A CASE STUDY EXPLORING THE WAYS PRESERVICE ELEMENTARY
TEACHERS WITH LOW LEVELS OF MATHEMATICS SELF-EFFICACY BELIEVE THEIR MATHEMATICAL ABILITY WILL AFFECT THEIR TEACHING EFFECTIVENESS

A Dissertation
Presented to
The Graduate Faculty of The University of Akron

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Lance Nelson
August, 2015
A CASE STUDY EXPLORING THE WAYS PRESERVICE ELEMENTARY TEACHERS WITH LOW LEVELS OF MATHEMATICS SELF-EFFICACY BELIEVE THEIR MATHEMATICAL ABILITY WILL AFFECT THEIR TEACHING EFFECTIVENESS

Lance Nelson

Dissertation

Approved:

Advisor
Dr. Lynne Pachnowski

Committee Member
Dr. Kristin Koskey

Committee Member
Dr. Renee Mudrey-Camino

Committee Member
Dr. Linda Saliga

Committee Member
Dr. Sandra Spickard-Prettyman

Accepted:

Department Chair
Dr. Peggy L McCann

Interim Dean of the College
Dr. Susan G. Clark

Interim Dean of the Graduate School
Dr. Rex Ramsier

Date

Dr. Linda Saliga

Committee Member
ABSTRACT

This study investigated the relationship between the actual mathematical ability and the perceived mathematical ability among preservice elementary teachers with low levels of mathematics self-efficacy. In addition, this study investigated how preservice elementary teachers with low levels of mathematics self-efficacy describe their mathematical ability and how it could affect their teaching effectiveness when they enter the classroom. Participants included 42 elementary preservice elementary teachers in a Great Lakes state during their mathematics methods course. Of the 42 elementary preservice teachers who participated in the study, 14 were self-identified as having low levels of self-efficacy with varying levels of mathematical ability. Six of the 14 agreed to be interviewed to gain a deeper understanding of their mathematical ability and their beliefs on being an effective mathematics teacher. Data sources included the self-revised Mathematics Confidence Scale and clinical interviews. The results concerning actual mathematical ability versus perceived ability were mixed. Also, the understanding of fractions, proportions, and ratios continue to be viewed as difficult topics. Findings revealed that the preservice elementary teachers with low-levels of mathematics self-efficacy believe they will be effective mathematics teachers when they enter the classroom, but only after time and much effort. In addition, these same preservice elementary teachers stated that they had negative experience during their elementary school years. Therefore, it can be generalized that there are, and potentially will be,
novice elementary teachers that will enter the classroom with (a) low levels of self-efficacy, (b) a lack of mathematical content knowledge, and (c) a lack of awareness of what their negative experiences during their elementary years could potentially do to their future students.
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF TABLES</td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>x</td>
</tr>
<tr>
<td>CHAPTER</td>
<td></td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Background of the Study</td>
<td>4</td>
</tr>
<tr>
<td>Significance of Study</td>
<td>5</td>
</tr>
<tr>
<td>Purpose of the Study</td>
<td>9</td>
</tr>
<tr>
<td>Research Questions</td>
<td>10</td>
</tr>
<tr>
<td>Definition of Terms</td>
<td>10</td>
</tr>
<tr>
<td>Summary</td>
<td>12</td>
</tr>
<tr>
<td>REVIEW OF THE LITERATURE</td>
<td>13</td>
</tr>
<tr>
<td>Bandura’s Self-Efficacy Theories</td>
<td>13</td>
</tr>
<tr>
<td>Mathematics Self-Efficacy</td>
<td>17</td>
</tr>
<tr>
<td>Teacher Efficacy</td>
<td>22</td>
</tr>
<tr>
<td>Summary</td>
<td>27</td>
</tr>
<tr>
<td>METHODOLOGY</td>
<td>30</td>
</tr>
</tbody>
</table>

---

v
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>30</td>
</tr>
<tr>
<td>Research Design</td>
<td>32</td>
</tr>
<tr>
<td>Design of Instrument</td>
<td>34</td>
</tr>
<tr>
<td>Validity and Reliability: Evidences for the MCS-II</td>
<td>38</td>
</tr>
<tr>
<td>Phase I: Quantitative Portion of the Study</td>
<td>42</td>
</tr>
<tr>
<td>Data Analysis: Quantitative Portion</td>
<td>42</td>
</tr>
<tr>
<td>Phase II: Qualitative Portion of the Study</td>
<td>46</td>
</tr>
<tr>
<td>Data Analysis: Qualitative Portion</td>
<td>48</td>
</tr>
<tr>
<td>Participant Consent</td>
<td>50</td>
</tr>
<tr>
<td>Trustworthiness of the Study</td>
<td>50</td>
</tr>
<tr>
<td>Subjectivity Statement</td>
<td>53</td>
</tr>
<tr>
<td>Assumptions of the Study</td>
<td>54</td>
</tr>
<tr>
<td>RESULTS</td>
<td>55</td>
</tr>
<tr>
<td>Quantitative Analysis</td>
<td>55</td>
</tr>
<tr>
<td>Qualitative Analyses</td>
<td>57</td>
</tr>
<tr>
<td>Chris: “I just wish it was more enjoyable.”</td>
<td>58</td>
</tr>
<tr>
<td>Jordan: “Math; Sometimes I like it, sometimes I hate it.”</td>
<td>64</td>
</tr>
<tr>
<td>Alex: “Every student should be able to learn math.”</td>
<td>68</td>
</tr>
<tr>
<td>Pat: “Math is scary”</td>
<td>75</td>
</tr>
</tbody>
</table>
Taylor: “Everything has some component of math in it” ................................. 80

Hayden: “I’m going to be an effective math teacher; if I need to be.” ............... 85

Summary .................................................................................................................. 92

SUMMARY, CONCLUSIONS AND IMPLICATIONS ........................................... 96

Quantitative Findings ........................................................................................... 97

Qualitative Findings ............................................................................................ 99

Conclusions .......................................................................................................... 107

Implications ......................................................................................................... 108

Future Research .................................................................................................... 115

REFERENCES ........................................................................................................ 117

APPENDICES ........................................................................................................ 124

APPENDIX A. PART I OF THE MCS-II ................................................................. 125

APPENDIX B. PART II OF THE MCS-II ............................................................... 130

APPENDIX C. INTERVIEW PROTOCOL ............................................................... 135

APPENDIX D. CONSENT FORM FOR PARTICIPATION (SURVEY) ............. 137

APPENDIX E. CONSENT FORM FOR PARTICIPATION (INTERVIEW) ....... 139

APPENDIX F. IRB NOTICE OF APPROVAL ...................................................... 141

APPENDIX G. FACTOR ANALYSIS .................................................................... 142
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Classification of questions for the MCS-II</td>
</tr>
<tr>
<td>2</td>
<td>Factor Load for each Item and Alpha if Item Deleted from MCS-II</td>
</tr>
<tr>
<td>3</td>
<td>Correlation among factors</td>
</tr>
<tr>
<td>4</td>
<td>Scoring rubric for Part II of the MCS-II</td>
</tr>
<tr>
<td>5</td>
<td>Classification of mathematical ability</td>
</tr>
<tr>
<td>6</td>
<td>Categorization of preservice teacher based on D-score</td>
</tr>
<tr>
<td>7</td>
<td>Frequency of Confidence Levels: 42 participants</td>
</tr>
<tr>
<td>8</td>
<td>Categorization of Participants (with low levels of mathematics self-efficacy)</td>
</tr>
<tr>
<td>9</td>
<td>Code List (Qualitative Data Analysis)</td>
</tr>
<tr>
<td>10</td>
<td>Frequency of Confidece Levels: 14 participants with low levels of mathematics self-efficacy</td>
</tr>
<tr>
<td>11</td>
<td>Categorization of Participants (with low levels of mathematics self-efficacy) who were interviewed</td>
</tr>
<tr>
<td>12</td>
<td>Profile of Chris</td>
</tr>
<tr>
<td>13</td>
<td>Profile of Jordan</td>
</tr>
<tr>
<td>14</td>
<td>Profile of Alex</td>
</tr>
<tr>
<td>15</td>
<td>Profile of Pat</td>
</tr>
<tr>
<td>16</td>
<td>Profile of Taylor</td>
</tr>
<tr>
<td>Figure</td>
<td>Title</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Overview of research design</td>
</tr>
<tr>
<td>2</td>
<td>Sample question on the MCS-II</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

