitive concerns about performance, such as worry about the testing situation or negative performances</td>
<td>8</td>
<td>6. The harder I work at taking a test the more confused I get</td>
</tr>
<tr>
<td>TAI -Total</td>
<td>General feeling about the test anxiety in addition to items already included in emotionality and worry scale. (Total score on the Test anxiety Inventory).</td>
<td>20 (16+4*)</td>
<td>13.During important tests I am so tense that my stomach gets upset.</td>
</tr>
</tbody>
</table>

* There were 4 items in the scale not included in any sub-construct but were part of the Total score in the Test anxiety Inventory.
The participants taking TAI choose from four possible choices: almost never=1, sometimes=2, often=3, and almost always=4 that represent how often they experience the feeling described in each statement. The Test Anxiety Inventory (TAI) has a minimum score of 20 and a maximum score of 80. The scores for the first question are: 4 (low anxiety), 3, 2, 1 (high anxiety) for the given choices, respectively. The scores for the questions 2 through 20 are: 1 (low anxiety), 2, 3 and 4 (high anxiety) in the ordering of the choices. The purpose of using TAI is to account for variance in performance in the math skills test and examine the relationship between test anxiety and math anxiety.

4.3 Reliability and Validity of the Anxiety Tests
The MAS test has been found to have a strong internal consistency and stability. Betz (1978) reported a reliability coefficient of .92 using the split half method. Dew et al. (1983) reported Cronbach’s alpha of .72 and a 2-week test-retest reliability of .87 on a sample of 769 undergraduates. Also, after comparing the MAS with other mathematics anxiety measures Dew et al. (1983) and Dew, Galassi, & Galassi (1984) reported that MAS had acceptable internal consistency and test-retest reliability and that it was the only one of four mathematics anxiety scales (including the MARS) that accounted for a significant portion of the variance in mathematics performance. Hopko et al. (2003) conducted a study to develop and establish the psychometric properties of the AMAS and found that the internal consistency and test-retest reliability was very strong. A two-week test-retest reliability for the AMAS test was .85 and a factor analysis yielded a two factor structure, learning mathematics anxiety and mathematics evaluation anxiety accounting for 70% of the overall variance in scores. In a recent study by Hopko (2003), learning math anxiety (LMA) which is anxiety about the process of learning and math evaluation anxiety (MEA), which is more related to testing situations, have been acknowledged as critical elements of math anxiety.

Spielberger (1980) calculated alpha coefficients for the TAI test on undergraduate students. An alpha coefficient of .95 was reported for females and .94 was reported for males. The internal consistency reliability coefficients range from .93 to .96 and correlations with other measures of test anxiety range from r=.85 to r=.95 with the Test Anxiety Scale (TAS; Sarason, 1978). Spielberger compared TAI scores
for 195 male and 72 female navy recruits with scores on recruit training examinations. Negative correlation results of -.34 and -.19 respectively were obtained when recruitment scores and anxiety scores were compared. Spielberger concluded that test anxiety has a negative effect on academic achievement.

The questionnaires of the two standardized math anxiety tests (MAS and AMAS) and also the test anxiety test (TAI) were translated into Dutch and adapted to the Dutch education system (see Appendices E and F). The fairness of the translations of the tests was assessed by two educational researchers and three PhD students in mathematics and science education (all native speakers of Dutch). These five persons were well acquainted with the Dutch curriculum and therefore were able to review the fairness of the translation from English to Dutch and the adaptation to the Dutch context. In general they agreed with the translations and I adopted some suggestions made. However, there was no time for doing a small-scale trial and so the standardized tests were administered directly.

### 4.4 Qualitative Research Instruments

In this section, I discuss the qualitative instruments that I used for my research study. In the first subsection I give the details of the semi-structured interviews with the first year pre-service teachers. Then I discuss the design of the workshop for the third year student teachers.

#### 4.4.1 Semi-Structured Interviews with First-Year Students

I observed some classes of the training sessions that the first year pre-service teachers took as a preparation for the second WISCAT-pabo test. The training sessions were mainly attended by the student teachers who had failed in the first WISCAT-pabo test, but some students who had a pass mark in the first WISCAT-pabo test also attended the sessions for the purpose of getting more practice and a better score in the re-test. I interviewed some pre-service teachers who volunteered for this and had a fairly low score in the first WISCAT-pabo test. Some of the questions asked in the interviews were:

1. **What are your feelings towards mathematics?**
2. **Did you like the mathematics lessons when you were in your school? If not, why? (Is it because of the teacher, friends or the subject itself)**
3. Have you had any negative experiences in your mathematics classroom when you were a student?
4. Did you always get help from your teacher when you had difficulty in understanding concepts being taught in class?
5. Have you ever felt confident before a test and when it actually comes to taking a test, do you forget most of the concepts that you knew so well.
6. Do you get nervous when you are timed for a test? Does it go away when the test is over?
7. Have you felt “totally blank” during tests although you had prepared well?
8. Do you think you can understand mathematics better in the HvA?
9. Why do you think you could not perform well in the WISCAT test?
10. Do you think the training sessions and peer tutoring in the HvA has helped you this semester? Why?

The questions were asked in random order and not necessarily in the above order. The first four questions (1-4) were asked to gather information about the pre-service teachers’ feelings towards mathematics, their past experiences in school as students and the behavior and attitude of their mathematics teachers when the pre-service teachers approached them as students for help. The next three questions (5, 6 and 7) were asked to find out the feelings of the pre-service teachers during test taking situations. The last three questions (8, 9, 10) were asked to find for the possible reason they thought that accounted for their poor performance in the first WISCAT-pabo test and how they were benefitted by the peer tutoring and optional training sessions in the HvA.

4.4.2 Workshop with the Third Year Student Teachers
In order to explore the PCK of third-year students about math anxiety I conducted a workshop on 2 different days. I prepared PowerPoint slides and a handout (Appendix G and H) in order to share my knowledge and understanding of math anxiety with the student teachers. I also gave the participants two articles (Jackson & Leffingwell, (1999); Rossnan (2006) regarding math anxiety as reference reading. The purpose of the workshop was two-fold: (1) make the student teachers aware of the existence of math anxiety; and (2) discuss with the student teachers their personal experiences during the practice teaching sessions and discuss strategies how to deal with pupils having math anxiety. The workshop on Day 1 took place the week before the pre-
service teachers went to schools for a week of full-time responsibility of teaching a class. The student teachers were given two assignments, to be carried out during their practice teaching sessions:

**Assignment 1:**
*Look for any symptoms of math anxiety during your one-week teaching session and write them down.*

**Assignment 2:**
*Think of the instructional strategies you may adopt in order to deal with pupils with math anxiety in your classrooms*

The workshop on Day 2 was a follow-up workshop in which the two assignments concerning the observations of the pre-service teachers during their practice sessions and their strategies to help pupils overcome math anxiety were discussed. The outline of the workshop is as follows:

**Day 1**
Discussion of
1. pre-service teachers’ content knowledge about math anxiety;
2. symptoms, origin and development of math anxiety;
3. teaching techniques that cause math anxiety;
4. different instruments used to measure math anxiety.

**Day 2**
Discussion of
1. personal experiences and classroom observation;
2. teacher’s role in helping pupils overcome math anxiety;
3. teaching strategies to reduce math anxiety in classrooms.

The workshop sessions were videotaped and the discussion about their knowledge and observations of math anxiety was also audio-recorded.

### 4.5 How I Answered the Research Questions
The first research question about the indication of math anxiety in the first year elementary pre-service teachers was answered using standard quantitative methods and statistics. I also considered the semi-structured interviews to get a deeper understanding about the possible causes of pre-service teachers math anxiety.
The second question and third questions about the correlation of the WISCAT-pabo test with the first math anxiety test and test anxiety test and also the correlation between all the three tests were answered quantitatively.

The fourth research question about the comparison of the results on the second WISCAT-pabo test with the result of the first WISCAT-pabo test for those students who took the training sessions and the peer tutoring were answered quantitatively (using the statistical methods) and qualitatively (semi-structured interviews).

The fifth research question about the reduction in the math anxiety level of the pre-service teachers who took the training sessions and the peer tutoring was answered quantitatively.

The sixth research question regarding the PCK of third year pre-service teachers is of qualitative nature. This question was answered through the discussions during the workshop sessions that has been video recorded.

### 4.6 Data Analysis Methods
Statistical and qualitative methods that I used to answer my research question were:
- Shapiro-Wilk test to check the normality of the data distribution;
- Pretest and posttest were compared via a $t$-test analysis;
- WISCAT-pabo tests were compared via the Wilcoxon signed-rank test analysis;
- Psychometric tests for the math anxiety and test anxiety instruments;
- One-tailed Pearson correlation test to measure the relationship between math anxiety score, test anxiety score and WISCAT-pabo score;
- Audio recordings of the semi-structured interviews;
- Video- and audiotapes of the workshop discussions.

### 4.7 Timeline of the Research
For ease of understanding, I give an outline of the ordering in time of the different activities that I carried out in my research study and the timing of the first and second WISCAT-pabo test.
5 Data Analysis and Findings

In this chapter I first present the data collected and the results of the analysis of the data obtained from the first and second administered mathematics anxiety scale [both equal and consisting of the Abbreviated Mathematics Anxiety Scale (AMAS) and the Mathematics Anxiety Scale (MAS)]. Since the first and second administration of the mathematic anxiety scale is used in a \( t \)-test analysis to explore the effect of the training sessions and peer tutoring I refer to these tests also as pre- and posttest. For this \( t \)-test analysis it is important that assumptions such as homogeneity of variance (that is, standard deviations of the scores in pre- and posttest are approximately equal) and normality of the distribution of the scores (in both tests) are met. I first check this, and then I explore the separate scoring on MAS and AMAS components, compare their reliability and factor analysis with literature results, and explore the level of correlation between these two tests. In the next section, I analyze the results of the Test Anxiety Inventory (TAI) and compare my results of the reliability and factor analysis of TAI with that of the literature results. In the subsequent sections, the scores of the marks obtained by first year pre-service teachers in the WISCAT-pabo test are presented and I explore the possible relationship between these test scores and the scores on the anxiety tests. The qualitative results of the interviews and the discussions of the workshop are also presented in this chapter.

5.1 Findings for Pre- and Posttest

This section is organized as follows: First I report on the process of data collection and what data I use in my data analysis. In the next subsections I present the results of the pre- and posttest, and I compare the scores.

