A NEW PERSPECTIVE ON GENDER DIFFERENCES IN
STUDENT SELF-PERCEPTIONS OF ABILITY IN MATHEMATICS

Meredith Craver Walton

A thesis submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Masters of Arts in the School of Education (Educational Psychology, Measurement, and Evaluation).

Chapel Hill
2008

Approved by,

Advisor: Dr. Judith L. Meece

Reader: Dr. Jill V. Hamm

Reader: Dr. Jeffrey A. Greene

ABSTRACT

MEREDITH CRAVER WALTON: A New Perspective on Gender Differences in Student Self-Perceptions of Ability in Mathematics
(Under the direction of Dr. Judith L. Meece)

The purpose of this investigation was to better understand the historical differences between boys and girls in the mathematics courses that are taken and their choices to pursue math-related careers when gender differences appear to be no longer prevalent on mathematics achievement tests. This descriptive study examines gender differences of middle school students in mathematics through the framework of the possible selves theory. Possible selves are self-conceptions of both what an individual hopes to become and fears becoming. Survey measures were designed and used to determine students' hopes and fears in mathematics. Results did not support the hypothesis of gender differences that girls would have more feared selves than boys. However, overall the students expressed a high regard for their mathematics abilities and had more hoped-for than feared possible mathematical selves. Speculations are made for why no gender differences were found in the sample. Other limitations and suggestions for further research are offered.

ACKNOWLEDGEMENTS

To all of the people who helped make this thesis possible: Judith Meece, Spike Peterson, Lara-Jeane Costa, my skilled editor and father, Tom Craver, and my loving husband Rob, for all of his support and patience.

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CHAPTER I

INTRODUCTION

Literature on the relationship between gender and mathematics performance is abundant in psychology and education. Although early findings in the 1970s and 1980s consistently showed that boys outperformed girls in most areas of mathematics (see Benbow & Stanley, 1980; Maccoby & Jacklin, 1974), recent findings have suggested that gender differences on mathematics achievement tests have diminished for all grade levels through high school (Hyde, 2005; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; National Center for Educational Statistics [NCES], 2004). However, there are still considerable differences in educational achievement and occupational attainment for men and women. College women continue to be underrepresented in math-related sciences such as engineering, computer and information science, physical science, and chemistry (Halpern et al., 2007; National Academy of Sciences [NAS], 2007; NCES, 2004). In addition, girls in high school show less interest in mathematics and are more likely to dislike advanced mathematics and science classes when enrolled (Halpern et al., 2007; NAS, 2007; NCES, 2004). Gender differences may no longer be as prevalent when focusing on mathematics achievement test scores but there are still continued differences between men and women in the mathematics courses that are taken and the career choices related to mathematics that are made.

Many researchers have studied this continued gender gap in the field of mathematics and have seen the role that motivation plays in these differences between males and females. Although the mathematics achievement levels of girls are comparable to those of boys, gender differences in students' self-perceptions of competence are still commonly found in the literature (Eccles et al., 1989; Eccles, Wigfield, Harold, & Blumenfeld, 1993; Wigfield, Eccles, Mac Iver, Reuman, & Midgley, 1991; Wigfield et al., 1997). These studies have shown that gender norms and stereotypes are followed in which boys hold higher competence beliefs in mathematics than girls (Eccles et al., 1989; Eccles et al., 1993; Wigfield et al.,1991; Wigfield et al., 1997). Some studies have even shown that students' self-perceptions of ability and expectancies for success are some of the strongest predictors of future performance and task choice (Eccles et al., 1989; Wigfield, 1994; Schunk, Pintrich, & Meece, 2008). These results suggest that to increase females' interests in mathematics courses and their desire to pursue careers in math-related fields, efforts need to target their perceptions of ability in mathematics.

CHAPTER II

REVIEW OF THE LITERATURE

There are a number of theoretical orientations guiding research in mathematics motivation and how they facilitate achievement. Most of the research in mathematics on student perceptions of ability is based on expectancy-value theory or self-efficacy theory (Meece, Glienke, & Burg, 2006). These theories of achievement motivation have a variety of different views of self-perceptions and how they vary for gender. In addition, possible selves theory, a theory from the field of social psychology that has been related to motivation, will be used in the present study in order to have a different viewpoint of present and future self-perceptions that students may have in mathematics.