As a senior college lecturer in the Department of Mathematics, I have extensive experience in working with preservice teachers who plan to become elementary school teachers. In the beginning, I naively assumed instruction in mathematics content and pedagogy would be sufficient to prepare these students to adequately handle the mathematics expectations required of them to be elementary school teachers. However, no matter how the courses were designed, most students still struggled with the mathematics content. In researching this phenomenon, I became aware of Bandura’s social cognitive theories and realized what I may have been dealing with was more than a lack of knowledge but, in fact, possibly low levels of mathematics self-efficacy. Self-efficacy, defined as the beliefs a person has about his/her capabilities to perform a specific task, is concerned not just with the skills one has but also with self-judgments of what one can do with the skills one possesses (Bandura, 1986). Using the groundwork of Bandura’s self-efficacy theories, mathematics self-efficacy is defined as “a situational or problem-specific assessment of an individual’s confidence in his or her ability to successfully perform or accomplish a particular mathematical task or problem” (Hackett & Betz, 1989, p.262). This lack of content knowledge and possible low levels of
mathematics self-efficacy concerned me greatly for many reasons, not least of which was, students are highly influenced by their elementary school teachers. In fact, some researchers claim a student’s view of what it means to know and do mathematics is shaped during his or her elementary school years, and that this view is difficult to change (Reys & Fennell, 2003). Reys and Fennell go on to suggest that elementary students who are presented with a limited view of mathematics by their elementary school teachers are unlikely to be interested in mathematics in their middle and high school years. In a study conducted by Cady (2007), the author determined that “preservice teachers’ confidence levels in mathematics, or lack thereof, potentially stems from their own experiences as elementary, middle school, and secondary school mathematics students” (p. 241). An alarming 96% of the preservice teachers in the study indicated their mathematics teacher influenced their beliefs about mathematics.

In addition to preservice elementary teachers’ level of mathematics self-efficacy, there are other possible factors that could contribute to their low level of mathematically ability. Mathematics anxiety, math self-concept, perceived usefulness of mathematics, and gender could be other causes. Mathematics anxiety is defined as the state of discomfort that occurs in response to situations involving mathematical tasks that are perceived as threatening to self-esteem (Cemen, 1987), and research has found that preservice teachers report high levels of mathematics anxiety (Bursal & Paznokas, 2006; Gresham, 2009). Mathematics self-concept is concerned with an individual’s feelings of doing well or poorly if asked to perform a mathematical task. The measure of an individual’s mathematics self-concept is based not on what he or she is actually able to
perform but on what the individual *thinks* he or she is able to perform (Rosenberg, 1979) and is usually measured via self-report assessments (e.g., “I am really good at math”). Perceived usefulness of mathematics is concerned with the beliefs an individual has regarding the importance of mathematics in today’s world. Fishbein and Ajzen (1975) claim that a person’s attitude is a function of their beliefs. Therefore, as individuals gather beliefs about a specific subject, they form an attitude toward that subject at the same time. This implies that the attitude an individual has toward mathematics relates to his or her perceived usefulness of mathematics. Given the constructs prevalent in the literature, a study conducted by Pajares and Miller (1995) found that the level of an individuals’ self-efficacy to solve math problems was more predictive of mathematical performance than other determinants such as gender or math background or than variables such as math anxiety, math self-concept, and perceived usefulness of mathematics. The study indicated that men and women differed in performance, but the difference was facilitated by the students’ self-efficacy perceptions. That is, “the poorer performance of women was largely due to lower judgments of their capability” (Pajares & Kranzler, 1995).

Because mathematics self-efficacy to solve math problems is a strong predictor of performance and because students are highly influenced by their elementary teachers, the levels of mathematics self-efficacy in future elementary teachers should be investigated before they enter the classroom. Additionally, there is evidence that early childhood teachers have less content knowledge and less positive attitudes toward mathematics compared to upper elementary teachers (Wilkins, 2008). This investigation could
strengthen an individual’s confidence in solving math problems successfully and therefore could possibly increase the levels of his or her mathematics self-efficacy.

Background of the Study

In recent years, as policymakers and researchers continued to search for ways to improve K-12 mathematics education, they focused almost exclusively on the presence of highly qualified teachers in the classroom. According to the No Child Left Behind Act passed in 2002, “highly qualified” is specifically defined and generally refers to a teacher who is certified and noticeably proficient in his or her content area. This proficiency involves an extensive knowledge of the field and perspective on its practice, as well as pedagogical knowledge, that enables teachers to expose the subject to learners, to highlight potentially confusing issues, and to pose strategic questions designed to help novices learn (Loewenberg-Ball & Forzani, 2010). According to the NCLB Act (P.L. No.107-110, H.R. 1, 2001), by the end of the 2005 – 2006 school year, every teacher working in a public school was required to be “highly qualified” in each subject he or she taught. In addition to this proficiency in a teacher’s mathematical content, The National Council of Teachers of Mathematics (NCTM) requires “solid mathematics curricula, competent and knowledgeable teachers who can integrate instruction with assessment, education policies that enhance and support learning, classrooms with ready access to technology, and commitment to both equity and excellence” (National Council of Teachers of Mathematics, 2000). According to Reys (2004), “If the Principles and Standards is to become a reality, then competent teachers must be in all mathematics classrooms” (p. 4).
For this implementation to be successful, it is vital that mathematics teachers have a solid foundation of mathematical content and pedagogical knowledge. While necessary, this foundation is not sufficient; it is also crucial that teachers have high levels of mathematics self-efficacy so that their confidence in their mathematical ability is high. According to Huinker and Madison (1997):

Even though individuals may possess certain skills, there is a distinct difference between possessing such skills and being able to perform them. Self-beliefs of efficacy mediate the relationship between knowledge and actions. In other words, to perform specific actions effectively requires both knowledge and skills and efficacy beliefs (p. 107).

Since students’ views of mathematics are shaped by their teachers, it is important students have “highly qualified” mathematics teachers throughout their education.

Significance of Study

According to Van Driel, De Jong, and Verloop (2002), the development of a teacher’s pedagogical knowledge depends to a large extent on his/her content knowledge. However, the teaching of mathematics involves more than just having a strong mathematical content knowledge. The Center for Research in Mathematics and Science Education (2007) points out the connection between the beliefs and confidence preservice elementary teachers have regarding their mathematical ability and pedagogical knowledge and lists this connection as one factor contributing to their effectiveness as educators. Teacher effectiveness has been shown to be a significant predictor of mathematics instructional strategies, and teachers with high levels of self-efficacy are more effective mathematics teachers than teachers with lower levels of self-efficacy (Swars, 2005).
Elementary mathematics teachers are faced with a number of content and pedagogical obstacles in the classroom. For instance, if a student believes zero is not a number, what is the role of the mathematics teacher to try and change his/her beliefs? If the fraction manipulatives (used to illustrate relationships and operations) a teacher is familiar with do not seem to work effectively and instead seem to confuse students, what is the mathematics teacher’s next step? Suppose a student provides justification for his/her (incorrect) answer to a mathematical question. How does a mathematics teacher respond to resolve the student’s confusion? These, as well as many others, are situations and scenarios mathematics teachers face on a daily basis in the classroom. Teachers’ reactions to these situations not only depend on their levels of content and pedagogical knowledge but also on their levels of mathematics self-efficacy. The confidence teachers have in their mathematical ability almost certainly influences their reactions to these situations and scenarios. This confidence is significant because “students’ understanding of mathematics, their ability to use it to solve problems, and their confidence in, and disposition toward, mathematics are all shaped by the teaching they encounter in school” (National Council of Teachers of Mathematics, 2000).