5.1.1 Data Collection and Data Analysis Procedure

Data for the pretest were collected during the compulsory mathematics class and during the optional training sessions. Due to some practical difficulties, data in the pretest were obtained for only 108 students out of a total of 180 students in the first year. Since the math anxiety test was not obligatory, 76 of them filled out the questionnaire before the first WISCAT-pabo test and 32 filled it out after the first WISCAT-pabo test. Those students who attended the optional training sessions and received peer tutoring were expected to take the posttest. Only 30 of them actually
appeared for the posttest. No data were obtained for the rest of the students, as they did not seem to come to HvA. The pre-service teachers who passed the first WISCAT-pabo test and had a low score in the pretest were excluded in the pre- and posttest comparison because they obviously did not participate anymore in the posttest and the second WISCAT-pabo test. However, there were 8 pre-service teachers who had passed the first WISCAT-pabo test, but were math anxious according to the pretest. Since they had already obtained a pass score in the WISCAT-pabo test, they did not attend the training sessions and so were unavailable for any interviews or further investigations.

5.1.2 Results of the Pre- and Posttest

I analyzed the data both with the statistical software STATA 9 and SPSS 18, just to have redundancy in my data analysis. Since I used a combination of two standardized tests, the sum of the scores on MAS and AMAS was considered as the final score on the math anxiety test. The mean value and standard deviation of the scores on the combined mathematics anxiety scale (MAS and AMAS) in the pretest and posttest is provided in Table 5.1. From this table one easily gets the impression that there is not much difference between the scores in pre- and posttest. I come back to this in Subsection 5.1.4.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest: (before WISCAT)</td>
<td>51.5</td>
<td>14.4</td>
<td>76</td>
</tr>
<tr>
<td>(after WISCAT)</td>
<td>46.5</td>
<td>18.4</td>
<td>32</td>
</tr>
<tr>
<td>Posttest</td>
<td>51.2</td>
<td>15.7</td>
<td>30</td>
</tr>
</tbody>
</table>

Table 5.1. Math anxiety score means and standard deviations for pre- and posttest.

I categorized participants scoring one standard deviation more than the mean as highly math anxious. In order to find the number of pre-service teachers who are math anxious according to the combined test used in my study, the two data sets (anxiety test administered before and after WISCAT-pabo test) have been analyzed separately. 12 out of 76 participants who took the math anxiety test before the WISCAT-pabo test were found math anxious according to the test scoring and 7 out of 32 students who took the math anxiety test after the WISCAT-pabo test were found math anxious according to the test scoring. In other words, these data suggest that about 16% of the students can be categorized as math anxious according to our
criterion. Assuming that the data of scores are normally distributed, this is a percentage in the order that one may expect.

5.1.3 Assumptions of the t-Test Analysis for Pre- and Posttest

Prior to conducting the $t$-test analysis in which pre- and posttest scores are compared, data were subjected to tests of multivariate normality. I used the Shapiro-Wilk statistic to check normality of the test scores of those students who took the math anxiety test before the WISCAT-pabo test. The obtained $p$-value of .73 was greater than alpha=.05, which suggests that the distribution of the scores is normal. When the combined scores are split into two parts, namely, the MAS and AMAS scores, then the Shapiro-Wilk test also suggests normal distribution of test scores ($p$-value is .72 and .06, respectively). However, the data obtained from the 32 students who took the anxiety test after the WISCAT-pabo test did not satisfy the normality test. The $p$-values for the Shapiro-Wilk tests are .005, .002 and .019 for the total scoring, MAS and AMAS, respectively. Since the $p$-values are all less than alpha=.05, I decided to exclude the results for these students in the data analysis for the following reasons: Firstly, their data did not show a normal distribution and secondly, out of the number of students who took the math anxiety pretest after the WISCAT-pabo test, only 3 of them also took the post test and only one of them has been identified as both math anxious and test anxious. Therefore, no harm is done in the data analysis when I restrict the analysis to the group of students who took the math anxiety test before the WISCAT-pabo test. To illustrate normality of test scores, I give one example as supplementary information to the Shapiro-Wilk normality tests: Figure 5.1 shows the 8-bin histogram of MAS scores in the pretest and the normal curve that approximately describes the distribution of the data.
In the $t$-test analysis comparing the pre- and posttest scores, I can obviously only consider the scores of those students who took both tests. Therefore I repeated the normality testing of the data set. Data for the posttest was also tested for normality. There were only 26 students in the $t$-test analysis. The high value in the Shapiro-Wilk test ($W = .96$) for normality of the pretest scores indicates that the math anxiety score was not significantly different from a normal distribution ($p$-value $= .44 > \alpha = .05$). The high value in the Shapiro-Wilk test ($W = .96$) for normality of the posttest scores indicates that the math anxiety score was not significantly different from a normal distribution ($p$-value $= .42 > \alpha = .05$).

Another assumption for applicability of $t$-test analysis is homogeneity of variance, that is, almost equality of standard deviations of test scores. The standard deviations were 12.7 and 16.4 for pre- and posttest, respectively. I used the Levene-test for this purpose and it supported the hypothesis that the standard deviations are not significantly different ($p$-value $= .185 > \alpha = .05$).

### 5.1.4 $t$-Test Analysis: Comparing Pre- and Posttest Scores

I examined the results of the math anxiety tests in detail. A positive difference indicated increase in math anxiety level while a negative difference indicated a reduction in math anxiety levels. Comparing the individual scores on the pre- and posttest I found that in general there was a reduction in the math anxiety level of the participants. When examined on an individual score level ($n = 26$), 15 participants' math
anxiety scores decreased from pretest to posttest. However, at the same time 9 participants’ scores on the math anxiety scale increased and two participants’ scores did not change. Therefore a more objective method for comparison of test scores was needed to explore whether there were significant difference in scores. A paired samples t-test was conducted to evaluate the hypothesis that there is no significant difference in the math anxiety level of the pre-service teachers in the pre- and posttest. The results indicated that the mean difference of scores in the pretest (M=53.9, SD=12.7) was statistically greater than the mean score in the posttest (M=51.5, SD=16.4), t= 1.082, df= 25, p=.289, p<.05). Therefore, I reject the null hypothesis and conclude that the mean difference of the scores in the pre- and posttest is not statistically significantly different from 0.

5.2 Psychometric Analysis of the Math Anxiety Tests

In this section I discuss the psychometric quality of the math anxiety tests. This consists of a reliability analysis and a factor analysis. In addition I compare the MAS and AMAS components of the mathematics anxiety scale used.

5.2.1. Reliability

Internal reliability of the 19-item math anxiety test was assessed for the pre- and posttest respectively, using the Cronbach α technique. Please note, in the reliability analysis of the pretest presented in this section I only look at the test administered before the WISCAT-pabo test with 76 participants (See Section 5.1.3). The 19-item math anxiety scale produced an alpha of .94 and .96 for the pretest (76 participants) and the posttest (30 participants), respectively. However, if the first item in the mathematics anxiety test is deleted, then the value of α for the pretest increases. Together with the observation that the inter-item correlation matrix has a first row and column with small inter-item correlations, this suggests that the first item (i.e. It doesn’t bother me at all to take more math classes) is a factor on its own unrelated with the other items. Therefore, in the factor analysis of the MAS component of the math anxiety tests, the first item will be removed.

The internal reliability of the MAS component and the AMAS component of the pre- and posttest were also explored and compared to the results obtained in the literature. Using the split-half method, a reliability coefficient of .81 and .85 for the 10-item MAS component of the pre- and posttest was found, respectively. These
values are smaller than the reliability coefficient of .92 reported by Betz (1978) in a study with 652 College students. However, it still suggests a sufficiently reliable math anxiety test. Using Cronbach’s $\alpha$ method, a reliability coefficient of .90 was found for the 10-item MAS component of the pre- and posttest. Using Cronbach’s $\alpha$ method, a reliability coefficient of .90 and .94 for the 9-item AMAS component of the pre- and posttest was found, respectively. These values are consistent with the value of .90 reported by Hopko et al. (2003) in a study with 206 undergraduates. Thus, it certainly suggests a sufficiently reliable math anxiety test. For the record, for the Learning Math Anxiety Scale (item 1, 3, 6, 7, 9 of AMAS) I found a reliability coefficient of .88 and .92 for the pre- and posttest. These values are consistent with the value .85 reported by Hopko et al. (2003) in a study with 206 undergraduates. For the record, for the Math Evaluation Anxiety Scale (item 2, 4, 5, 8 of AMAS) I found a reliability coefficient of .84 and .86 for the pre- and posttest. These values are consistent with the value .88 reported by Hopko et al. (2003) in a study with 206 undergraduates. Table 5.2 summarizes the Cronbach’s $\alpha$ found for the various math anxiety tests.

<table>
<thead>
<tr>
<th></th>
<th>MAS (10 items)</th>
<th>AMAS (9 items)</th>
<th>Combined (19 items)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>.90</td>
<td>.90</td>
<td>.94</td>
</tr>
<tr>
<td>Posttest</td>
<td>.90</td>
<td>.94</td>
<td>.96</td>
</tr>
</tbody>
</table>

Table 5.2. Cronbach’s $\alpha$ for math anxiety tests (pre-and posttest scores)

### 5.2.2 Factor Analysis of the Math Anxiety Test

For the pretest, I conducted an exploratory factor analysis on the 10-item MAS component and on the 9-item AMAS component of the math anxiety test. In case of the MAS test, I excluded the first item in the factor analysis (See Section 5.2.1).

The factor analysis of the 9-item remainder of the MAS test resulted in only one component. This result was as expected from the research literature about the MAS test that explains that the test was designed as such. The positive and negative wordings in MAS do not lead to separate principal components: this is the result one desires because the testing of math anxiety should not depend on the direction in which the items are phrased (positive or negative).

An exploratory factor analysis was conducted on the 9-item AMAS component of the math anxiety test using a principal components extraction and varimax
rotation with Kaizer normalization within a two-factor forced solution. The two-factor exploratory analysis accounted for 69.6% of the variance. This agrees with the results of Hopko et al. (2003). These authors interpreted the factors using the subscale designations of Learning Math Anxiety (LMA) and Math Evaluation Anxiety (MEA). I was particularly interested whether I would find the same splitting of items into the LME and MEA components as the author cited and similar factor loadings. Table 5.3 illustrates the excellent agreement between my results and those of Hopko et al. (2003). Only the designation of the component of the first item (i.e. Having to use the tables in the back of a math book) in my anxiety test is indecisive; probably because the item may have confused the students because Dutch mathematics textbooks do not heavily use tables in the back of the book.