Expectancy-Value Theory

Expectancy-value theories have often been used to examine motivation and achievement in mathematics, particularly when studying gender differences (Eccles, Adler, & Meece, 1984). The theory asserts that there are two major self-belief components that motivate individuals to engage in and achieve at various tasks. Eccles and colleagues support the idea that self-competence beliefs and an individual's values, or the importance of achievement in a given domain, are the two important components in human motivation (Eccles & Wigfield, 1995). The theories are built upon the ideas of Atkinson (1957) and Weiner (1985) in which a cognitive approach is used to look at academic choices with a focus on a social component for understanding how students shape achievement-related beliefs as well as identity development processes (Meece et al., 2006).

Students' competency beliefs and the gender differences associated with these perceptions have been studied thoroughly. Eccles et al. (1993) found that small gender differences in children's competency beliefs begin to emerge in early elementary school. The results followed gender norms and stereotypes with boys having more positive competence beliefs for mathematics than girls even though they perform equally well in the academic domain (Eccles et al., 1993; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Wigfield et al., 1997). Gender differences favoring males in confidence in mathematics have been reported internationally, for example, by Bohlin (1994), Hannula, Maijala, and Pehkonen (2004), and Hannula and Malmivuori (1997). Research has shown that decreases in competency beliefs occur for all children in mathematics as they move through school (Jacobs et al., 2002; Wigfield & Eccles, 2000; Wigfield et al., 1997).

Self-Efficacy Theory

Self-efficacy theory has often been used by researchers to understand gender differences in achievement motivation for specific academic tasks such as mathematics. Self-efficacy refers to the belief that one is capable of performing in a certain manner to attain certain goals (Bandura, 1977). The beliefs that people hold about their abilities powerfully influence the ways in which they will behave and are stronger predictors of attainment than what people know, the skills they possess, or their previous accomplishments (Pajares, 2005). Studies have shown that self-efficacy beliefs mediate multiple types of achievement related behaviors, such as effort and task persistence, selfregulatory strategies, course enrollment, and career choices (Pajares, 1996; Pajares, 2005; Schunk & Pajares, 2002).

Studies of the relationship between gender and mathematics self-efficacy have been abundant in psychology and education. Many studies have documented that boys tend to report higher self-efficacy and expectancy beliefs than girls about their performance in math (Pajares, 1996; Seegers & Boekaerets, 1996; William, 1994; Zimmerman & Martinez Pons, 1990). Seegers and Boekaerets (1996) reported that even after controlling for achievement in mathematics, eighth-grade boys express stronger judgments of their mathematics capability than do eighth-grade girls. In addition, female students have lower self-efficacy than do male students about their prospects to succeed in mathematics-related careers (Hackett, 1985; Hackett & Betz, 1989). Research in self-efficacy beliefs suggests that gender differences emerge in the middle school years (Wigfield & Eccles, 1995). These age-related gender differences in self-efficacy beliefs have been attributed to increased concerns about conforming to gender-role stereotypes, which typically coincide with the entry into adolescence (Wigfield et al., 1996).

Possible Selves Theory

The above two motivation theories have provided some understanding to the gender differences that exist in mathematics. There is another related theory that was developed in the area of social psychology that could provide a new perspective on the gender gap in mathematics enrollment patterns. The theory of possible selves examines students' future self-perceptions for who they hope to become and what they most fear becoming (Markus & Nurius, 1986). These future-driven cognitive representations of students are thought to arise from self-competence beliefs and values. They are also considered the conceptual link or mechanism with achievement-related task choices and performance at the individual level (Markus & Nurius, 1987; Markus & Ruvolo, 1989).

Hoped-for possible selves are images of how an individual both hopes to be and that he or she believes are possible in the future that are generally considered positive. Feared possible selves are images of oneself in the future that an individual both fears or dreads and that he or she believes are possible for him or her (Knox, Funk, Elliot, & Bush, 2000). They also function to motivate behavior toward personally-defined goals (hoped-for possible selves) and away from personally meaningful negative outcomes (feared or undesired possible selves) (Knox, 2006). In other words, the choices that people make in the present are based on their desire to develop toward the person they hope to become and away from the person they fear becoming (Leondari, 2007). Most of the research on hoped-for and feared possible selves has focused on students overall concept of self in the future. Knox and colleagues studied gender differences in hoped-for and feared possible selves by having students generate their own possible selves from any area of their life and rating them on hoped-for and feared scales (Knox et. al, 2000). The results found that girls both generated more feared possible selves and rated feared possible selves as more likely to occur than boys (Knox et. al, 2000). A limited amount of research has looked at possible selves in relation to specific academic domains of learning. For this study, mathematics will be examined by looking at what students hope-for and fear in relation to domain.