The pedagogical approaches a teacher uses are related to the degrees of their own self-efficacy. For example, highly efficacious teachers have been found to be more likely to use inquiry and student-centered teaching strategies, while teachers with a low level of efficacy are more likely to use teacher-directed strategies, such as lecture and reading from the textbook (Czerniak & Schriver, 1994). Because of the high level of confidence, highly efficacious teachers want their students to be autonomous learners by using
strategies that allow their students an opportunity to make their own decisions and draw
their own conclusions. On the contrary, teachers with low levels of self-efficacy may
convey insecurity with their abilities to teach content effectively and believe their
strengths revolve around their ability to provide step-by-step algorithms to arrive at
correct answers.

Given the research to support that elementary school teachers play an important
role in their students’ view of mathematics and that teachers’ degree of mathematics self-
efficacy influences their teaching, it is important to investigate preservice elementary
teachers’ levels of mathematics self-efficacy and how having low levels of mathematics
self-efficacy might impact their effectiveness in teaching mathematics. In a study
conducted by Briley (2012), elementary preservice teachers completed three surveys to
measure mathematics teacher efficacy, mathematics self-efficacy, and mathematical
beliefs. The study found the individuals who reported stronger beliefs in their
capabilities to teach mathematics effectively were more likely to have more confidence in
solving mathematics problems. As suggested by the author, “For future research, a
qualitative study might yield rich descriptions of the relationships among mathematics
teacher efficacy, mathematics self-efficacy, and mathematical beliefs” (p. 10). The
author goes on to suggest that a future study which included the measure of preservice
teachers’ performance on successfully solving mathematics problems, along with
mathematics self-efficacy, mathematics teacher efficacy, and mathematical beliefs,
might be worthwhile. One of the purposes of this study is to investigate how preservice
elementary teachers with low levels of mathematics self-efficacy describe their
mathematical ability using participant interviews. Bates, Latham, and Kim (2011) examined preservice teachers’ mathematics self-efficacy and mathematics teacher efficacy and compared them to their mathematical performance. The Mathematics Self-Efficacy Scale (MSES) and the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) were used to measure participant’s mathematics self-efficacy and mathematics teacher efficacy, respectively. The Illinois Certification Testing System (ICTS) was used to measure participant’s mathematical performance. The study found mathematics performance is positively correlated to both mathematics self-efficacy and mathematics teacher efficacy. A possible limitation to this study is the structure of the ICTS. The ICTS is a multiple choice assessment. If an individual answered a question correctly, was it because he or she “guessed” the answer correctly or because they knew how to solve the problem? The instrument implemented for this study asks participants to answer open-ended mathematics questions where “guessing” an answer will not be an option. A second purpose of this study was to investigate the relationship between the mathematics ability of preservice elementary teachers with low levels of mathematics self-efficacy and their perceived ability.

In conducting their research, Bates and his colleagues provided a possible suggestion for future research stating, “conducting interviews of preservice teachers with high and low mathematics self-efficacy and teacher efficacy should provide researchers with deeper insight into the attitudinal and dispositional differences between these groups” (p. 332). A final purpose of this study was to investigate the ways elementary
preservice educators with low levels of mathematics self-efficacy believe their perceived mathematical ability might affect their teaching of mathematics.

Purpose of the Study

To align with the vision statement of mathematics education provided by the NCTM, teachers need to cultivate an environment for mathematical thinking by emphasizing the thinking processes of students rather than student performance (National Council of Teachers of Mathematics, 2000). For this type of teaching and learning to possibly occur in the classroom, a teacher’s mathematics self-efficacy, a teacher’s belief in their mathematical ability, as well as their beliefs in their effectiveness to teach mathematics should be investigated. Preservice teachers enter a teacher education program with a set of predetermined beliefs about mathematics and the teaching and learning of mathematics (Philipp, 2007). Research has shown that preservice teachers’ beliefs can be influenced by teacher education programs (Swarz, Smith, Smith, & Hart, 2009). But, for this change in their beliefs about mathematics and the teaching and learning of mathematics to possibly occur, I feel preservice educators’ beliefs about their mathematics self-efficacy and their beliefs about their mathematical ability should be identified and reflected upon early in their program. The purpose for choosing preservice elementary teachers with low levels of mathematics self-efficacy was to challenge their beliefs and possibly heighten the awareness of their mathematics self-efficacy and its effect on teaching mathematics before they enter a classroom.

One purpose of this study is to examine the ways preservice elementary teachers with low levels of mathematics self-efficacy describe their mathematical ability and how
their ability might affect their teaching effectiveness. In addition, in this study, I examined how their perceptions of their mathematical ability reflect their actual ability to solve mathematical problems.

Research Questions:

1. How closely, if at all, does the actual mathematical ability of elementary preservice teachers with low levels of mathematics self-efficacy match their perceived mathematical ability?

2. How do elementary preservice teachers with low levels of mathematics self-efficacy describe their mathematical content knowledge?

3. In what ways, if at all, do elementary preservice teachers with low levels of mathematics self-efficacy believe their mathematics content knowledge will affect their teaching of mathematics?

Definition of Terms

Terms which will be used extensively in this study are operationally defined below:

**Mathematics ability** is operationally defined to be the knowledge, skills, and abilities an individual has to perform mathematical tasks successfully. It should be noted this construct does not include a person’s confidence to perform mathematical tasks.

**Self-efficacy** refers to one’s beliefs about his/her capabilities to produce effects (Bandura, 1994). It is concerned not with the skills one has but with judgments of what one can do with the skills one possesses (Bandura, 1986). This construct has been found
to be task specific. Therefore, for the purposes of this study mathematics self-efficacy refers to one’s beliefs about their capabilities to perform certain mathematical tasks.

**Mathematics teacher efficacy** is content specific. Teacher efficacy has been defined as a teacher’s judgment of his or her capabilities to bring about desired outcomes of student engagement and learning even among those students who may be difficult or unmotivated (Armor et al., 1976). Therefore, mathematics teacher efficacy is a more domain specific construct measuring a person’s efficacy to teach mathematics as well as the belief a person has regarding the mathematical methods to improve students’ mathematics achievement.

An **elementary preservice teacher** is defined to be an undergraduate student admitted to a program training to become a future educator of students in grades kindergarten through grade three.

**Mathematics pedagogical knowledge** is content specific. Pedagogical content knowledge is defined to be the knowledge of the most useful ways of representing and formulating the subject that makes it comprehensible to others, understanding of what makes the learning of specific topics easy or difficult, and the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons (Shulman, 1986). Therefore, mathematics pedagogical knowledge is operationally defined to be the understanding and familiarity with the multiple approaches to teaching mathematics.
Summary

Given Bandura’s (1997) assertion that self-efficacy beliefs are most at play in early learning and that, once developed, are resistant to change, it was important to collect the entry levels of teacher self-efficacy beliefs of future beginning teachers. Although there have been numerous studies examining preservice teachers’ mathematics anxiety, perceived usefulness of mathematics, mathematics self-concept, and mathematics teacher efficacy, these studies fail to assess their mathematics self-efficacy as it relates to their mathematical performance. There is a gap in the literature exploring how preservice elementary teachers describe their mathematical ability and how their descriptions may link to or could affect their teaching effectiveness. This study will contribute to closing this gap by investigating the beliefs preservice elementary teachers with low levels of mathematics self-efficacy carry with them regarding their ability and how these beliefs could guide their instruction in the classroom.