<table>
<thead>
<tr>
<th>Original AMAS Items</th>
<th>Factor loadings in my research study</th>
<th>Factor loadings in Hopko et al (2003)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LME</td>
<td>MEA</td>
</tr>
<tr>
<td>1. Having to use the tables in the back of a math book</td>
<td>.52</td>
<td>.52</td>
</tr>
<tr>
<td>2. Thinking about an upcoming math test 1 day before</td>
<td>.30</td>
<td>.84</td>
</tr>
<tr>
<td>3. Watching a teacher work an algebraic equation on the blackboard</td>
<td>.69</td>
<td>.43</td>
</tr>
<tr>
<td>4. Taking an examination in a math course.</td>
<td>.35</td>
<td>.79</td>
</tr>
<tr>
<td>5. Being given a homework assignment of many difficult problems that is due the next class meeting</td>
<td>.47</td>
<td>.60</td>
</tr>
<tr>
<td>6. Listening to a lecture in math class</td>
<td>.89</td>
<td>.22</td>
</tr>
<tr>
<td>7. Listening to another student explain a math formula.</td>
<td>.90</td>
<td>.12</td>
</tr>
<tr>
<td>8. Being given a “pop” quiz in math class</td>
<td>.06</td>
<td>.84</td>
</tr>
<tr>
<td>9. Starting a new chapter in a math book</td>
<td>.73</td>
<td>.34</td>
</tr>
</tbody>
</table>

| Table 5.3. Factor loadings of AMAS items (designated factors in boldface)

5.2.3 Correlation between MAS and AMAS components

I computed the correlation between the student scores on the MAS test (item 1 excluded) and the AMAS test in the pretest. The math anxiety measured via MAS was positively related to the math anxiety measured via AMAS with a Pearson correlation coefficient of $r = .71$ and the (one-tailed) significance value is less than .01, which means that the correlation was significant.
Figure 5.2 show the scatterplot of the MAS-measured anxiety level and the AMAS-measured anxiety level containing a least-squares line fit with the goodness-of-fit value of $R^2 = .5$.

![Figure 5.2](image)

Figure 5.2. A scatterplot of MAS and AMAS-measured anxiety level and a line fit.

5.3 Findings for the Test Anxiety Inventory
In this section I first report the process of data collection and what data I use in my data analysis. In the next subsections I present the results of the test.

5.3.1 Data Collection and Data Analysis Procedure
Data for the Test Anxiety Inventory (TAI) were collected from those students who had not passed the first WISCAT-pabo test or wanted to improve their WISCAT-pabo score. The test was administered during the optional training sessions, three weeks after the WISCAT-pabo test. Because I wanted to compare the students’ math anxiety level and test anxiety level, I only analyzed the scores of the students who had taken the math anxiety test before the WISCAT-pabo test. This means that data of 42 students were analyzed.

5.3.2 Results of the Test Anxiety Inventory
The mean score of the 20-item TAI dataset with a 4-point Likert scale was 41.8 with a standard deviation of 11.0. Figure 5.3 shows the 12-bin histogram of TAI scores and the normal curve that approximately describes the distribution of the data.
Figure 5.3. A histogram of TAI-measured test anxiety of students.

I also used the Shapiro-Wilk statistic to check normality of the test score. The high value in the Shapiro-Wilk test ($W = .96$) indicates that the test anxiety score was not significantly different from a normal distribution ($p$-value = .1 > alpha = .05).

In order to find the pre-service teachers who were test anxious, I categorized them such that the score on the TAI was one standard deviation more than the mean. 6 out of 42 students were found test anxious.

### 5.4 Psychometric Analysis of the Test Anxiety Inventory

In this section I discuss the psychometric quality of the test anxiety test. This consists of a reliability analysis and a factor analysis.

#### 5.4.1 Reliability

Internal reliability of the 20-item test anxiety inventory (TAI) was assessed via the Cronbach $\alpha$ technique. The TAI administered for 42 students produced an $\alpha$ of .94. This is in excellent agreement with the values reported by Spielberger (1980) for undergraduates: $\alpha = .94$ (males) and $\alpha = .95$.

Spielberger (1980) divided the TAI into two subscales that assess worry and emotionality components of test anxiety. The eight items that form the TAI Worry subscale (TAI-W) are: 3, 4, 5, 6, 7, 8, 14, 17, and 20. The eight items that form the
TAI Emotionality subscale (TAI-E) are: 2, 8, 9, 10, 11, 15, 16, and 18. I also assessed the internal reliability of these 8-item TAI subscales using Cronbach’s $\alpha$ technique and found the following reliability coefficients: .85 (TAI-W) and .88 (TAI-E).

5.4.2 Factor Analysis of the Test Anxiety Test
An exploratory factor analysis was conducted on the 20-item Test Anxiety Inventory using a principal components extraction and varimax rotation with Kaizer normalization. It resulted into 4 components for which the eigenvalue was greater than 1 and that contributed 23.9%, 18.9%, 14.1%, and 10.1% of the total variance. From the research literature I had expected three components: (1) the TAI-W items; (2) the TAI-E items; and (3) the rest category of items 1, 12, 13 and 19. I also tried a factor analysis using a principal components extraction and varimax rotation with Kaizer normalization within a three-factor forced solution, but this did not lead to the literature result: 4 items out 8 TAI-W items were grouped into the ‘worry component’ and 5 items out 8 TAI-E were grouped into the ‘emotionality components’. In a third attempt to get good agreement with literature results, I conducted an exploratory factor analysis on the 16-item TAI-(W+E) (excluding items 1, 12, 13, 19) using a principal components extraction and varimax rotation with Kaizer normalization within a two-factor forced solution. This also did not reproduce the categorization of the items into TAI-WS and TAI-E as found in the literature. Problematic items were in two last factor analyses: 3, 5, 6, 14 (TAI-W), 15, 16, 18 (TAI-E).

5.5 Findings of the WISCAT-pabo Tests
In this section, I report the process of data collection and results of the first and second WISCAT-pabo test.

5.5.1 Data Collection and Data Analysis Procedure
Data of the first WISCAT-pabo were collected for the participants who took the pretest of the math anxiety test. According to this test, a candidate who scored 103 points or more was considered to have passed the WISCAT-pabo test. Since I was interested here to find the influence of the math anxiety level on the performance of the participants in the first WISCAT-pabo test, I analyzed the data for 72 participants who took both the pretest as well as the first WISCAT-pabo test.
For the second WISCAT-pabo test I collected the data for the students who appeared for the first WISCAT-pabo test and also went to the training sessions offered by the staff of HvA as well as peer tutoring by peers. I wanted to compare here the results of the first and second WISCAT-pabo and furthermore investigate if there was an improvement in the performance of the student teachers in the second WISCAT-pabo after having attended the training sessions and peer tutoring. I analyzed the data for 46 participants who appeared for the first and the second WISCAT-pabo test and also attended the training sessions.

5.5.2 Results of the First and Second WISCAT-pabo Test

The mean score of first and second WISCAT-pabo test was 99.1 and 90.2 respectively. The standard deviation of the first and second WISCAT-pabo was 30.5 and 25.2, respectively. I used the Shapiro-Wilk test to check if the data in the first and second WISCAT-pabo satisfied the test for normality. The high value in the Shapiro-Wilk test ($W= .97$) for normality indicated that the scores on the first WISCAT-pabo test were not significantly different from a normal distribution ($p$-value $= .07 > \alpha = .05$). Out of the total participants, 62.5% pre-service teachers failed in the first WISCAT-pabo test.

However, the Shapiro-Wilk test ($W= .91$) for normality indicated that the scores on the second WISCAT-pabo test were significantly different from a normal distribution ($p$-value $= .002 < \alpha = .05$). 57.4% pre-service teachers failed in the second WISCAT-pabo test.

Because of the problems with normality of the data distribution I applied a non-parametric test that has fewer assumptions than the parametric counterpart such as the paired samples $t$-test: I used the Wilcoxon signed ranks test for comparison of the means of the WISCAT-pabo tests.

The Wilcoxon signed ranks test showed that WISCAT-pabo test scores for those students doing the re-test were significantly higher in the second skills test (median = 96.5) than in the first test (median = 88.0), $z = -3.92$, $p = .000 < \alpha = .05$. I also observed a drop in the attendance of the pre-service teachers in the second WISCAT-pabo test when compared to the first one.
5.6 Correlation of Math Anxiety, Test Anxiety, and Test Performance

In this section I report my findings for the correlation of the Math Anxiety, Test Anxiety, and Test Performance (WISCAT-pabo). In Subsection 5.6.1, I discuss the results obtained when I analyzed the relationship of the scores on the first math anxiety test (of 72 students) and the performance of the student teachers’ on the first WISCAT-pabo test. In Subsection 5.6.2, I discuss the results of the correlations of the first math anxiety test, first WISCAT-pabo test and the test anxiety test for 31 students having scores on all three tests.

5.6.1 Correlation of Math Anxiety Test and First WISCAT-pabo Test

A linear regression analysis was conducted to find the relationship of the result on the pretest and the performance of the pre-service teachers in the first WISCAT-pabo test. The scatterplot for the two variables, pretest and first WISCAT-pabo test (as shown in Figure 5.6) indicates that the two variables are linearly related such that higher the score on the math anxiety test, lower is the score on the WISCAT-pabo test. I computed the correlation between the combined score (MAS+AMAS) of the math anxiety pretest and the marks obtained in the first WISCAT-pabo test for 72 participants. One-tailed Pearson correlation coefficient $r = -.62$, $p < .01$ indicated a significant correlation between the math anxiety score and the WISCAT-pabo score. The negative correlation signifies that as the score on the math anxiety test increases, the performance score in the WISCAT-pabo test decreases. Figure 5.6 shows the scatterplot of the WISCAT-pabo score plotted against the math anxiety score and the least-squares line fit with the goodness-of-fit value of $R^2 = 0.4$
Figure 5.6 A scatterplot of the WISCAT-pabo score plotted against the math anxiety score and the least-squares line fit.

5.6.2 Correlation of the Anxiety Tests (Pretest & TAI) and the First WISCAT-pabo Test.

I computed the correlations between the scores on the first math anxiety test, first WISCAT-pabo test, and the test anxiety inventory for the 31 participants who appeared for all the three tests. Table 5.6 provides the results of the one-tailed Pearson correlation coefficient.

<table>
<thead>
<tr>
<th></th>
<th>Test anxiety</th>
<th>wiscat</th>
<th>Math anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test anxiety</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>-.380*</td>
<td>.614**</td>
</tr>
<tr>
<td>Sig. (1-tailed)</td>
<td></td>
<td>.018</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>31</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>wiscat</td>
<td>-.380*</td>
<td>1</td>
<td>-.401*</td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td></td>
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<tr>
<td>Sig. (1-tailed)</td>
<td>.018</td>
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<td>N</td>
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<td>31</td>
</tr>
<tr>
<td>Math anxiety</td>
<td>.614**</td>
<td>-.401*</td>
<td>1</td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (1-tailed)</td>
<td>.000</td>
<td>.013</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>31</td>
<td>31</td>
<td>31</td>
</tr>
</tbody>
</table>

*. Correlation is significant at the .05 level (1-tailed).