The many experiences that students have with mathematics help to contribute to the development of their perceptions of mathematical ability, referred to in this study as ‘possible mathematical selves.’ Each math experience adds to a student’s beliefs about his or her abilities and competence in mathematics. Students may develop beliefs about how good they are in certain types of activities. For example, as children pursue mathematics and other subjects in school, they constantly receive feedback about their abilities from their interactions with teachers, comparisons made between themselves and other students, and from the types of grades they may receive (Eccles & Wigfield, 1995). Through these various experiences, children construct beliefs about their own abilities in mathematics. Markus and Nurius (1987) hypothesize that individuals are likely to construct possible selves for themselves in domains in which they feel competent and feel they can succeed. Possible selves develop as a function of life experiences which may contribute to individuals' competence beliefs, and in turn, contribute to the types of possible selves individuals construct for themselves. These positive or negative possible selves have been shown to dramatically influence performance in mathematics (Anderman, Anderman, & Griesinger, 1999).

Although the theory of possible selves has mostly focused on students' overall concept of self in the future, there are some studies that have examined academic domains and gender differences related to possible selves. Multiple studies have associated possible selves with academic achievement at the high school and college level. Oyserman, Gant, and Anger (1995) found a relationship between achievement-related possible selves and academic achievement, particularly for college age African American adolescent males. The study suggested that individuals who possess possible selves that are positive in achievement domains, such as mathematics, may have better academic performance. Lips (1995) examined that college age students in two studies and found that students who affirmed positive mathematical self-schematics later took more math courses. A more recent study by Lips (2004) examined gender differences for possible selves in a variety of academic domains with high school and college students. Male students reported more ability and identification with mathematics, science, and technology than did female students. This study will build on previous research by using the possible selves theory to gain a better understanding of gender differences in students' perceptions of ability in mathematics for adolescents.

Present Study

For this study, present and possible mathematical selves will be identified and compared to see if significant differences are found for gender in a sample of middle school students. The theory of possible selves will be used as a framework for examining students' perceptions of their mathematics ability. This theory will be used to look at the self-concepts for what students would like to be (hoped-for) and what they are afraid of becoming (feared) in mathematics. The study will be guided by these research questions:

Will the analysis of the Possible Mathematical Selves Measure yield two dimensions of hoped-for and feared possible mathematical selves?

Are there statistically significant differences for gender for students' possible mathematical selves?

If gender differences exist, which possible mathematical self, hoped-for or feared, will be more prevalent?

Based on prior research, it is hypothesized that female students will have statistically significant lower scores than male students for hoped-for possible mathematical selves. Additionally, gender differences will be prevalent for feared mathematical selves with girls having statistically significant higher scores than males. The results of this study will help teachers, parents, and other professionals to understand where the differences exist in students’ perceptions of ability in mathematics and the potential role that stereotypes play into these perceptions.

CHAPTER III

METHODS

This investigation involves secondary analysis of data from the Mathematics Identity Development and Learning (MIDDLE) project[1], a three-year study of middle school mathematics. The larger project focused on students' developmental and contextual processes in mathematics achievement and understanding during the middle school years. During the study, participants were followed as they moved from sixth through eighth grade. However, for the current analysis, a cross-sectional sample of the data will used in the study.

Participants

The data were collected in middle schools located in a medium size urban school district in southeastern United States with a student population of about 30,500. The district serves a diverse student population of 55% African-American students, 27% white students, and a growing population of Latino students. The student population was also diverse in terms of family income levels with district records indicating that 49% of students were receiving free or reduced lunch.

The MIDDLE research project included six middle schools participating from within the district. The students for this study were recruited from classrooms by

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[1] The Mathematics Identity Development and Learning (MIDDLE) project was awarded to Drs. Jill V. Hamm, Carol E. Malloy, and Judith L. Meece at the University of North Carolina at Chapel Hill and funded by the National Science Foundation.

teachers who chose to participate from the middle schools in the district. In this study, data were used from 44 mathematics classrooms ranging from sixth to eighth grade.