Discussion of this study has been ordered into five chapters. The first chapter offers an introduction, important information regarding the study, and definitions/terms which will be used throughout the study. Chapter II presents a review of the literature, including sections on the efficacy, mathematics efficacy, and mathematics teacher efficacy. The third chapter provides a detailed overview of the methodology used in the study. Chapter IV provides a comprehensive analysis of the data collected from both the quantitative and qualitative phases of the study. The fifth chapter presents a discussion of the results with some implications, and recommendations based the results observed from the collected data.
CHAPTER II

REVIEW OF THE LITERATURE

The purpose of this study was to describe the beliefs regarding the mathematical ability and the mathematics self-efficacy of a group of elementary preservice teachers during the second phase of their undergraduate education program. In addition, I will investigate how their beliefs in these preservice elementary teachers’ mathematical ability and their mathematics self-efficacy may affect their mathematics teaching effectiveness. The literature review includes sections on (a) Bandura’s social cognitive theories on self-efficacy, (b) mathematics self-efficacy, (c) teacher efficacy, and previous studies examining how preservice teachers describe their mathematics teaching effectiveness.

Bandura’s Self-Efficacy Theories

According to Bandura’s (1986) social cognitive theory, individuals possess a self-system that enables them to exercise a measure of control over their thoughts, feelings, motivations, and actions. Among the mechanisms of personal agency, none is more central or pervasive than a person’s beliefs in his/her capabilities to exercise control over the level of functioning and environmental demands (Bandura, 1986). If individuals lack the belief they can achieve a particular goal, the less likely it is that individuals will
Implement the actions to strive for the goal. This self-efficacy belief system influences aspirations and strength of goal commitments, level of motivation and perseverance in the face of difficulties and setbacks, resilience to adversity, quality of analytic thinking, causal attributions for successes and failures, and vulnerability to stress and depression (Bandura, 1996). Therefore, for the purposes of this study, self-efficacy is defined to be the belief in one’s capabilities to organize and execute the courses of action required to produce given attainments (Bandura, 1997).

Bandura delineates the construct of self-efficacy into two dimensions: efficacy expectations and outcome expectations. An efficacy expectation is the conviction that one can successfully execute the task necessary to produce the desired outcome. Outcome expectancy is an individual’s estimate that a given task will lead to certain outcomes. Regarding outcome expectancy, people who believe their goals are achieved by the belief in the skills they possess tend to be more active than those who do not have a strong belief in their skill set for particular tasks. Beliefs that outcomes are determined by one’s own behavior can be either demoralizing or empowering, depending on whether or not one believes he/she can produce the required behavior. For example, an elementary teacher who lacks understanding of finding the area of polygons and expects to be able to teach this concept to children has every reason to feel demoralized, therefore possibly decreasing the level of the teacher’s self-efficacy.

Cognitively, Bandura (1977) believes individuals with high levels of self-efficacy are more likely to have high aspirations, think soundly, set for themselves difficult challenges, and commit themselves firmly to meeting those challenges. These
individuals guide their actions by visualizing successful outcomes instead of dwelling on personal deficiencies or ways in which things might go wrong. Additionally, people who see themselves as highly self-efficacious set challenges for themselves and are more likely to persist in their efforts until they succeed.

In contrast, an individual with low levels of self-efficacy avoids difficult tasks and has low aspirations and weak commitment to their goals. A person identified with low levels of self-efficacy attributes their failures to their own inadequacies and strongly opposes tackling difficult tasks; they slacken or give up in the face of difficulty, recover slowly from setbacks, and easily fall victim to stress and depression (Bandura, 1997).

Self-efficacy beliefs are constructed from four principal sources of information. The first, and most influential source of efficacy according to Bandura, is *enactive mastery experiences*. The more success a person has in performing specific tasks, the higher their level of self-efficacy. If an individual performs well on a specific task, he/she is more likely to feel confident and have high self-efficacy on a similar task in the future. This individual’s self-efficacy will be high in this particular area and therefore the person will more likely try harder and complete similar tasks with more determination and better results (Bandura, 1997). Failure, on the other hand, may weaken a person’s level of self-efficacy, especially if this failure occurred before the individual has established a firm sense of self-efficacy. Research conducted with different educational levels and subject domains such as mathematics and science suggested that students rely predominantly on enactive experiences as a main informational source to formulate their perceptions of efficacy (Britner, & Pajares, 2006; Pajares, Johnson, & Usher, 2007).
During the process of setting goals, individuals face a number of obstacles and setbacks. These difficulties serve a valuable purpose in teaching that success usually requires continuous effort. How an individual handles these obstacles and setbacks could determine the level of an individual’s self-efficacy. The second source of self-efficacy beliefs is through the vicarious experiences of others. If a person sees someone similar to them (e.g., a classmate, colleague, etc.) succeed, it could possibly increase his or her self-efficacy. However, the opposite is also true; seeing someone similar to them fail could possibly lower their self-efficacy. In most societies, people compare themselves to particular associates in similar situations, such as classmates, work associates, competitors, or people in other settings engaged in similar endeavors. Surpassing associates or competitors raises self-efficacy beliefs, whereas being outperformed lowers them (Weinberg, Gould, & Jackson, 1979). For teachers, an example of how vicarious experiences can increase self-efficacy in the classroom is through professional development programs, where teachers are able to work with their colleagues and mentors. For students, having role models of achievement in mathematics, particularly female role models for girls (Bandura, 1986) may increase students’ self-efficacy.

Verbal persuasion is the third source of self-efficacy. This persuasion serves as a means to either strengthen or weaken an individual’s beliefs that they possess the capabilities to achieve particular tasks. People who are persuaded verbally that they possess the capabilities to master given tasks are likely to mobilize greater effort and sustain it than if they harbor self-doubts and dwell on personal deficiencies when difficulties arise (Bandura, 1997). In the classroom setting, verbal feedback such as...
“Timmy, you’re doing really well” or “That’s a tough problem, just move on to the next one” could raise or lower the level of a student’s self-efficacy.

The fourth source of self-efficacy is the physiological and affective states from which people partly judge their capableness, strength, and vulnerability to dysfunction. People experience sensations from their body, and how they perceive this emotional arousal influences their beliefs of self-efficacy (Bandura, 1977). Although this source is the least influential of the four, it is important to note that if one is more at ease with the task at hand, they will feel more capable and have higher beliefs of self-efficacy (Redmond, 2010).

In the academic setting, self-efficacy research has primarily focused on two major areas. The first has studied the relationship among efficacy beliefs, related psychological constructs, and academic motivation and achievement (Linnenbrink & Pintrich, 2002; Schunk, 1991). The second has attempted to explore the link between efficacy believes and college major and career choices (Lent & Hackett, 1987). Bandura (1986) cautioned that judgments of self-efficacy are task and domain specific. This led many researchers to focus on investigating mathematics self-efficacy and its possible effects on motivation and achievement.

Mathematics Self-Efficacy

Early studies focused on individual’s confidence in learning mathematics, a forerunner to mathematics self-efficacy, as a predictor of their math-related behavior and performance. This confidence was assessed by asking general questions about an individual’s perceived mathematical abilities and attitudes toward mathematics. For
example, if an individual had a positive attitude toward mathematics and had positive beliefs in their mathematical ability, it was assumed they would be able to solve mathematics problems successfully and therefore, have a high level of mathematics self-efficacy. Mathematics self-efficacy has more recently been assessed in terms of an individual’s judgments of their capabilities to solve specific math problems, to perform math-related tasks, and to succeed in math-related courses (Betz & Hackett, 1983). Therefore, mathematics self-efficacy is defined as a “situational or problem-specific assessment of an individual’s confidence in her or his ability to successfully perform or accomplish a particular [mathematics] task or problem” (Hackett & Betz, 1989, p. 262).