**. Correlation is significant at the .01 level (1-tailed).

The correlation between the scores on the math anxiety scale and the test anxiety scale was significant at $r = .61$, $p < .01$. The positive correlation between the scores on the math anxiety scale and the test anxiety scale indicated a positive relationship.
as a measure of the anxiety construct. The correlation coefficient yields a coefficient of determination ($r^2$) of .38 which indicates that 38% of the variance is accounted for by the relationship.

The correlation between the scores on the math anxiety scale and the WISCAT-pabo was significant at, $r = -.40, p < .05$ and that of the test anxiety inventory and WISCAT-pabo was found to be significant at $r = -.38, p < .05$. However, the negative correlation of the score on the WISCAT-pabo test with that of math anxiety score and test anxiety score indicated an inverse relationship. This means that as the scores on the anxiety scales increased, the performance score on the WISCAT-pabo test decreased.

5.6.3 Comparison of the Results on the Math Anxiety Scale and the Test Anxiety Scale.

Out of the small group of 31 students who took the math anxiety test and the test anxiety inventory, it was found that 8 out of 31 students were math anxious and 6 out of 31 students were test anxious and subsequently scored very low in the first WISCAT-pabo test. Only 4 out of 31 students were found to be both math anxious and test anxious. This is in agreement with a study conducted by Betz (1978) in which she concluded that the degree of relationship between the mathematics anxiety and test anxiety suggests that some students who were found to be test anxious may be primarily math anxious individuals who experience their greatest difficulties with anxiety during mathematics tests. My results indicated that although math anxiety and test anxiety are two different constructs, they may be related.

5.7 Findings from the Interviews

18 pre-service teachers who were identified math anxious or test anxious or both volunteered to participate in semi-structured interviews. The student teachers were interviewed on days on which they attended the training sessions. The interviews took approximately 10 to 15 minutes and consent was obtained from the pre-service teachers to record the interviews. The interviews were conducted in English and some participants who were not confident in answering in English sought help of their peers for translation.

From the interviews, I found that that 11 out 18 interviewees disliked mathematics and lacked self-confidence when they had to solve mathematical problems. In
this group of students, one of them was suffering from dyscalculia and said that she had to work “extra hard” to pass the tests. The pre-service teacher’s mentioned the following reasons for their dislike towards mathematics: they found mathematics very hard to do; they could not apply what they had learnt; they had a feeling that they were never good at mathematics; they had difficulty in understanding what was being taught in class. The pre-service teachers pointed out that they started to dislike mathematics during the shift from primary to secondary. The negative attitude of the teacher and the difficulty to understand mathematics problems were seen as common causes for their aversion towards mathematics. Some examples of responses from the students during the interviews are the following:

“When I was in the primary school and when I had difficulty, the teacher did not want to help me. The teacher would say- you are dumb.”

“I hate mathematics because I find it difficult to understand. I did not get any help in the school because teachers did not have time for it and they did not care at all. A teacher even told me that I will be never good at math and that I will never learn. That’s when I started to believe that I cannot do mathematics.”

Most of the participants felt as though their negative feelings towards mathematics could have been prevented in elementary school, if they had received proper instruction and guidance from their teachers.

Seven students (out of 18) liked mathematics as long as they were able to understand the problems and solve by themselves. These pre-service teachers were more worried during test taking situations. One of them said: “I like math but I don’t like math tests.”

Regarding the possible reasons for not doing well in the first WISCAT-pabo test, pre-service teachers came up with several answers. The feelings of the participants during timed mathematics activities, such as testing situations became very evident. Some of them were very nervous because they were not well prepared for the test. The majority of them had forgotten what they had learnt at primary school level, while others did not take up mathematics in their previous education and so had lost touch with the subject altogether. Not only did they lack practice for the WISCAT-pabo test, but they had also forgotten the concept of mental calculation owing to the
extensive use of calculators in the high school. As a result, it was considered a
difficulty to compute mentally even the simplest of all problems. Few pre-service
teachers had the opinion that they did not learn the concepts very well in their
primary school. One of them remarked: “We do not get all the information we need
to know when we come out of primary level.”

I also asked the pre-service teachers how they thought the optional training
sessions and peer tutoring benefited them. Most of them voiced their opinion for peer
tutoring, as they could assimilate better in comparison to the training sessions. The
identified advantages and disadvantages of peer tutoring and optional training ses-
sions respectively were as follows:

Advantages of Peer Tutoring:
- Peer tutors were of their age and so understanding was better.
- Peer tutoring took place in a small group of 3-4 students and so there was
  more scope for individual communication.
- Tutoring happened in a friendly environment.

Disadvantages of Optional Training Sessions:
- Assignments were given on paper in contrast to the WISCAT-pabo test that is
  computer based and involves mental arithmetic.
- Took place in the classroom setting.
- Focus was more on practicing the primary level mathematics rather than pre-
  paring them to overcome the difficulty of online tests.
- Assignments were given every class that had to be done on their own.
  (pre-service teachers expected the teaching faculty of HvA to teach them con-
  cepts of primary level mathematics and not just give them assignments to do
  on their own).

Last but not the least, the pre-service teachers always felt the pressure to pass
the WISCAT-pabo test in order to continue in the study program. The very fact that
failure in the mathematics skills test would result in their expulsion from the teacher-
training program made them more nervous and this could also be one of the possible
reasons that could have affected their performance in the skills test.
5.8 Findings from the Discussions in the Workshop

In order to answer the sixth research question concerning the PCK of third-year pre-service teachers about math anxiety, I conducted workshops in two sessions. In the first workshop I discussed about the causes, symptoms, origin and measurement of math anxiety. When I asked the pre-service teachers the question “What do you know about math anxiety?” Some of the responses were as follows:

Math anxiety is the fear

• of doing mathematics;
• of doing wrong;
• of not understanding mathematics;
• for the teacher who is very strict;
• for asking help;
• to solve mathematical problems even before you see them;
• for being punished;
• for numbers;
• of failing to solve mathematical problem; or
• feeling that you cannot do mathematics.

At the end of the workshop two assignments were given to the pre-service teachers, which was discussed with them in the second workshop. The second workshop was conducted 4 weeks later after the pre-service teachers had spent one whole week teaching in a school. The aim of the second workshop was to find out if the pre-service teachers had observed any symptoms of math anxiety in their students during their practice in school and the possible instructional strategies they could think of to deal with such children. Some excerpts of the discussion of the two assignments are as follows:
**Assignment 1:**

*Observe for any symptoms of math anxiety during your one-week of teaching session and write them down.*

Pre-service teacher’s response to Assignment 1

<table>
<thead>
<tr>
<th>Pre-service teacher</th>
<th>Quotations</th>
</tr>
</thead>
</table>
| **A** (Taught group-8) | I observed one boy who was doing all possible things but concentrate in the class. When I asked him if he could go to the board and solve the problem, he refused to do so although he got the right answer. I could make out from his body language that he was afraid that he would do it wrong in front of others. I spoke to the boy and from his work I could see that he was able to understand and he was trying to solve the problems but kept saying all the time: I am not sure whether I am right.  
I saw a girl who was going to the toilet many times and doing other things trying to get away from the math class.  
Also, what the teacher speaks in the class is very important. For e.g. during my practice teaching session, I heard the teacher say that “now we are going to do a very easy problem which you all can do” and I saw that this boy became very conscious and was turning away. Although the problem was very easy but the fact that the teacher said that it was so easy that, the boy became very nervous and he was going through total blackout. |
| **B** (Taught 4-6 year olds) | The children do sort of mathematics but they do not come to the board to solve or so but they do mathematics in the form of counting, to find what is more or less and so on. I think it is very difficult to see math as math anxiety in very young children. I have seen in years before in the 5th grade that children were very nervous. When they had to do a task in the book they were doing all kinds of other stuff but not the thing they had to do because they didn't know what to do and were afraid to make mistakes. At that point of time I only knew that they were not good at math so they found it very hard to make the sum. |
| **C** (Taught 10 year olds) | I observed a boy who was also doing other things during the math class and does not want to give answers. There is something wrong with his base in math. He is not able to calculate and so wants to stay away. |
| **D** | I had a girl in my class who would postpone all her work in math. When I worked with her one-to-one then she tried to do although she was very slow. She was fine in all other subjects but during the math lessons, she would draw some pictures in the book and not listen to the teacher. She thinks she cannot do mathematics. |
Assignment 2:

Think of the instructional strategies you may adopt in order to deal with pupils with math anxiety in your classrooms.

Pre-service teacher’s response to Assignment 2

<table>
<thead>
<tr>
<th>Pre-service Teacher’s</th>
<th>Quotation</th>
</tr>
</thead>
</table>
| A                     | I would like to give them stuff, which is more visual, and not with too much numbers because then they may not understand and so they might be afraid of it.  
I would also like to sit together with the child who has some difficulties so that he is not afraid of solving problems. When he is in the whole class he is afraid to ask questions but when you are with him he is no more afraid. |
| B                     | You have to let them feel safe. I keep telling my students to ask me if they do not understand a problem and keep asking till they understand it well.  
If I already know that a child is math anxious before I give a lesson then first I will teach the whole class and then I will attend to the math anxious children separately and give them the same instruction in a different context and in this way they get the instruction twice. |
| C                     | Create a safe and supportive environment.  
Provide the self-confidence to the children that they can do mathematics.  
Working with manipulatives like blocks. |
| D                     | Work with the child on one-to-one. |

Some of them did not observe any symptoms of math anxiety but had few points to give when asked about the instruction strategies they would adopt in their future to deal with math anxious students. For e.g.,

- Give them easy assignments  
- Work with the math anxious students at a slower pace  
- Make them sit with a child who is good in mathematics  
- Work on the self-esteem and motivate them by saying – “you can do it.”

Ironically, the teachers in the schools where the pre-service teachers went for their training also did not take any measures towards students who did not perform
very well in mathematics. When I asked the pre-service teachers if they discussed their observation with their mentor teachers in school, the answer was- “yes, but the teacher said that they do not give turn to children who cannot do it well. She thought she was doing a good thing but I think that she should have given easy questions to them and helped them.”