A total of 786 students was used for the secondary analysis for this study. The student sample included 51.1% African American, 32.3% White (not of Hispanic origin), 5.8% Hispanic, 5.2% Multiracial, 2.5% Asian or Pacific Islander, 1.2% American Indian/Alaskan Native, and 1.9% other. There were 367 sixth-grade (46.7%), 220 seventh-grade (28.0%), and 199 eighth-grade (25.3%) students. The total sample included 331 boys and 455 girls.

Procedure

The primary researchers in the Mathematics Identity Development and Learning (MIDDLE) project received informed consent from all participating students. The students were surveyed through group administration after the study was presented to them. During a single mathematics class period, trained researchers administered self-report survey instruments. Before beginning the survey, students were told that their answers would be kept confidential. In addition, they were informed that participation was voluntary and that they could stop taking the survey at any time. During the 40-minute survey, the administrator read the initial instructions and the participants read and answered the questions. Accommodations were made for students with language difficulties. Students received a small school item (i.e., pencil) for their participation.

Measures

Possible Mathematical Selves Scale

One of the measures used in this study included a set of 14-items that related to students' views of their present and future potential in mathematics (see Appendix).

These “Possible Mathematical Selves” questions were generated by the primary investigators. Most of the previous research in academic possible selves has been with high school and college students and used open-ended self-concept measures (Packard & Conways, 1990). However, researchers have found that adolescents have difficulty generating specific selves (Oyserman & Markus, 1990). The items in this measure were developed with a Likert-type scale specifically for middle school students.

Students responded to the prompt “For me it is *possible* to” for all of the items. Some of the statements asked the students to rate what they hoped for or what they hoped to become related to mathematics: “For me it is possible to be a math helper or tutor” and “For me it is possible to study math in college.” Other statements focused more on what students feared becoming in the future: “For me it is possible to do poorly on my next test.” and “For me it is possible to not be able to do the math required for my job when I am an adult.” Students were asked to respond to each item on a 6-point Likert-type scale (1 = Not Possible, 6= Very Possible). Information about the students’ gender, grade level, and ethnicity were self-reported and collected through the questionnaires (see Appendix).

Self-Efficacy and Value Scales

In addition to the Possible Mathematical Selves scale, composite scores for both Self-Efficacy and Value scales were used to check validity during analysis. These scales were also a part of the survey used in the Mathematics Identity Development and Learning (MIDDLE) project and data were collected at the same time as the Possible Mathematical Selves scale. The Self-Efficacy scale focused on how confident individuals were in their ability to succeed in mathematics. The scale consists of 4-items from Midgley, Maehr, and Urdan (1993) that were modified to be applicable to mathematics. These items asked students to rate how confident they were in their ability to succeed in mathematics: “I am sure I will get a good grade in my math class” and “I am certain that I can do even the hardest work in my class.” The internal consistency alpha coefficient for the scale was .70 across grade levels. The other related scale, the Value scale, was 5-items adapted from Meece, Wigfield, and Eccles (1990) and focused on enjoying mathematics as well as valuing the importance and usefulness of mathematics outside of school and for the future. The students were asked to rate their enjoyment of math and how important or useful math is for them: “Learning to solve new math problems is interesting to me” and “What I am learning in math is important for what I plan to do after high school.” The internal consistency alpha coefficient for the scale was .70 across grade levels. Both scales asked students to respond to each item on a 6-point Likert-type scale (1 = Very much like me, 6 = Not at all like me). Composite scores for the Self-Efficacy and Value scales were created by computing an average for items within each scale.

Mathematics Achievement Scores

Mathematics achievement information for each student was provided from the MIDDLE project. The Grade 5 End-of-Grade (EOG) test scores for mathematics were available in order to control for prior ability if necessary. The EOG test was designed to measure student performance on the competencies specified in the goals and objectives for the fifth grade.