Dowling (1978) was the first to researcher to create a confidence measure, The Mathematics Confidence Scale, to specifically correspond with a performance assessment in which students were asked to solve the same or similar math problems on which their confidence was based. Using the Performance subscale of the Mathematics Confidence Scale as well as creating two additional subscales (one to access students’ confidence to perform math-related tasks and the other to assess an individual’s confidence to earn an A or B in certain math-related courses), Betz and Hackett (1983) created the Mathematics Self-Efficacy Scale (MSES). The reason for the creation of the two additional subscales was because the authors believed that mathematics self-efficacy required “detailed specification of the domain of math-related behavior” (Betz & Hackett, 1982, p. 331) and that the domains created included solution of math problems, math behaviors used in daily life, and satisfactory performance in a college course.
To support Bandura’s (1986) claim that self-efficacy beliefs predict academic performance, there are a number of studies examining the relationship of mathematics self-efficacy, using the Mathematics Self-Efficacy Scale, with other constructs. For example, Hackett and Betz (1989) examined 153 women and 109 men enrolled in an undergraduate introductory psychology course. Participants were administered the MSES to measure the level of mathematics self-efficacy and the Performance subscale of the Mathematics Confidence Scale to measure mathematics performance. The study investigated the relationship between mathematics self-efficacy and mathematical performance. In addition, the Fenema-Sherman Mathematics Attitude Scale was used to examine the relationship of mathematics self-efficacy expectations to other attitudes toward mathematics. Finally, the Bem Sex-Role Inventory (BSRI: Bem, 1974) was used to examine the relationship of sex-role variables to mathematics self-efficacy expectations and mathematics performance and achievement. The authors found that mathematics self-efficacy and mathematical performance were positively correlated to each other. As a result of this conclusion and its importance to mathematics education, the authors suggest, “mathematics teachers should pay as much attention to self-evaluations of competence as to actual performance” (p. 271).

A study conducted by Pajares and Miller (1994) used path analysis to investigate the mathematics problem-solving performance and mathematics self-efficacy of 350 undergraduates enrolled in an education course. In addition to investigating this relationship, the researchers investigated the role of self-efficacy on gender, prior experiences on self-concept, and perceived usefulness. Similar to the earlier study
conducted by Hackett and Betz (1989), the MSES was used to measure the level of mathematics self-efficacy and the Performance subscale of the Mathematics Confidence Scale to measure mathematics performance. In addition, the mathematics anxiety was measured using the Mathematics Anxiety Rating Scale (MARS), math self-concept was measured using The Self Descriptions Questionnaires (SDQ), gender, and participants’ prior level of mathematics were asked. Results of the study found that the level of the students’ self-efficacy to solve math problems was more predictive of mathematical performance than other determinants such as gender or math background or than variables such as math anxiety, math self-concept, and perceived usefulness of mathematics. In addition, the researchers found a vast number of the students tested demonstrated strong confidence in their ability to solve mathematics problems but found the confidence was not matched with ability when asked to solve the problems. The study also discovered that females had lower mathematics performance, mathematics self-efficacy, and self-concept than males, but it was concluded that these gender differences were facilitated by their self-efficacy perceptions; “that is, the poorer performance and lower self-concept of the female students were largely due to lower judgments of their capability” (p. 200).

Similar results (using similar constructs) were found in a study conducted by Pajares and Kranzler (1995). The researchers used path analysis to test the influence of mathematics self-efficacy on the math-problem-solving performance of 329 high school students. Results showed that students’ self-efficacy beliefs about their math capability had a strong effect on mathematics problem-solving. They also found that high school
students were more confident about mathematics abilities than college students. The authors explain that the more experience individuals attain, the more accurate they become in evaluating their own abilities. In addition, as seen in the 1994 study by Pajares and Miller, it was determined that when male and female students did differ in their mathematical performance (men had a higher average score on the performance measure than the women), it was largely facilitated by the levels of their mathematics self-efficacy.

Bates, Latham, and Kim (2011) examined the mathematics self-efficacy and mathematics teacher efficacy of 89 preservice teachers and compared them to their mathematical performance. Participants for this study were selected prior to student teaching. The MSES was used to measure mathematics self-efficacy, the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) was used to measure mathematics teacher efficacy and the Illinois Certification Testing System (ICTS) Basic Skills Test was used to measure mathematical performance. The ICTS assesses students’ ability to solve problems involving integers, fractions and decimals, unit of measurement, algebra, and geometry and is a multiple choice assessment. Results of the study found that the ICTS mathematics score was positively correlated with overall mathematics self-efficacy. Therefore, preservice teachers who had higher scores on the ICTS were more likely to be confident in their mathematics teacher efficacy.

As seen in the mentioned studies, research has shown that there is a positive correlation between the level of individuals’ mathematics self-efficacy and their mathematics performance. For mathematics educators, the level of their mathematics
self-efficacy may drive the type of instruction presented in the classroom, leading to differing levels of mathematics teacher efficacy. As will be seen in the next section, it appears that teachers’ mathematics content knowledge impacts their sense of efficacy to teach mathematics.

Teacher Efficacy

Self-efficacy, defined by Bandura (Bandura, 1997), is the belief in one’s capabilities to organize and execute the courses of action required to produce given attainments. Teacher efficacy was derived from Bandura’s conceptualization of self-efficacy and therefore defined to be the teacher’s belief in his or her capability to organize and execute courses of action required to successfully accomplish a specific teaching task in a particular context (Tschannen-Moran, Hoy, & Hoy, 1998). Teachers with higher teacher efficacy find education meaningful and rewarding, expect students to be successful, assess themselves when students fail, set goals and establish strategies for achieving those goals, have positive attitudes about themselves and students, have a feeling of being in control, and share their goals with students (Ashton, 1985). Applying Bandura’s self-efficacy theories, teacher efficacy is also considered to be a two-dimensional construct. The first represents a teacher’s belief in his or her skills and abilities to be an effective teacher and the second represents a teacher’s belief that effective teaching can bring about student learning regardless of external factors such as home environment, family background, and parental influences (Dembo & Gibson, 1985). Therefore, teachers with a high level of teacher efficacy believe they have the ability to strongly influence student achievement and motivation. The general analysis of
efficacy beliefs suggests that a strong sense of teacher efficacy requires that teachers (a) conceptualize what is efficacious about their actions and find positive results of those actions in student learning, (b) maintain and draw upon a personal history of past teaching success, and (c) recognize that their effectiveness will vary with different students and contexts (Smith, 1996).

In regard to the relationship between mathematical ability and mathematics self-efficacy in educators, a high level in one could vary directly with the other. In particular, the level of mathematics self-efficacy a teacher has could influence the type of instruction being presented in the classroom as well as how teachers respond to students’ answers. Gibson and Dembo (1984) found significant differences in classroom behavior between teachers with low and high levels of teacher efficacy. In terms of instructional strategies, highly efficacious teachers have been found to be more likely to use inquiry and student-centered teaching strategies, while teachers with a low sense of efficacy are more likely to use-teacher-directed strategies, such as lecture and reading from the textbook (Czerniak & Schriver, 1994). In terms of student engagement, Gibson and Dembo (1984) observed that when students gave an incorrect response to poorly efficacious teachers’ questions, less than 5% of these interactions resulted in teacher feedback in the form of criticism; there were no observations of criticism from highly efficacious teachers. Poorly efficacious teachers demonstrated a lower persistence in that they were more likely to respond to incorrect responses by giving the answer, asking another student, or allowing another student to call out before a student gave the correct response. In
contrast, highly efficacious teachers were more effective in leading students to correct responses through their questioning.

In a study conducted by Esterly (2003), 60 students in a Master’s of Education initial certification program at a large state university in the Midwest were administered the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI-B) to measure mathematics teacher efficacy, the Domain Specific Beliefs Questionnaire (DSBQ) to measure epistemological beliefs about mathematics and The Mathematics Confidence Scale to measure mathematics self-efficacy. Since the participants of the study were in a Master’s of Education program, all of the participants had some teaching experience. The study explored teachers’ epistemological beliefs and examined the relationship between teachers’ mathematics epistemological beliefs and their self-efficacy to teach mathematics. Three participants were purposefully selected to be interviewed and observed based on their scores received on the MTEBI-B. Quantitatively, it was found the more sophisticated the teacher’s epistemological beliefs, the higher the mathematics teacher efficacy tended to be. This relationship was further validated in the qualitative study using the three participants.