5.9 Comparison of Math Anxiety Test Scores and Self-Ratings
It was not really part of my research study, but out of curiosity I also asked students in the pretest to rate their math anxiety level on a scale from 1 to 10. This allowed me to compare the math anxiety test scores with the self-ratings. It turned out that these quantities correlated significantly. Figure 5.9 shows the scatterplot of the score on the math anxiety scale plotted against the self rating of the participants and the least square line fit with the goodness-of-fit value of $R^2 = .5$.

![Figure 5.9](image.png)

**Figure. 5.9** A scatterplot of the score on the math anxiety scale plotted against the self-rating and the least-square line fit
6 Discussions and Conclusions

In this chapter, I summarize my findings relative to the quantitative analysis described in Chapter 5 and organize the conclusions by answering my research questions.

Research question 1

*Does the standardized math anxiety tests indicate the existence of math anxiety amongst first year elementary pre-service teachers when they enter the teacher-training program?*

The results of this study add to the current literature on the existence of mathematics anxiety in the pre-service teachers. According to the mathematics anxiety scale used in my study, which was a combination of two short standardized tests indicated that, math anxiety existed in the first year elementary pre-service teachers. Results indicated that 16% and 22% of the population, who administered the math anxiety test before and after the WISCAT-pabo test respectively, had a high score when they entered the teacher-training program. The math anxiety test was given to the pre-service teachers in the form of a questionnaire (see Appendix A) where they also had to self-analyze their math anxiety level on a scale from 1 to 10. The strong correlation between the score on the math anxiety test and their self-analysis indicated that the pre-service teachers were aware of their own anxiety level in mathematics.

The Psychometric tests done on the two standardized tests 10-item MAS and 9-item AMAS used in my study indicated that both these instruments provide a reliable assessment of mathematics anxiety in elementary pre-service teachers. The internal reliability Cronbach $\alpha=.94$ for the 19-item test indicated that the choice I made to combine two standardized tests was an appropriate one and gave me satisfactory results for my target group of pre-service teachers. Since the results obtained in the two standardized tests to measure math anxiety are similar, I conclude that MAS and AMAS tests can be used separately or in combination in future studies to investigate math anxiety in pre-service teachers.

Furthermore, the pre-service teachers who were found to be math anxious according to the standardized test also expressed their dislike and fear towards
mathematics related situations during the semi-structured interviews. The main cause of their anxiety has been their negative classroom experiences in mathematics in the primary level. Most of the pre-service teachers interviewed, attributed their major source of dislike towards mathematics to the teachers and/or teaching methodology during their course of study in school. Some of them developed an aversion towards mathematics in the primary level while some others in their high school level. Since they had minimal family support and outside help during their school years, not much was done to address their anxiety level in mathematics. However, during the interviews the pre-service teachers’ said that they realized the need and importance to overcome their anxiety level in mathematics before they started their full time teaching career. Therefore, teacher education program should encourage prospective teachers to become aware of their level of mathematics anxiety and take serious measures to help them overcome their anxiety level before they begin their career as full time teacher at a primary school.

**Research question 2**

*Is there a correlation between students’ results on the first math anxiety test and their performance in the first WISCAT-pabo test?*

In order to check for the correlation between students’ results on the first math anxiety test and their performance in the first WISCAT-pabo test for my target group of 72 students, I calculated the Pearson correlation coefficient. The negative correlation between the results of the pretest was significant with that of the result of the first WISCAT-pabo test. The scatter plot between the two variables (pretest and WISCAT-pabo test) indicated a linear relationship between them. This means that as the score on the math anxiety scales increased, participants exhibited poorer performance in the WISCAT test, irrespective of the instrument (MAS or AMAS) used. The findings of this study concur with the results of other studies (Betz, 1978; Hembree, 1990) in which the researchers have found that people with high math anxiety level exhibit low performance in mathematics achievement test and vice versa.

During the time of the semi-structured interviews with the first year pre-service teachers, I asked them for possible reasons that in their opinion explained their low score in the first WISCAT-pabo test. Some of the pre-service teachers
thought that they lacked practice and had also forgotten arithmetic taught at their primary school level. This made them nervous before the test and they lacked self-confidence. Some of them thought that they had not learnt the concepts very well during their primary school time and so did not know how to solve the problems asked in the WISCAT-pabo test. The majority of them expressed their fear and dislike towards the subject itself.

The pre-service teachers were of opinion that it would have been beneficial if they were given practice sessions online. Since the WISCAT test is online and the first few questions had to be solved mentally, lot of students had difficulty in this section. This could be attributed to the use of scientific calculators in the high school, which disables the capability for mental arithmetic. Furthermore, a low score in the WISCAT-pabo test could also be the result of student teacher’s conceptual weakness in arithmetic.

Research question 3

For those students who participate in the trainings sessions after the first WISCAT-pabo test (those who failed and those who wanted to improve their test score) and take the test anxiety test, what are the students’ results on the math anxiety test and the test anxiety test? Are there correlations between the three test results?

The findings of my research study were in agreement with studies conducted by researchers on math anxiety and test anxiety (as discussed in Chapter 2). A number of researchers have found that there exists a relationship between math anxiety and test anxiety (Dew, Galassi & Galassi, 1984). In my analysis I found that the test anxiety scale had a strong correlation with the math anxiety scale, which reflects the relationship between test anxiety and math anxiety. The comparison of the results on the math anxiety scale and the Test Anxiety Inventory indicated that 13% of the pre-service teachers who took the two tests were both math anxious and test anxious. The positive correlation between the scores on the math anxiety scale and test anxiety scale indicated a positive relationship between the two scales as a measure of the anxiety construct.

In order to check whether the scores on the math anxiety scale, test anxiety scale and WISCAT-pabo test were correlated, I did the Pearson correlation coefficient test. The results indicated a negative correlation between the WISCAT-pabo test
with that of the math anxiety test and test anxiety test respectively. This means that as the scores on the anxiety scales increased, the performance score on the WISCAT-pabo decreased. One of the possible reasons for this low performance in the WISCAT-pabo test could also be due to the stress experienced by pre-service teachers due to computerized adaptive testing. Therefore, the poor performance of the student teachers in the first WISCAT-pabo test could be attributed to their math anxiety, test anxiety, or both.

The factor analysis of the Test Anxiety Inventory (TAI) did not lead to results comparable to those reported in research literature. Based on this literature, I was looking for the two components- worry and emotionality components in the TAI scale. According to my results I got 4 components for the TAI scale. Although the 20-item TAI test seemed to be a reliable test to measure test anxiety, the factor analysis did not yield the results reported in the literature. Maybe the rather small number of participants (42) is an explanation.

**Research question 4**

*How do results on the second WISCAT-pabo test compare with results of the first WISCAT-pabo test for those students who take the training sessions and the peer tutoring?*

According to the Wilcoxon test, the score on the second WISCAT-pabo test was significantly higher than the first WISCAT-pabo test. Also, the percentage of pre-service teachers who failed the second WISCAT-pabo test (57.4%) was lower than the ones who failed in the first WISCAT-pabo test (62.5%). I also conclude from the results of the second WISCAT-pabo test that most of the pre-service teachers who did not perform well in the first WISCAT-pabo test managed to score better marks and some of them even passed the retest.

During the interview sessions with the pre-service teachers I had asked them if they found the training sessions and peer tutoring helpful enough to prepare them for the second WISCAT-pabo test. The pre-service teachers seemed indeed more confident and thought that they were better prepared for the second WISCAT-pabo test for the following reasons:

- Pre-service teachers had become familiar with the pattern of the WISCAT pabo test.
• The training sessions and peer tutoring provided them with opportunities for practice.
• Revision of mathematical topics learnt in the primary level during training sessions were helpful.
• One-to-one help during peer tutoring

When asked about the usefulness of optional training sessions and peer tutoring, many of them commented that they understood mathematics much more when their own peers taught them. Although some of them thought that they benefitted from the training sessions, some others did not find them very useful. They expected the teaching faculty of HvA to teach them concepts of primary level mathematics and not just give them assignments to do on their own. Moreover, as a preparation to the online WISCAT-pabo test, the pre-service teachers looked for assignments that were computer-based and involved mental arithmetic and not just on paper. Nevertheless, the performance in the second WISCAT-pabo was an indication that pre-service teachers had certainly benefitted in some ways to perform better in the second WISCAT-pabo test.

Research question 5

How do results on the second math anxiety test compare with the result of the first math anxiety test for those students who take the training sessions and the peer tutoring?

I first compared the results of the scores on the pre- and posttest on an individual score level. In general there was a reduction in the math anxiety level in 15 out of 26 participants. The results of the $t$-test indicated that the mean difference of scores in the pretest was statistically greater than the mean score in the posttest. Therefore, there was a significant reduction in the math anxiety level in the pre-service teachers in the posttest when compared to the pretest.

When examined on an individual score, 9 out of 26 participants’ scores on the math anxiety scale increased. During the interview sessions with these student teachers, they had expressed their fear in terms of passing the WISCAT-pabo test in order to continue their program in the pabo. These student teachers did not seem very confident to appear for the retest, because they still felt they could “not do mathematics”. Having not passed the first WISCAT-pabo test, the pre-service teachers felt
pressure to pass the second test in order to continue their study in the teacher-training program in the PABO. This could be a possible reason for the increase in their anxiety level. In fact, four of them did not even appear for the second WISCAT-pabo test.

**Research question 6**

*What Pedagogical Content Knowledge about mathematics anxiety do third year pre-service teachers have?*

*a) Did they observe mathematics anxiety amongst their pupils during their teaching practice sessions?*

*b) If so, what instructional strategies did they think of and/or have they used in their lessons in order to deal with their pupils’ anxiety.*

Regarding the pedagogical content knowledge of math anxiety, the majority of third-year pre-service teachers could identify the terminology with “fear” in the general sense, but they did not have a clear idea that it is the fear or dislike exhibited by their students towards the subject mathematics. Prior to my workshop, the pre-service teachers had already many opportunities in the past to meet primary school pupils during their practice teaching sessions who had shown their discomfort and dislike towards mathematics. The pre-service teachers considered this behavior as a lack of confidence to do mathematical problems. Some of them even thought that probably the child was not good at math and so had difficulty with problem solving. In conclusion, although the pre-service teachers came up with some responses in terms of the literal meaning of ‘math anxiety’, the answers were not very convincing to conclude that the third year pre-service teachers had the PCK of math anxiety.

When asked if the student teachers’ observed any symptoms of math anxiety amongst their pupils during their teaching practice sessions, the student teachers responded in the affirmative sense; what follows is a list of their observations:

- Lack of concentration in the class.
- Lack of confidence to solve problems.
- Being afraid to solve problems on the board even though h/she has got the right answer.
- Finding excuses to escape the math class.
- Nervousness while doing tasks from the book.
Postponing work in the math class and instead drawing pictures in the math book.