Data Analysis

For this study, the initial analysis involved using a number of methods to evaluate the psychometric quality of the Possible Mathematical Selves measure using SPSS 16.0. Initially, the descriptive statistics were checked to confirm that the data were normal and had no outliers. Exploratory factor analysis (EFA) was the preliminary technique used to identify factors that statistically explain the variation and covariation among the items in the measure. After determining the indicators of the possible selves constructs, both item analysis procedures were completed for each factor and composite scores for possible mathematical selves were correlated with the Self-Efficacy and Value measures to establish construct validity. In addition, internal consistency estimates of reliability were calculated for the Possible Mathematical Selves measures.

Analysis of the Measure

Exploratory factor analysis. Principal Components Analysis was used to identify factors in the measure. An exploratory factor analysis was chosen over a confirmatory factor analysis because no *a priori* theoretical model was tested or available to support a factor structure. However, the researchers who created this measure hypothesized that it would have two dimensions: present possible selves and future possible selves. Three criteria were used to determine the number of factors to rotate: the *a priori* hypothesis that the measure was bidimensional, the absolute magnitude of the eigenvalues (e.g., eigenvalue-greater-than-one criterion), and the relative magnitudes of the eigenvalues (e.g., scree test) (Green & Salkin, 2005). When the number of factors had been determined, a rotational method, direct oblimin method with the delta equal to zero, was used to yield the factors. An oblique rotation was chosen because the constructs were expected to be correlated. To clarify the final factors, the pattern matrices for the rotated factors were examined for high factor loadings (i.e., $\geq .35$) and absence of strong factor cross-loadings (i.e., no measure would load $\geq .35$). Additionally, the measures were examined for their theoretical justification and importance to the interpretation of the factor. The proportion of variance accounted for by each of the rotated factors was reported to indicate their relative importance.

Creation of factor scores. Factor scores were then created based on loadings that emerged from the factor analysis using the regression method. The factor scores were derived by having each variable weighted proportionally to its involvement in the pattern matrix. The more involved a variable, the higher the weight. Variables that were less related to the given pattern matrix were weighted lower.

In addition to completing the factor analysis for the items within the entire sample, a factor analysis was completed for each gender. This analysis helped to verify that the same factor structure was found between girls and boys for the possible mathematical selves items. After completing the same factor analysis procedures for each gender group, the pattern matrices for the rotated factors were examined for high factor loadings (i.e., $\geq .35$) and absence of strong factor cross-loadings (i.e., no measure would load $\geq .35$). If the measures loaded the same, or were very similar for each gender, the evaluation of the psychometric qualities continued. If differences in factor loadings occurred, the items were reevaluated to determine which should be removed and the items were reanalyzed.

Validity of the measure. After the number of factors was determined, item analyses were conducted to assess the hoped-for and feared possible mathematical selves.

Initially, each item was correlated with its own scale (with the item removed) and with the other possible selves scale. Next, construct validity was assessed for the newly derived Possible Mathematical Selves scales. In order to demonstrate that the scale had construct validity, each item was correlated with its own scale (with the item removed) and with the other possible selves scale. There was support for the measure's validity if the items were more highly correlated with their own scale than with the other scale. In addition to item analysis procedures, the possible selves scale was correlated with the Self-Efficacy and Value scales to check construct validity. Support for construct validity for the possible selves scale was shown if the items were only moderately correlated with the Self-Efficacy and Value scales.

Reliability of the measure. The internal consistency estimate of reliability was calculated for the two factors using Cronbach's alpha coefficient. Cronbach's alpha coefficient was chosen because it measures the extent to which item responses obtained at the same time correlate highly with each other. If Cronbach's alpha was 0.70 or higher, the scores for the measure were considered to have satisfactory reliability.

Multivariate Analysis of Variance

Multivariate analysis of variance (MANOVA) was employed for the data analysis using SPSS version 16.0. The independent variable was gender and the dependent variables were the factor scores for the hoped-for and feared possible mathematical selves that were determined through factor analysis. A one-way MANOVA was conducted to evaluate the differences between gender and both hoped-for and feared possible selves. The raw scores for the students on the Grade 5 End-of-Grade (EOG) test were available to control for achievement. However, the scores were first analyzed to determine whether there were significant gender differences for the Grade 5 EOG scores since 11.7% of the scores were missing. If significant differences were found, prior mathematics achievement were controlled for using the scores. Otherwise, analyses were completed without controlling for prior ability so that there was more power to detect gender differences. If statistical significance was found, effect sizes were examined to quantify the difference between genders.