Of importance to the present study, in the research conducted by Esterly (2003), each of the teachers’ first response to what affects their sense of efficacy to teach mathematics was their knowledge of mathematics. In addition, the study found mathematics content knowledge as indicated by performance on a mathematics test was not a predictor of mathematics teacher efficacy. In fact, it was found that the teachers received very poor scores on the Performance subscale of The Mathematics Confidence Scale. The author
provided some possible reasons for the low scores and why mathematics knowledge and mathematics self-efficacy were not significant predictors of mathematics teacher efficacy. For one, the mathematics problem-solving instrument that was used to measure both mathematics self-efficacy and mathematics knowledge may not have reflected the level or type of mathematics that the elementary teachers believed they would be responsible to teach. Another reason the author suggests is that “the teachers did not take the mathematics test seriously or simply wanted to finish quickly, and thus the results do not accurately reflect their actual mathematics knowledge” (p. 237). But it is possible that the participants truly tried to answer the mathematics questions, however, their lack of content knowledge resulted in poor performance.

For this study, participants will be elementary preservice teachers (before having any teaching experience) selected to be interview, based on the level of their mathematics self-efficacy. In addition, The Mathematics Confidence Scale (measuring mathematics self-efficacy and mathematics performance) will be modified from its original design in 1978. This modification of the Mathematics Confidence Scale will hopefully reflect the level of mathematics the elementary teachers will be responsible to teach one day and accurately provide their mathematical ability.

Swarz (2004) investigated perceptions of effectiveness in teaching mathematics among preservice teachers with differing levels of mathematics teacher efficacy. The study explored the commonalities and differences between elementary preservice teachers with high and low levels of mathematics teacher efficacy and their perceptions of their skills and abilities to teach mathematics. Twenty-eight elementary preservice
teachers at a mid-sized university in the southeastern United States participated in the study. The participants were administered the MTEBI where the two participants with the highest score and the two with the lowest score were interviewed. Three themes emerged from the data collected from interviews: past experiences of mathematics teaching effectiveness, influences upon perceptions of mathematics teaching effectiveness, and mathematics instructional strategies.

The study found the preservice teachers with the lowest degree of mathematics teacher efficacy reported negative experiences with mathematics in grade school. It was concluded by the author that the preservice teachers’ experiences of failure with mathematics in school may have contributed to a lower sense of mathematics teacher efficacy. These past negative experiences led the preservice teachers to perceive that they would be effective mathematics teachers only with much time, work, and effort. They believed difficulties they experienced in past mathematics courses would make them better mathematics teachers because they would have empathy toward the struggles some of their future students would have with mathematical content. In contrast, the preservice teachers with the highest degree of mathematics teacher efficacy had differing past experiences with mathematics. The research failed to describe these differing past experiences.

Regarding instructional strategies, the use of manipulatives was strongly embraced by those preservice teachers with the highest degree of mathematics teacher efficacy. The view of the preservice teachers with the highest degree of mathematics teacher efficacy in regard to mathematics manipulative usage is consistent with the
reform vision of mathematics presented by the National Council of Teachers of Mathematics. One of the participants with a low level of mathematics teacher efficacy expressed concerns about the use of manipulatives as a teaching and learning aid in the mathematics classroom. These findings are consistent with previous research, concluding there is a consistent relationship between teacher efficacy and classroom instructional strategies as well as willingness to embrace reform strategies (Wertheim & Leyser, 2002). Based on the third research question for the proposed study, I will examine the ways elementary preservice teachers’ believe their perceived mathematical ability will affect their teaching of mathematics. Differing from the previous studies, the elementary preservice teachers selected to be interviewed in the proposed study will be based on the level of their mathematics self-efficacy and not the level of their mathematics teacher efficacy.

Summary

With the many variables and determinants that may affect teachers’ beliefs in their mathematical teaching, there seems to be a common theme in the literature concerning the examination of preservice mathematics training at the middle and elementary levels. The report of the National Mathematics Advisory Panel (2008) offered many conclusions about math curriculum, cognition, and instruction. One of the recommendations provided by the panel is the mathematics preparation of elementary and middle school teachers must be strengthened for improving teachers’ effectiveness in the classroom. The panel researched numerous studies focusing on math curriculum, cognition, and instruction. They found research on the relationship between teachers’
Mathematical knowledge and students’ achievement confirms the importance of teachers’ content knowledge. The panel claims,

Because most studies have relied on proxies for teachers’ mathematical knowledge (such as teacher certification or courses taken), existing research does not reveal the specific mathematical knowledge and instructional skill needed for effective teaching, especially at the elementary and middle school level. Existing research on aspects of teacher education, including standard teacher preparation programs, alternative pathways into teaching, support programs for new teachers (e.g., mentoring), and professional development, is not of sufficient rigor or quality to permit the Panel to draw conclusions about the features of professional training that have effects on teachers’ knowledge, their instructional practices, or their students’ achievement (pg. 40).

As stated earlier, the mathematics preparation of elementary and middle school teachers must be strengthened as one means for improving teachers’ effectiveness in the classroom. Teachers must know in detail and from a more advanced perspective the mathematical content they are responsible for teaching and the connections of that content to other important mathematics, both prior to and beyond the level they are assigned to teach (National Mathematics Advisory Panel, 2008). In regard to teacher preparation, the panel recommends that more precise measures should be developed to uncover in detail the relationship between teachers’ knowledge, their instructional skill, and to identify the mathematical and pedagogical knowledge needed for teaching. Based on a review of the literature, the level of mathematics self-efficacy and the level of mathematical ability a preservice elementary educator holds could be detrimental to the beliefs he/she may have regarding their teaching effectiveness. Research frequently emphasizes the strong role of teacher beliefs as being one of the most influential factors determining teacher effectiveness (Hoffman, 2010).
Research has shown there may possibly be a link between the level of an individual’s actual mathematical ability and the level of their mathematics self-efficacy. In addition, research has also indicated that the mathematics self-efficacy beliefs preservice elementary teachers carry with them regarding their actual mathematical ability may affect their teaching effectiveness in the classroom.
CHAPTER III

METHODOLOGY

Introduction

Operationally defined, mathematics content knowledge describes an individual’s skill and ability to perform mathematical tasks successfully (Ball, 2000). For the mathematics educator, mathematics content knowledge involves not only an understanding of the mathematical language and knowing important facts and concepts (why), but also the ability to perform tasks successfully (how). The beliefs an individual holds about his/her mathematical skills (mathematics self-efficacy) and the ability to teach these skills effectively (mathematics teacher efficacy) have been shown to be significant predictors of the types of instructional strategies used in the classroom (Enon, 1995; Swars, 2005). In this study, I investigated the beliefs concerning the mathematical content knowledge and teaching effectiveness held by preservice elementary teachers with low levels of mathematics self-efficacy. The following research questions were addressed:

1. How closely, if at all, does the actual mathematical ability of elementary preservice teachers with low levels of mathematics self-efficacy match their perceived mathematical ability?
2. How do elementary preservice teachers with low levels of mathematics self-efficacy describe their mathematical content knowledge?

3. In what ways, if at all, do elementary preservice teachers who self-identified as having low levels of mathematics self-efficacy believe their level of mathematics self-efficacy will affect their teaching of mathematics?

According to Yin (1994), the form of the research question(s) provides an important clue regarding the most relevant research strategy to be used. Research questions including “how” or “why” indicate that a case study is the most appropriate research method. One purpose for a case study is to develop an understanding of a complex phenomenon in its natural context and from the perspective of the participants involved in the phenomenon (Gall, Gall, & Borg, 2003). For this study, the phenomena of interest are mathematical ability and mathematical teaching effectiveness from the perspective of preservice elementary teachers with low levels of mathematics self-efficacy.