Feeling that one cannot do mathematics.

One of the student teachers, who taught at kindergarten level (4-6 years old), thought that it was difficult to see symptoms of math anxiety in very young children. Another student teacher, along with her observation of the pupils in the classroom, also observed the attitude of the teacher in the class and made a very good point that it is important that the teacher should be aware of what he/she speaks in class as it may also cause anxiety in the children.

Thus, the pre-service teachers observations of few students in their class made clear that they had in practice become aware of the symptoms of math anxiety and also realized that such pupils need to be given lot of support and attention.

When I asked the student teachers whether they thought of any particular instructional strategy or if they had used any teaching methodology during their practice teaching sessions to deal with math anxious students in their classroom, the responses were as follows:

- I will use visual stuff.
- I sat together with the child and provided support.
- I will try to make the students feel safe and comfortable in math class.
- I shall give individual attention and different kind of instruction.
- I provided self-confidence to the child by saying “you can do mathematics.”
- I will work with manipulatives.
- I will provide with assignments that are easier.
- I made the child sit with a peer who is kind and good at math.

The above strategies cited by the student teachers were a clear indication that the pre-service teachers had not only become aware of math anxiety but also had thought about possible instructional strategies they would implement in their classrooms to help students with math anxiety. The pre-service teachers had begun to identify pupils who struggled with mathematics in their classroom and thought that they must help them out. Ironically, the mentor teachers in the schools where the student teachers went for their practice sessions seemed to exhibit negligence towards children who did not perform well in mathematics. One of the student teachers who observed this attitude of the mentor teacher felt that the teacher’s approach was not
the right one. Instead of ignoring the child who is weak in mathematics and not giving him/her opportunities, the student teacher felt that the teacher should have given the child easy questions and individual attention.

In conclusion, I considered the workshop that I conducted as a successful one: the third year student teachers seemed to benefit from it and it increased their awareness about the symptoms of math anxiety and their knowledge about possible ways to help children overcome their anxiety. Although some of them did attempt to try out some of these methods during their one week of practice sessions, some others only hoped to implement them in their future classrooms in order to deal with math anxious students.
7 Limitations and Recommendations

In this chapter I discuss limitations of my study, based on the constraints of the research design and the practicalities of the research at the PABO, and implications and recommendations for future studies.

7.1 Limitations

Based on the data collection and findings of this study, the following limitations should be considered:

- Not all participants took the math anxiety and test anxiety tests at the planned moments.
- Only few participants were available for all the three tests: pre- and posttest of math anxiety test and test anxiety test.
- Some of the student teachers who took the pretest were not available for the posttest of math anxiety. I could only compare the results of pre- and posttest of math anxiety for a rather small number of participants. Therefore, it is not possible to generalize the findings of this study to the large student population with regards to change in the math anxiety levels with respect to the first and the second WISCAT test.
- The difficulty in using self-report instruments is whether the participant honestly reports his/her feelings or emotions. It is quite possible that the participant’s frame of mind at the time of the test may influence his/her response.

7.2 Implications and Recommendations

The implication of this study for primary teacher training programs was that there is a need for increased attention on the mathematics anxiety of pre-service teachers and their negative attitudes about mathematics. I recommend that pre-service teachers be made aware of their mathematics anxiety level and their attitudes about mathematics. As seen in many literatures, math anxiety is also transmitted from the math anxious teachers to their students during their process of teaching. In order to combat this, it is important to make the teachers themselves aware of their math anxiety levels and help them to overcome their fear and their negative attitudes about mathematics.
Secondly, teacher education programs better acknowledges and addresses the importance of these affective variables and their role in pedagogy. Therefore, as educators and teacher training institutes prepare students to pursue a teaching career, they better examine mathematics anxiety specifically as it relates to pre-service teachers and its influences on the attitudes of the teacher and their teaching in the elementary school classroom.

This research study did not find statistically significant results regarding the factor analysis of the Test anxiety Inventory. With hindsight, the choice of the testing instrument or the translation of the TAI instrument in order to adapt to the Dutch educational system may have impacted the results of my study. However, the same was not true for the choice of Math anxiety instruments. The results were highly comparable with those found in the literature. The choice of two standardized math anxiety instruments, as well as the translation of the items in Dutch, seemed to be apt for my target group of students.

The findings of this study indicated that the pre-service teachers in the first year teacher-training program had an aversion and negative attitude towards mathematics. Interestingly, there were eight pre-service teachers who were math anxious but had passed the WISCAT-pabo test. Although these pre-service teachers were found math anxious according to the standardized test, no step was taken to help them reduce or overcome their anxiety. Since these student teachers had passed the WISCAT-pabo test they did not attend any training sessions and therefore did not take the test anxiety test. Because there was no opportunity to meet them or interview them, I could not investigate further regarding their math anxiety. This is something that the faculty staff of PABO can look into in the future.

As suggested in the literature, the teacher transmits their own negative feelings and anxiety in mathematics to their students. However, this negative feelings and even hatred towards mathematics can be attributed to the poor mathematics instruction the pre-service teachers underwent in their elementary school time and some of the blame also lies with schools of education at secondary level.

I make the following recommendations:

- All pre-service teachers undergo a mathematics anxiety test at the beginning of the semester, followed by additional support to be provided for pre-service teachers who are math anxious. This support to reduce mathematics anxiety
can be provided by giving mathematics courses focusing on the content and methodology.

- Students are provided with mathematics courses before the WISCAT-pabo test. Since many of the students entering the teacher training program are from different educational backgrounds with some of them having lost practice with mathematics in their previous education, it was observed that many of them lacked the practice and hence the confidence to solve primary level mathematics problem. One better acts upon this.

- Pre-service teachers should be given mathematics practice sessions where they have to solve mathematics problem mentally in order to prepare them for the WISCAT-pabo test.

- The training sessions set up to help pre-service teachers pass the WISCAT-pabo test should also contain sessions about solving mathematical problems online, rather than focusing only on paper-and-pencil exercises.

- The pre-service teachers during their program should have a lesson on math anxiety in order to increase their Pedagogical Content Knowledge (PCK) about math anxiety and the strategies they could use on their pupils to overcome the same. All future teachers must be made aware of the causes, symptoms and remedies to decrease math anxiety and foster the development of mathematical literacy.

In conclusion, student support strategies may be beneficial in reducing math anxiety and improve the performance in the online WISCAT test. Last but not the least, it is my hope that this research study contributes to the larger literature on mathematics anxiety among pre-service teachers and encourages teacher education programs to be more responsive to the mathematics anxiety and consider this as a critical aspect in the progress of prospective teachers.
References


Appendix A

Questionnaire

for the purpose of research on math anxiety of beginning PABO-students

Math anxiety is a state of a sinking feeling, uncertainty and despair at doing arithmetic and mathematics. I investigate in my research project in the Master of Mathematics and Science Education at the UvA to what extent math anxiety is present amongst beginning PABO-students and how it develops further. For the purpose of collecting research data I have created a short questionnaire, in which you may also interpret the term ‘mathematics’ in the more narrow sense of ‘arithmetic’. I will maintain the confidentiality of the provided information and I will use the information only for research purposes; I will not publicly discuss data of individuals. I hope and have faith in your serious participation. I thank you in advance for filling out the questionnaire.

Reshmi Pradeep
Student Master of Mathematics and Science Education, UvA

Personal data

Name: _______________________________ Student id: __________________

Age: _____ year Gender: male / female

Highest prior education:

☐ HAVO
☐ VWO
☐ MBO
☐ different, namely: _____________________

In case of HAVO/VWO education, the chosen mathematics programme:

☐ mathematics A
☐ mathematics B
☐ mathematics C
☐ mathematics D
☐ different, namely: _____________________

self-analysis of math anxiety:

On a scale from 1 to 10 (1 = no anxiety at all; 10 = extreme anxiety/phobia) I rank my own math anxiety as follows (circle the mark that is the best indicator your judgment):

1 2 3 4 5 6 7 8 9 10

no anxiety at all extreme anxiety
Appendix B

Original MAS

The following are math anxiety statements, about which your opinion is sought. For each statement, please circle the response that most closely indicates your extent of agreement or disagreement with the statement.

1. It doesn’t bother me at all to take more math classes.

   Strongly Agree    Agree    neutral    Disagree    Strongly Disagree

2. I have usually been at ease during math tests.

   Strongly Agree    Agree    neutral    Disagree    Strongly Disagree

3. I have usually been at ease during math courses.

   Strongly Agree    Agree    neutral    Disagree    Strongly Disagree

4. I usually don’t worry about my ability to solve math problems.

   Strongly Agree    Agree    neutral    Disagree    Strongly Disagree

5. I almost never get uptight during math tests.

   Strongly Agree    Agree    neutral    Disagree    Strongly Disagree

6. I get really uptight during math tests.

   Strongly Agree    Agree    neutral    Disagree    Strongly Disagree

7. I get a sinking feeling when I think of trying hard math problems.

   Strongly Agree    Agree    neutral    Disagree    Strongly Disagree

8. My mind goes blank and I am unable to think clearly when working mathematics.

   Strongly Agree    Agree    neutral    Disagree    Strongly Disagree

9. Mathematics makes me feel nervous and uncomfortable.

   Strongly Agree    Agree    neutral    Disagree    Strongly Disagree

10. Mathematics makes me feel uneasy and confused.

   Strongly Agree    Agree    neutral    Disagree    Strongly Disagree
Appendix C

Original AMAS

The following are math anxiety statements, about which your opinion is sought. For each statement, please circle the response that most closely indicates your extent of agreement or disagreement with the statement.

1. Having to use the tables in the back of a math book.
   
   Not at all   a little bit   a bit   fairly much   very much.

2. Thinking about an upcoming math test 1 day before.
   
   Not at all   a little bit   a bit   fairly much   very much.

3. Watching a teacher work an algebraic equation on the blackboard.
   
   Not at all   a little bit   a bit   fairly much   very much.

4. Taking an examination in a math course.
   
   Not at all   a little bit   a bit   fairly much   very much.

5. Being given a homework assignment of many difficult problems that is due the next class meeting.
   
   Not at all   a little bit   a bit   fairly much   very much.

6. Listening to a lecture in math class.
   
   Not at all   a little bit   a bit   fairly much   very much.

7. Listening to another student explain a math formula.
   
   Not at all   a little bit   a bit   fairly much   very much.

8. Being given a “pop” quiz in math class.
   
   Not at all   a little bit   a bit   fairly much   very much.

   
   Not at all   a little bit   a bit   fairly much   very much.
Appendix D

Original Test Anxiety Inventory

The following are test anxiety statements about which your opinion is sought. For each statement, please circle the response that most closely indicates your extent of agreement or disagreement with the statement.