CHAPTER IV

RESULTS

Through these data analyses, the researcher aimed to answer the question: Are there statistically significant differences for gender for students' hoped-for and feared-for possible mathematical selves? First, the items were reduced into scales using exploratory factor analysis. The final factors were used to conduct the MANOVA, and ultimately to answer my research question and address my hypotheses.

Descriptive Statistics

The initial descriptive statistics were considered in order to determine whether assumptions could be met for further analysis. The means, standard deviations, skewness, and kurtosis statistics showed that the assumption for normal distribution had been met for the Possible Mathematical Selves scale.

Analysis of the Measure

The first research question concerned the exploratory factor analysis of the possible mathematical selves scale to determine how many dimensions were yielded. The 14 items in the scale were factor analyzed using principal components analysis. Any missing values for possible selves items were replaced with the mean. The factor analysis for the scale resulted in two factors with eigenvalues greater 1.0 (i.e., 4.52 and 2.09) accounted for 47.3% of the variance in possible mathematical selves scale. Rotation using the direct oblimin method was performed to achieve a simple factor structure. The rotated pattern matrix, shown in Table 1, reflected a two-factor structure.

The Factor 1, labeled hoped-for possible mathematical selves, consisted of nine items that reflected students' self-perceptions in mathematics for which they hope to become and accounted for 32.3 % of the variance. Factor 2, labeled feared possible mathematical selves, contained five items that related to their beliefs about their abilities in mathematics for what they most fear becoming and accounted for 15.0 % of the variance. Factor scores were then created for later analysis based on loadings that emerged from the factor analysis using the regression method.

A factor analysis was completed for each gender to verify that the same, or very similar, factor structures were found for girls and boys. Principal components analysis was used to extract two factors from the measure for each gender using the same procedures as were completed for the entire sample. The rotated pattern matrix for boys loaded highly on most items and reflected the same two-factor structure as was found with the entire sample. For the girls, the rotated pattern matrix loaded highly on all the same items except one. The item "For me it is possible to get good grades in math" loaded slightly higher for the feared possible mathematical selves factor than the hoped-for possible mathematical selves factor (i.e, .40 and .39 respectively). This result was the opposite for what loaded for the entire sample. The slight difference between the genders of one item was considered minor enough to continue the evaluation of the psychometric qualities of the original two-factor structure.

The Cronbach's Alpha internal consistency estimate of reliability was calculated for both factors in order to gain more support for how well the items measured each latent construct. The values for coefficient alpha were .83 and .76 respectively. These scores for the two dimensions of the measure were higher than .70 and were considered to provide satisfactory reliability.

Item analyses were conducted on the 14 items that were found to assess hoped-for and feared possible mathematical selves to determine if there was support for construct validity. Each item was correlated with its own scale (with the item removed) and with the other scale. All items were more highly correlated with their own scale than the other scale (see Table 2) showing support for the measure's validity. Further support for construct validity for the possible mathematical selves scale was shown by correlating it with a self-efficacy and values scale. The results yielded moderate correlations with the self-efficacy scale (.68) and the values scale (.64). Moderate correlations were hypothesized given that the constructs of self-efficacy and values are related to possible selves but are still considered to be separate constructs.

The second portion of the analysis addressed the research question of how boys and girls differ on the two factors of hoped-for and feared-for possible mathematical selves. Before conducting the main analysis, the raw scores for the students on the Grade 5 End-of-Grade (EOG) test were analyzed to determine whether there were significant gender differences and control for achievement was necessary. The results indicated that no significant differences were found for the 88.3% of the cases in which scores were provided. Therefore, analyses were completed without controlling for prior ability so that there was more power to detect gender differences for possible mathematical selves.

Gender Differences

A one-way multivariate analysis of variance (MANOVA) was conducted to determine if differences were present. The two dimensions of the possible mathematical selves scale were compared for boys and girls using the factor scores created during factor analysis. No significant differences were found for gender on the hoped-for or feared dimensions of the possible mathematical selves scale, Wilks's $\lambda = .999$, $F(2,783) = .305$, $p > .05$. Table 3 contains the means and standard deviations of the scale scores both hoped-for and feared possible mathematical selves within each gender. The composite scores shown here were created by calculating the average of all the scores for each factor.