Yin (1994) uses the term “descriptive” for cases describing an intervention or phenomenon and the real-life context in which it occurred. This study provides a thick description of the phenomena using reliable participant data. Depth is added to the study by identifying themes within the participant data and relating these data to findings reported in the literature. This study also provides detailed statements of the participant data to re-create situations as they were experienced by the researcher.

As mentioned earlier, case study research is an in-depth study of instances of a phenomenon in its natural context and from the viewpoint of the participants involved in the phenomenon. For this study, the phenomena are mathematical ability and teaching
effectiveness, the *case* is mathematical ability and teaching effectiveness in preservice elementary teachers with low levels of mathematics self-efficacy, the *foci* are 1) how preservice elementary teachers with low levels of mathematics self-efficacy describe their mathematics content knowledge, 2) how closely, if at all, the actual mathematical ability of an elementary teacher with low levels of mathematics self-efficacy matches their perceived mathematical ability and 3) in what ways, if at all, do elementary teachers with low levels of mathematics self-efficacy believe their mathematics content knowledge will affect their mathematical teaching effectiveness. The *unit of analysis* is preservice elementary teachers with low levels of mathematics self-efficacy in a teacher education program at a public university in a Great Lakes state.

**Research Design**

This study examines the ways preservice elementary teachers with low levels of mathematics self-efficacy describe their mathematical ability and how their ability may affect their teaching effectiveness. In addition, this study examines how the elementary preservice teachers’ perceptions of their mathematical ability reflect their actual ability to solve mathematical problems. To explain these phenomena, a sequential (quan→QUAL) exploratory mixed methods design is utilized (Teddlie & Tashakkori, 2009). The notational system used in mixed methods research was created by Morse (1991) and involves three distinctions: (1) the “quan” represents a quantitative portion of the study and “QUAL” represents a qualitative portion of the study; (2) the upper and lower case of each research design represents which design is more dominant (upper case letters) and which is less dominant (lower case letters); and (3) the arrow (→) indicates that the study
has a sequential order. Therefore, in this case study, using mixed methods, the quantitative portion of the study drives the qualitative portion of the study. The quantitative portion is implemented to assign numerical levels of mathematics self-efficacy and numerical levels of mathematical ability for each preservice teacher and drives the qualitative portion of the study, providing participants’ descriptions of their actual mathematical ability and how their mathematics content knowledge could affect their teaching of mathematics in the classroom. This type of design can be implemented to use quantitative participant characteristics to guide purposeful sampling for a qualitative phase (Creswell, Plano Clark, Gutmann, & Hanson, 2003). Figure 1 illustrates the research model.

Participants are purposefully chosen, given that the unit of analysis is preservice elementary teachers with low levels of mathematics self-efficacy in a Great Lakes state. Purposive sampling techniques involve selecting certain units or cases “based on a specific purpose rather than randomly” (Teddlie & Tashakkori, 2003). Teddlie and Tashakkori (2009) define intensity sampling as selecting very informative cases that represent a phenomenon of interest intensively (but not extremely), such as good teachers/poor teachers, above-average tennis players/below average tennis players. This type of sampling fits the design of this study by intensively selecting preservice teachers with varying levels (low/medium/high) of mathematical ability and having low levels of mathematics self-efficacy.

The participants for the quantitative portion of the study are preservice teachers enrolled in an undergraduate course in a teacher education program during their
sophomore/junior year. Six preservice elementary educators from the quantitative portion of the study are intensively, purposefully chosen for the qualitative portion of the study. Students enrolled in these courses have been admitted into the College of Education and (presumably) have as their goal to becoming teachers from kindergarten through grade three. This study focuses on preservice elementary teachers because mathematics (along with science) is a subject area where teachers at the elementary school level struggle the most (Harlen, 1997) and the self-efficacy beliefs of teachers have been shown to influence the perceptions of mathematics in their students (Steele, 1997). Research has identified teacher beliefs as being one of the most influential factors determining teacher effectiveness (Woolfolk Hoy, Davis, & Pape, 2006).

Design of Instrument

To examine the preservice teachers’ mathematics self-efficacy and mathematics ability, a modified version of the Mathematics Confidence Scale (MCS) is used. For future reference, this modification of the original MCS is identified as MCS-II (see Appendix A for the full instrument). The Mathematics Confidence Scale was initially developed by Delia M. Dowling in 1978 to measure the confidence in mathematics of beginning college students and how their confidence affected the learning of mathematics. In particular, Dowling created and implemented the instrument to examine mathematics confidence in female college students. Before the development of Dowling’s instrument, many surveys were created solely to measure individuals’ attitudes toward mathematics (Fennema & Sherman, 1976). These surveys typically contained statements of feelings about mathematics with choices similar to: (1) strongly
agree, (2) agree, (3) undecided, (4) disagree, and (5) strongly disagree. For example, possible questions on these types of surveys would be, “I am sure that I can learn math” or “Math is not important for my life.” There seemed to be an early assumption that participants who received a high score (and who therefore indicated a positive attitude toward mathematics) would be able to perform mathematical tasks successfully. Dowling did not whole-heartedly agree with these assumptions and concluded that a high level of confidence did not necessarily imply successful performance in solving problems. This concern led to her development of the Mathematics Confidence Scale.

Dowling’s MCS provides a measure of confidence in mathematics with respect to three particular topics in mathematics (arithmetic, algebra, and geometry), three levels of cognitive demand (computation, comprehension, and application), and two problem contexts (real and abstract). According to Dowling (1978), the constructs to be measured using the MCS are defined as follows:

- **Computation** – items designed to require straightforward manipulation of problem elements according to rules the subjects presumably have learned (Romberg & Wilson, 1969).

- **Comprehension** – items designed to require either recall of concepts and generalization or transformation of problem elements from one mode to another (Romberg & Wilson, 1969).

- **Application** – items designed to require: (1) recall of relevant knowledge, (2) selection of appropriate operations, and (3) performance of the operation (Romberg & Wilson, 1969).
• Real – problem arising from some practical situation.

• Abstract – problem stated in a purely mathematical setting, with no reference to a particular situation.

In the 1970s, when developing the MCS, Dowling look at the areas of arithmetic, algebra, and geometry. For this study, her version was updated to the MCS-II to meet the reform vision of the National Council of Teachers of Mathematics (NCTM). Therefore, the MCS-II includes the Common Core Standards presented by the NCTM: (1) Operations and Algebraic Thinking, (2) Number and Operations, (3) Geometry, (4) Measurement and Data. In the Operations and Algebraic Thinking domain, by the end of the third grade, students should be capable of solving problems involving the four operations (addition, subtraction, multiplication, and division) and identify patterns in arithmetic. Within the Numbers and Operations domain, by the end of third grade, students should be able to use place value understanding and properties of operations to perform multi-digit arithmetic. In addition, students should be able to develop an understanding of fractions as numbers. This reasoning involves applying geometric definitions to identify polygonal figures. In the Geometry domain, by the end of the third grade, students should be able to reason with shapes and their attributes. This reasoning in measurement of liquid volumes and masses of objects includes using standard units of grams (g), kilograms (kg), and liters (L). In addition, students should understand the concept of area.
The original MCS is a two-part survey with each part consisting of 18 questions. The first part used a Likert-type scale requiring preservice elementary teachers to rate their perceived confidence in solving mathematics problems – without physically solving them. For example, a possible question might be, “Find the area of a circle with a diameter of 5 centimeters.” As an alternative to answering the question, participants are asked to rate their confidence IF they had been asked to solve the problem: (A) No confidence at all, (B) very little confidence, (C) some confidence, (D) much confidence, or (E) complete confidence. The second part of her survey asked participants to actually solve the same 18 questions on which they had just ranked their confidence levels. The survey contained six problems for each of the three components (arithmetic, algebra, and geometry). Within each of the components, each question was identified with a specific context (abstract or real) and a demand (computation, comprehension, or application). For example, one question might be classified as Geometry – Computation – Abstract while another question might be classified as Arithmetic – Application – Real.