1. I feel confident and relaxed while taking tests.

   Almost Never    Sometimes    Often    Almost Always

2. While taking final examinations I have an uneasy upset feeling.

   Almost Never    Sometimes    Often    Almost Always

3. Thinking about the grade I may get in a course interferes with my work on tests.

   Almost Never    Sometimes    Often    Almost Always

4. I freeze up on final exams.

   Almost Never    Sometimes    Often    Almost Always

5. During exams I find myself wondering whether I will ever get through school.

   Almost Never    Sometimes    Often    Almost Always

6. The harder I work at taking a test, the more confused I get.

   Almost Never    Sometimes    Often    Almost Always

7. Thoughts of doing poorly interfere with my concentration on tests.

   Almost Never    Sometimes    Often    Almost Always

8. I feel very jittery when taking an important test.

   Almost Never    Sometimes    Often    Almost Always

9. Even when I am well prepared for a test, I feel very anxious about it.

   Almost Never    Sometimes    Often    Almost Always

10. I start feeling very uneasy just before getting a test paper back.

    Almost Never    Sometimes    Often    Almost Always
11. During tests I feel very tense.
   Almost Never   Sometimes   Often   Almost Always

12. I wish examinations did not bother me so much.
   Almost Never   Sometimes   Often   Almost Always

13. During important examinations I am so tense that my stomach gets upset.
   Almost Never   Sometimes   Often   Almost Always

14. I seem to defeat myself while working on important test.
   Almost Never   Sometimes   Often   Almost Always

15. I feel very panicky when I take an important test.
   Almost Never   Sometimes   Often   Almost Always

16. If I were to take an important exam, I would worry a great deal about taking it.
   Almost Never   Sometimes   Often   Almost Always

17. During tests I find myself thinking about the consequences of failing.
    Almost Never   Sometimes   Often   Almost Always

18. I feel my heart beating very fast during important tests.
    Almost Never   Sometimes   Often   Almost Always

19. As soon as an exam is over I try to stop worrying about it, but I just cannot.
    Almost Never   Sometimes   Often   Almost Always

20. During a course examination I get so nervous that I forget facts I really know.
    Almost Never   Sometimes   Often   Almost Always
Appendix E

Dutch version of the Math anxiety tests

Vragenlijst t.b.v. onderzoek naar wiskundeangst bij beginnende PABO-studenten

Wiskundeangst is een gevoelstoestand van beklemming, onzekerheid en vertwijfeling bij rekenen en wiskunde. Ik onderzoek in mijn afstudeerproject binnen de Master of Mathematics and Science Education aan de UvA in hoeverre wiskundeangst bij beginnende PABO-studenten aanwezig is en hoe het zich verder ontwikkelt. Om onderzoeksgelijke gegevens te verzamelen heb ik een korte vragenlijst opgesteld, waarin het woord 'wiskunde' ook in engere zin als 'rekenen' geïnterpreteerd mag worden. Ik zal de verstrekte informatie vertrouwelijk en alleen voor onderzoeksdoeleinden gebruiken; individuele gegevens worden niet publiekelijk besproken. Ik hoop en vertrouw op serieuze medewerking. Bij voorbaat dank voor het invullen van de vragenlijst.

Reshmi Pradeep
Student Master of Mathematics and Science Education, UvA

Persoonlijke gegevens

Naam: _______________________________ Studentnummer: _______________________________

Leeftijd: ____ jaar Geslacht: man / vrouw

Hoogste vooropleiding:
- [ ] HAVO
- [ ] VWO
- [ ] MBO
- [ ] anders, namelijk: _______________________________

Bij HAVO/VWO vooropleiding, het gekozen wiskundeprogramma:
- [ ] wiskunde A
- [ ] wiskunde B
- [ ] wiskunde C
- [ ] wiskunde D
- [ ] anders, namelijk: _______________________________

Zelfoordeel over wiskundeangst:
Op een schaal van 1 tot 10 (1 = helemaal geen angst; 10 = extreme angst/fobie) rangschik ik mijn eigen wiskundeangst als volgt (omcirkel het cijfer dat je oordeel het best aangeeft):

1 2 3 4 5 6 7 8 9 10
helemaal geen angst extreme angst
Vragenlijst over wiskundeangst
Onderstaande vragenlijst bestaat uit 19 vragen, opgedeeld in 2 deellijsten. De vragen zijn zodanig opgesteld dat de beantwoording ervan weinig tijd vergt: je hoeft alleen maar een vakje aan te kruisen dat je mening het best beschrijft.

Onderdeel 1: Meningen over wiskundeangst.
Hieronder staan 10 uitspraken over wiskundeangst. Plaats voor elke uitspraak een kruisje bij de aanduiding die je mening het best beschrijft (neutraal betekent hierbij dat je het er noch mee eens, noch mee oneens bent of helemaal geen mening hebt).

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1. Ik heb er helemaal geen problemen mee als ik meer wiskunde zou krijgen.
   zeer mee eens   mee eens   neutraal   mee oneens   zeer mee oneens

2. Ik heb me meestal op mijn gemak gevoeld tijdens wiskundeproefwerken.
   zeer mee eens   mee eens   neutraal   mee oneens   zeer mee oneens

3. Ik heb me meestal op mijn gemak gevoeld tijdens wiskundelessen.
   zeer mee eens   mee eens   neutraal   mee oneens   zeer mee oneens

4. Ik maak me meestal geen zorgen dat ik wiskundeopgaven kan oplossen.
   zeer mee eens   mee eens   neutraal   mee oneens   zeer mee oneens

5. Ik geraak bijna nooit in stress tijdens wiskundeproefwerken.
   zeer mee eens   mee eens   neutraal   mee oneens   zeer mee oneens

6. Ik kan echt de zenuwen krijgen tijdens wiskundeproefwerken.
   zeer mee eens   mee eens   neutraal   mee oneens   zeer mee oneens

7. Ik krijg een beklemd gevoel als ik denk aan het maken van moeilijke wiskundesommen.
   zeer mee eens   mee eens   neutraal   mee oneens   zeer mee oneens

8. Ik heb last van black-outs en kan niet helder denken tijdens wiskunde.
   zeer mee eens   mee eens   neutraal   mee oneens   zeer mee oneens

zeer mee eens mee eens neutraal mee oneens zeer mee oneens

10. Wiskunde bezorgt me een onbehagelijk en verward gevoel.

zeer mee eens mee eens neutraal mee oneens zeer mee oneens

Onderdeel 2: Gevoelens van wiskundeangst.

Hieronder staan 9 activiteiten voor of tijdens wiskunde lessen. Plaats voor elke activiteit een kruisje bij de aanduiding die je mate van angstgevoel het best beschrijft.

11. Gebruik moeten maken van de tabellen achterin een wiskundeboek.

helemaal niet een klein beetje een beetje tamelijk veel heel veel

12. Denken aan een wiskundeproefwerk dat de volgende dag afgenomen wordt.

helemaal niet een klein beetje een beetje tamelijk veel heel veel

13. Kijken naar een leraar die een wiskundige vergelijking uitwerkt op het schoolbord.

helemaal niet een klein beetje een beetje tamelijk veel heel veel


helemaal niet een klein beetje een beetje tamelijk veel heel veel

15. Huiswerk opgedragen krijgen dat uit veel moeilijke opdrachten bestaat en dat af moet zijn voor de volgende les.

helemaal niet een klein beetje een beetje tamelijk veel heel veel

16. Luisteren naar klassikale uitleg/bespreking door de wiskundedocent.

helemaal niet een klein beetje een beetje tamelijk veel heel veel

17. Luisteren naar een medeleerling die een wiskundeformule uitlegt.


helemaal niet  een klein beetje  een beetje  tamelijk veel  heel veel

18. Een beurt krijgen tijdens de wiskundeles.

helemaal niet  een klein beetje  een beetje  tamelijk veel  heel veel


helemaal niet  een klein beetje  een beetje  tamelijk veel  heel veel

Nogmaals bedankt voor het invullen van de vragenlijst.
Reshmi Pradeep
Appendix F

Dutch version of the test anxiety test

Vragenlijst t.b.v. onderzoek naar toetsangst bij beginnende PABO-studenten

We spreken van toetsangst als een testssituatie (bijvoorbeeld een proefwerk of examen) een spanning teweegbrengt die een negatieve invloed kan hebben op de testsuitslag. Overmatige nervositeit tijdens de voorbereiding op een test of tijdens de test zelf is een sterke indicatie van toetsangst. Ik onderzoek in mijn afstudeerproject binnen de Master of Mathematics and Science Education aan de UvA in hoeverre toetsangst toetsangst bij beginnende PABO-studenten aanwezig is en mogelijk een negatieve invloed heeft op de uitslag van de WISCAT-pabo reken- en kien. Om onderzoekergegevens te verzamelen heb ik een korte vragenlijst opgesteld. Ik zal de verstrekte informatie vertrouwelijk en alleen voor onderzoekdoeleinden gebruiken; individuele gegevens worden niet publiekelijk besproken. Ik hoop en vertrouw op serieuze medewerking. Bij voorbaat dank voor het invullen van de vragenlijst.

Reshmi Pradeep
Student Master of Mathematics and Science Education, UvA

Persoonlijke gegevens

Naam: ___________________________ Studentnummer: ___________________________

Leeftijd: ____ jaar Geslacht: man / vrouw

Zelfoordeel over toetsangst:
Op een schaal van 1 tot 10 (1 = helemaal geen toetsangst; 10 = extreme toetsangst) rangschik ik mijn eigen toetsangst als volgt (omcirkel het cijfer dat je oordeel het best aangeeft):

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<td>helemaal geen toetsangst</td>
<td>extreme toetsangst</td>
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Vragenlijst over toetsangst

Onderstaande vragenlijst bestaat uit 20 vragen. De vragen zijn zodanig opgesteld dat de beantwoording ervan weinig tijd vergt: je hoeft alleen maar een vakje aan te kruisen dat je mening het best beschrijft.