CHAPTER V

DISCUSSION

The purpose of this study was to evaluate the psychometric quality of the Possible Mathematical Selves measure and to determine if gender differences existed for the factors (or constructs) that were identified in the measure. The factor analysis yielded two factors as was hypothesized: hoped-for and feared possible mathematical selves. Further analysis showed the measures to have good support for internal reliability (i.e., $\alpha = .83$ and .76, respectively) and construct validity was supported for the purposes of examining students hoped-for and feared possible selves as they relate to mathematics. However, the results from the MANOVA suggested that no statistically significant gender differences exist for hoped-for and feared possible mathematical selves. As such, the original hypothesis that girls would have higher feared selves than boys was not supported for this sample.

It is important to note that although no gender differences were found between hoped-for and feared possible mathematical selves, overall the students expressed a high regard for their mathematics abilities. The mean for the entire sample on hoped-for possible mathematical selves was moderately high (i.e., $M = 4.13$) on a 6-point scale with 64% of the sample having a scale score between 3.17 and 5.05. In addition, the mean for the feared possible mathematical selves was moderately low (i.e., 2.24) with 64% of the sample having a scale score between 1.22 and 3.26. These results indicate that students' self-perceptions of ability were reasonably positive, which may, in turn, predict higher performance in mathematics and higher enrollment in math courses (Eccles et al., 1989; Wigfield, 1994; Schunk, Pintrich, & Meece, 2008).

There are many speculations as to why no gender differences were found for possible mathematical selves for the sample. The first explanation may be that differences no longer exist in students' self-perceptions of ability in mathematics, as was found in previous research (Eccles et al., 1989; Eccles et al., 1993; Wigfield et al., 1991; Wigfield et al., 1997), just as differences in mathematics achievement scores have diminished (Hyde, 2005; Hyde et al., 2008; NCES, 2004). It is possible that the hopes and fears about mathematics are not different between young adolescent boys and girls and that some other explanations exist for why girls are more likely to avoid taking higher level mathematics courses and are less likely to pursue math-related careers (Halpern et al., 2007; NAS, 2007; NCES, 2004). Previous research has shown that gender differences in possible selves occur in more advanced mathematics courses (Lips, 1995, 2004). These differing results may indicate that the emergence of gender differences occurs later in adolescence and early adulthood.

Other possible explanations for why no significant differences were found are (1) the use of the possible selves theory as a framework in this study and (2) the age group of the sample. Although possible selves theory is an attractive theory of human motivation because it provides a bridge between various motivation constructs and theories, very little empirical work has been done testing the possible selves model developmentally in the domain of academic achievement motivation (Vernon, 2005). This is probably due, in part, to the fact that possible selves theory was originally developed by social psychologists, and because other motivation theories such as expectancy-value theory (e.g. Eccles and colleagues) were developed during similar time periods. These theories were adapted to developmental models and, therefore, became more popular and prominent in academic motivation. Possible selves theory, however, was created to get a better understanding of an individual's global self-view and has been related to self-esteem and self-concept (Knox et al., 2000; Marcus & Nurius, 1986; Markus & Ruvolo, 1989). Although the theory asserts that individuals are likely to construct positive possible selves in domains in which they feel competent (Markus & Nurius, 1987), it was originally intended to be used in evaluating students' self-perceptions of social domains and not specific domains in academics. The use of hoped-for and feared possible selves may not be applicable to understanding students' perceptions of ability in mathematics.

Speculations can also be made as to whether the age of the sample was appropriate for determining students' hoped for and feared possible selves. Although possible selves were originally designed to assess adolescents' future perceptions, this study's sample was made up of almost 50% six-graders who ranged in age from 11 to 12 years old. Thus almost half the sample had just entered adolescence. Previous research where gender differences were found for possible selves was with college students who were taking more advance courses in mathematics (Lips, 1995, 2004). Middle school students may not have had enough experience with mathematics to formulate self-perceptions of ability in mathematics, especially for items assessing a future self (e.g., "For me it is possible to get a job that requires math skills").

Limitations

Methodological limitations of the factor analysis must be addressed. The first limitation to the psychometric quality of the Possible Mathematical Selves measure was the original intentions for which the measure was written. The items in the measure were first written to look at present and future possible mathematical selves. However, when the items were factor analyzed, the results indicated a different set of constructs. Upon reviewing the literature further on possible selves, it was determined that the items loaded into two factors of positive or “hoped-for” personal desires in mathematics and negative or “feared” self-beliefs of ability for mathematics. This change in the underlying constructs of the measure from the originally intended constructs makes drawing conclusions from the results more difficult.

Another limitation for the measure was the low factor loadings for several of the items in the Possible Mathematical Selves scale. Although the loadings met the standards set prior to analysis, several of the factor loadings for the items were relatively low (e.g. “For me it is possible to get a good grade in math this year,” “For me it is possible to not be able to do the math required for my job when I am an adult”). These results suggest that even though theoretically the items assess the same construct, based on the analyses, the precision of the two-dimensional measure may be problematic.

The method of sampling may also be considered a limitation of the study. The sample may not have been representative of the population because the participants were self-selected. Only participants that returned consent forms to school where teachers consented to participate were selected for the study. The limited sample may lead to decreased accuracy in generalizing the results to the target population.

Conclusion

Previous research on self-perceptions of ability in mathematics has generated a wide range of results. This study contributes a new viewpoint for studying the gender differences that still persist in the mathematics courses taken and the career choices related to mathematics that are made. Although this study found no significant gender differences for possible mathematical selves, teachers, parents, and other professionals still need to support girls in developing positive self-perceptions of ability as well as boys. This can be done through a number of actions, such as providing connections between math and girls' lives or through establishing female role models who have math-related careers (Coates, 2007).

The results of this study indicate that more research needs to be done to examine why girls are less likely to pursue math-related careers when they are achieving at the same level as boys. What is causing these distinct gender differences in the persistence of mathematics in post-secondary school and beyond? In addition, further research needs to be completed with possible selves in mathematics and other academic domains of learning to gain a better understanding of how these perceptions are formed and what role they play in future academic achievement.

APPENDIX

Mathematical Identity Development and Learning
School of Education, University of North Carolina at Chapel Hill

- Your responses will be kept top secret.
- If you don't feel comfortable answering a question, you can leave it blank.

Marking Instructions

- Use a No. 2 pencil only.
- Make solid marks that fill the oval completely.
- Make no stray marks on the form.
- Do not use ink, ballpoint, or felt tip pens.
- Erase clearly any marks you wish to change.
- Do not tear or mutilate this form.

Grade Level
O 6th
O 7th
O 8th

Gender
O Boy
O Girl

My background is:
O African American
O American Indian/Alaskan Native
O Asian or Pacific Islander
O White (not of Hispanic origin)
O Hispanic
O Multiracial
O Other

School	
⓪	⓪
①	①
②	②
③	③
④	④
⑤	⑤
⑥	⑥
⑦	⑦
⑧	⑧
⑨	⑨

Classroom	
⓪	⓪
①	①
②	②
③	③
④	④
⑤	⑤
⑥	⑥
⑦	⑦
⑧	⑧
⑨	⑨

DIRECTIONS FOR RATINGS:
Students have different thoughts and feelings about their math classes. We need your opinions about math and your math class. Read each statement carefully, and use the scales to rate your opinions. Be sure to circle one number for each statement. Remember there are no right or wrong answers.

For me it is <u>possible</u> to…	Not Possible		Possible			Very Possible
1) think like a mathematician	①	②	③	④	⑤	⑥
2) be a math helper or tutor.	①	②	③	④	⑤	⑥
3) not be able to do the math required for my job when I am an adult.	①	②	③	④	⑤	⑥
4) get a good grade in math this year.	①	②	③	④	⑤	⑥
5) earn poor grades in high school math classes.	①	②	③	④	⑤	⑥
6) be one of the top math students next year.	①	②	③	④	⑤	⑥
7) be afraid to take more math classes	①	②	③	④	⑤	⑥
8) help my friends get good grades in math next year.	①	②	③	④	⑤	⑥
9) use my math skills to solve problems outside of school.	①	②	③	④	⑤	⑥
10) fail a math class in high school.	①	②	③	④	⑤	⑥
11) study math in college.	①	②	③	④	⑤	⑥
12) do poorly on my next math test.	①	②	③	④	⑤	⑥
13) become a math teacher.	①	②	③	④	⑤	⑥
14) get a job that requires math skills	①	②	③	④	⑤	⑥

Thanks for helping us today!

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