1. Ik ben zelfverzekerd en ontspannen als ik een proefwerk maak.
   ______ ______ ______ ______
   bijna nooit  soms  vaak  bijna altijd

2. Tijdens een eindtoets voel ik me niet op mijn gemak en ben ik angstig.
   ______ ______ ______ ______
   bijna nooit  soms  vaak  bijna altijd
3. Denken aan het cijfer dat ik kan voor een vak kan halen verstoort mijn prestatie in toetsen.
   bijna nooit    soms    vaak    bijna altijd

4. Ik raak verlamd van de zenuwen bij eindtoetsen.
   bijna nooit    soms    vaak    bijna altijd

5. Tijdens examens betrap ik mezelf er wel eens op dat ik me afvraag of ik ooit wel zal slagen.
   bijna nooit    soms    vaak    bijna altijd

6. Hoe hard ik werk voor een proefwerk, hoe meer ik in de war raak.
   bijna nooit    soms    vaak    bijna altijd

7. Gedachten aan een mogelijk slecht resultaat verstoren mijn concentratie tijdens het maken van proefwerken.
   bijna nooit    soms    vaak    bijna altijd

8. Ik krijg de kriebels van het deelnemen aan een belangrijk proefwerk.
   bijna nooit    soms    vaak    bijna altijd

9. Zelfs als ik goed voorbereid ben voor een toets voel ik me toch angstig.
   bijna nooit    soms    vaak    bijna altijd

10. Ik begin me niet op mijn gemak te voelen kort voordat ik een proefwerk terug krijg.
    bijna nooit    soms    vaak    bijna altijd

11. Tijdens proefwerken voel ik me heel gespannen.
    bijna nooit    soms    vaak    bijna altijd
12. Ik zou graag willen dat ik minder problemen zou hebben met het afleggen van 
examens.

   bijna nooit   soms   vaak   bijna altijd

13. Tijdens belangrijke examens ben ik zo gespannen dat mijn maag van streek 
geraakt.

   bijna nooit   soms   vaak   bijna altijd

14. Ik lijk mezelf wel in de weg te zitten bij het maken van een belangrijk proefwerk

   bijna nooit   soms   vaak   bijna altijd

15. Ik ben paniekerig als ik een belangrijk proefwerk maak.

   bijna nooit   soms   vaak   bijna altijd

16. Als ik een belangrijk examen moet afleggen, dan heb ik daar vooraf al veel 
zorgen over.

   bijna nooit   soms   vaak   bijna altijd

17. Tijdens proefwerken betrap ik mezelf er wel eens op dat ik aan de gevolgen van 
en een slecht resultaat denk.

   bijna nooit   soms   vaak   bijna altijd

18. Ik voel mijn hart in de keel kloppen tijdens belangrijke proefwerken.

   bijna nooit   soms   vaak   bijna altijd

19. Zodra een examen afgelopen is probeer ik er niet meer over te piekeren, maar dat 
lukt me niet.

   bijna nooit   soms   vaak   bijna altijd

20. Tijdens een proefwerk wordt ik zo nerveus dat ik dingen vergeet die ik wel weet.

   bijna nooit   soms   vaak   bijna altijd

Nogmaals bedankt voor het invullen van de vragenlijst, Reshmi Pradeep
Appendix G

Workshop I: PowerPoint Slides and Handout

MATH ANXIETY

How it Affects Teachers and Students

By
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Masters in Mathematics and Science Education
University of Amsterdam

Some Quotes from Students

• “Only some people can do math- not me!!!!”
• “When I look at math problems my mind goes blank”
• “Math exams terrifies me”.
• “I hate math classes because I do not understand what the teacher is saying”.
• “I hate math classes because my teacher punished me for 1 week for not having learnt the multiplication tables.”
What is Math Anxiety?

- Feeling of anxiety that people have about their ability to understand and do mathematics
- Fear or dislike towards mathematics
- Negative attitudes and beliefs about mathematics
- Fear of not accomplishing goals
  (Nonintellectual factor)

Consequences of Math Anxiety (according to Literature)

- Dislike towards mathematics
- Enrollment in fewer math courses
- Poor performance on math tests
- Effect on their achievement in mathematics.
- Low motivation
Aim of this workshop

- Share knowledge about math anxiety
- Raising awareness in pre-service teachers
- Identifying students who are math anxious

Common Symptoms

General
- Panic - feeling of helplessness - will never be able to do math
- Paranoia - feeling that everyone knows the answer except them
- Avoidance of math related situations
Symptoms

Physical
- Tension
- Stomach pains
- Sensation of unease, discomfort (vomiting)
- Sweaty palms

Symptoms

Psychological
- Sense of going blank
- Hard time organizing things
- Hard to concentrate
- Inability to cope
Symptoms seen in Classrooms

- Afraid of solving a problem on the board
- Afraid to ask questions in the class
- Worried about being called on in math class
- Loosing concentration in the class
- Do not know how to study for math tests
- Understand in the class but forget once they are out.

Origin

- Intellectual
  - Lack of determination
  - Self doubt
  - Not confident in their mathematical ability
  - Lack of belief in the usefulness of mathematics

- Personal
  - Low self confidence
  - Shy or reluctant to ask questions
• Environmental
  ◦ Parental demands or pressures
  ◦ Teacher dominated classrooms
  ◦ Experiences from the past
  ◦ Influence from math anxious adults

How does Math Anxiety Develop in Class?

• Negative experience in classrooms
  - Teachers imposing personal views
  - Exhibiting gender bias
  - Uncaring attitude
  - Embarrassing in front of peers
• Teaching methodology
  - Different learning styles not considered
  - Quality of instruction
• Pressure of assessment
  - Memorizing mathematical concepts
  - Timed or online tests
• Math anxiety in teachers
  - Transfer from teacher to student
Teaching that may lead to Math Anxiety

- Following the textbook problem by problem
- Insisting on only one way to solve a problem
- Assigning the same work for all in class
- Assigning written work everyday
- Assigning mathematics homework as punishment for misbehaving
- Teaching mathematics as only rules and formulas

Measurement

- MARS (Mathematics Anxiety Rating Scale)
  Richardson & Suinn (1972), 98 items, Likert scale
- MARS-Revised
  Plake & Parker (1982), 24 items
- AMAS (latest)
  Hopko et al. (2003), 9 items
- MARS-E (For Elementary School Students)
  Suinn, Taylor & Edwards (1988), 26 items
Self Reporting Test

Self Evaluation
On a scale of 1 to 10, rate your level of anxiety in mathematics with 1 as low anxious and 10 as highly anxious.

1 10

Math Anxiety Test- AMAS

9 item, 5 point Likert scale

- helemaal niet = 1 (not at all)
- een klein beetje = 2 (a little bit)
- een beetje = 3 (a bit)
- tamelijk veel = 4 (fairly much)
- heel veel = 5 (Very much)
Scores

Scores on the AMAS

0-15 = Low anxious
15-30 = medium anxious
30-45 = highly anxious

Assignment

• Observe for any symptoms of math anxiety during your one week of teaching session and write them down.

• Think of the instructional strategies you may adopt in order to deal with pupils with math anxiety in your classrooms.
Thank you for your participation

Any Questions
Handout for the student teachers

1. **What is Math Anxiety?**
   Math anxiety is an irrational fear of mathematics that occurs in response to situations involving mathematical tasks and can create a negative attitude towards mathematics. It is described as a feeling of uncertainty of not being able to do well in mathematics or with numbers.

2. **How does Math Anxiety develop?**
   - Negative experience in classrooms
     - Teachers imposing personal views
     - Exhibiting gender bias
     - Uncaring attitude
     - Embarrassing in front of peers
   - Teaching methodology
     - Different learning styles not considered
     - Quality of instruction
   - Lack of understanding of the subject
     - Memorizing mathematical concepts
     - Timed or online tests
   - Math anxiety in teachers

3. **Teaching techniques that leads to Math Anxiety**
   - Assigning the same work for all
   - Lecturing
   - Following the textbook problem by problem
   - Assigning written work everyday
   - Insisting on only one way to solve a problem
   - Assigning mathematics homework as punishment for misbehaving
   - Teaching mathematics as only rules and formulas
4. What should you look for during your teaching sessions?

Symptoms seen in math anxious students are:

- Afraid to answer questions in class
- Afraid to ask for help
- Avoid math and any math related situations
- Struggle to pay attention in the class
- Extremely uncomfortable in the class.

The symptoms differ from one student to the other and can be seen or found in both genders. Some students suffering from Math Anxiety are surprisingly *hard workers in the classroom who study regularly and always finish their homework but still lack the ability to show what they know* because of math anxiety. In this same category are students *who are not nervous or anxious but have made themselves incapable of paying attention because they believe that they will never understand math*. These students then become restless because they have no intention of learning math. As a teacher, one must understand that these are symptoms when the students are actually struggling with their confidence in the math classroom.

**Assignment for the next workshop**

1. Observe for any symptoms of math anxiety during your one-week of teaching session and write then down (if any) on a paper for a discussion.
2. Think of the instructional strategies you may adopt in order to deal with pupils with math anxiety in your classrooms.
MATH ANXIETY

How it Affects Teachers and Students
(workshop- part2)

By
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University of Amsterdam

Aim of this workshop

• How a teacher can help the pupils overcome math anxiety
• Teaching strategies that would help reduce math anxiety in classrooms.
Assignment
(workshop part-1)

- Observe for any symptoms of math anxiety during your one week of teaching session and write them down.

- Think of the instructional strategies you may adopt in order to deal with pupils with math anxiety in your classrooms.

Discussions-1

Was there any indications of math anxiety in the pupils, observed during your practice teaching session?
If yes, what were the symptoms you noticed.
Discussion-2

What are the instructional strategies you thought of, in order to deal with pupils with math anxiety in your classrooms?

Strategies by NCTM

Strategies developed by National Council of Teachers of Mathematics(2000) to reduce or overcome Math Anxiety.

- Remove the importance of ego from classroom practice
- Make mathematics relevant
- Emphasize the importance of quality thinking rather than rote manipulation of formulas.
design positive experiences in mathematics classes
Accommodate for different learning styles
Emphasize that everyone makes mistakes in mathematics.

Role of a Teacher

• Show that they (teachers) like mathematics
• Tell the students that everyone can perform well in math
• Develop self confidence in the students
• Provide encouragement and support.
• Encourage students to trust their own intuitions
• Avoid humiliating experiences
• Adapt instructions to students interests
• Avoid unnecessary time pressures
Recommendations

In general
• Accommodate for different learning styles
• Assessment of learning as part of instruction
• Focus on student centered learning
• Provide activities according to their level of understanding
• Cooperative learning and peer tutoring
• Group activities and discussions

In specific
• Relate mathematics to everyday life
• Make mathematics more exciting and fun to do
• Incorporate technology (manipulative)
• Teaching mastery of concepts prior to introducing new concepts
• Focus on the process rather than product
Old Chinese proverb

“Tell me mathematics and I forget; show me mathematics and I may remember; involve me and I will understand mathematics.

If I understand mathematics, I will be less likely to have math anxiety. And if I become a teacher of mathematics, I can begin a cycle that will produce less math anxious students for the generations to come.”

Paraphrased by Williams (1988)