The items in the MCS-II reflect the importance of the Common Core Standards created by the NCTM, while staying consistent with Dowling’s two-part instrument and consists of six questions related to Operations and Algebraic Thinking, six questions related to Number and Operations, two questions related to Geometry, and two questions related to Measurement and Data; they include the same context and demand classifications Dowling used. Table 1 provides the classification of each item for the MCS-II. Based on the Common Core standards, elementary teachers’ primary focus from kindergarten through grade three is to develop a solid foundation of number sense.
and operations. For this reason the majority of the questions are from the Operations and Algebraic Thinking and the Number and Operations Standard.

Table 1

Classifications of Questions for MCS-II

<table>
<thead>
<tr>
<th>Item</th>
<th>Standard</th>
<th>Demand</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Number and Operation</td>
<td>Computation</td>
<td>Abstract</td>
</tr>
<tr>
<td>2</td>
<td>Algebraic Thinking</td>
<td>Application</td>
<td>Real</td>
</tr>
<tr>
<td>3</td>
<td>Geometry</td>
<td>Computation</td>
<td>Abstract</td>
</tr>
<tr>
<td>4</td>
<td>Algebraic Thinking</td>
<td>Application</td>
<td>Real</td>
</tr>
<tr>
<td>5</td>
<td>Algebraic Thinking</td>
<td>Comprehension</td>
<td>Abstract</td>
</tr>
<tr>
<td>6</td>
<td>Algebraic Thinking</td>
<td>Computation</td>
<td>Real</td>
</tr>
<tr>
<td>7</td>
<td>Measurement</td>
<td>Application</td>
<td>Real</td>
</tr>
<tr>
<td>8</td>
<td>Algebraic Thinking</td>
<td>Application</td>
<td>Real</td>
</tr>
<tr>
<td>9</td>
<td>Number and Operation</td>
<td>Comprehension</td>
<td>Abstract</td>
</tr>
<tr>
<td>10</td>
<td>Geometry</td>
<td>Comprehension</td>
<td>Real</td>
</tr>
<tr>
<td>11</td>
<td>Number and Operation</td>
<td>Computation</td>
<td>Real</td>
</tr>
<tr>
<td>12</td>
<td>Algebraic Thinking</td>
<td>Application</td>
<td>Real</td>
</tr>
<tr>
<td>13</td>
<td>Measurement</td>
<td>Comprehension</td>
<td>Real</td>
</tr>
<tr>
<td>14</td>
<td>Number and Operation</td>
<td>Computation</td>
<td>Real</td>
</tr>
<tr>
<td>15</td>
<td>Number and Operation</td>
<td>Comprehension</td>
<td>Abstract</td>
</tr>
<tr>
<td>16</td>
<td>Number and Operation</td>
<td>Computation</td>
<td>Real</td>
</tr>
</tbody>
</table>

Validity and Reliability: Evidences for the MCS-II

To support the content validity of the MCS-II, a pilot version of this scale was created using exercises from Bennett and Nelson’s *Mathematics for Elementary Teachers: A Conceptual Approach* (2007, seventh edition). The primary objectives of the
textbook are to provide: (1) a conceptual understanding of mathematics, (2) a broad knowledge of basic mathematical skills, and (3) ideas and methods that generate enthusiasm for learning and teaching mathematics (Bennett & Nelson, 2007). The authors of the textbook were guided by the same beliefs as found in the National Council of Teachers of Mathematics’ *Principles and Standards for School Mathematics*: all students should be taught in a way that fosters conceptual understanding of mathematical concepts and skills. After its creation, the MCS-II was piloted to preservice elementary teachers. Only one question, item seven, was found to be confusing or misleading and was therefore modified by the researcher. On this item, the grid containing the nonstandard unit of measure was smaller than the grid containing the polygon participants were asked to find the area of; students stated the different grid sizes created confusion. This confusion was resolved by creating similar sized grids before the final version of the MCS-II was administered to the preservice elementary teachers participating in this study.

To test the reliability of the scores produced by the pilot version of the MCS-II, the instrument was administered to students in a Calculus course and a course titled Excursions in Mathematics (N=160). Typically, students enrolled in a Calculus course have chosen a major that requires a higher level of mathematical ability and, thus, should feel very confident in their ability to answer the questions presented on the pilot version of the MCS-II. In contrast, because of the design and prerequisite for the Excursions in Mathematics course, students enrolled in this course may feel less confident in their ability to answer the questions presented on the pilot version of the MCS-II.
After the students’ responses from both courses were analyzed via SPSS, an exploratory factor analysis (using a rotated component matrix) was conducted to determine the number of factors from the 17 items on the pilot version of the MCS-II. A Cronbach’s alpha of 0.88 was calculated for the pilot version of the MCS-II. According to Nunnaly (1978), an alpha coefficient higher than $\alpha = 0.7$ indicates acceptable reliability. Table 2 displays the factor loadings for each item and the Cronbach’s alpha score of the piloted MCS-II if the item was removed.

Table 2
Factor Load for each Item and Alpha if Item Deleted from MCS-II

<table>
<thead>
<tr>
<th>Factor</th>
<th>Item</th>
<th>Factor Load</th>
<th>$\alpha$ if item deleted within subscale</th>
<th>$\alpha$ if item deleted from full scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fractions &amp; Decimals</td>
<td>9</td>
<td>0.50</td>
<td>0.84</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>0.47</td>
<td>0.84</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>0.62</td>
<td>0.82</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>0.76</td>
<td>0.83</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>0.78</td>
<td>0.82</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>0.64</td>
<td>0.82</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>0.67</td>
<td>0.82</td>
<td>0.87</td>
</tr>
<tr>
<td>No Algebra</td>
<td>3</td>
<td>0.55</td>
<td>0.66</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>5a</td>
<td>0.78</td>
<td>0.71</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>5b</td>
<td>0.72</td>
<td>0.63</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>0.63</td>
<td>0.59</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>0.46</td>
<td>0.65</td>
<td>0.88</td>
</tr>
<tr>
<td>Integers</td>
<td>1</td>
<td>0.69</td>
<td>0.58</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.70</td>
<td>0.69</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0.47</td>
<td>0.63</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>0.61</td>
<td>0.69</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>0.65</td>
<td>0.61</td>
<td>0.88</td>
</tr>
</tbody>
</table>

The scree plot (see Appendix G) suggested a three-factor model: Factor 1 (labeled Fractions & Decimals) containing seven items assessing students ability to solve
questions including fractions and decimals, Factor 2 (labeled No Algebra) containing five items that do not require any algebraic manipulation (i.e., pattern recognition, identifying angle measures, and finding the area of a polygon using nonstandard units of measure), and Factor 3 (labeled Integers) containing five items assessing students ability to solve questions dealing exclusively with integers. Because each factor contained approximately the same amount of items and the Cronbach’s alpha score did not dramatically change if an item was removed, all 17 items on the piloted version of the MCS-II were used for the final version of the MCS-II used in this study.

Table 3 provides the correlation coefficients among each factor. All factors shared a statistically significant correlation, $\rho < 0.01$.

Table 3
Correlation Among Factors

<table>
<thead>
<tr>
<th></th>
<th>Integers Factor 3</th>
<th>Fractions &amp; Decimals Factor 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fractions &amp; Decimals</td>
<td>0.61</td>
<td>---</td>
</tr>
<tr>
<td>No Algebra Factor 2</td>
<td>0.40</td>
<td>0.57</td>
</tr>
</tbody>
</table>

An overview of the research design for this study can be seen in Figure 1 below.

![Figure 1: Overview of the research design](image-url)

Phase I: Part I & II: MCS

Analysis: Participants selected from quan results

$a prior$ interview protocol created for interviews

Data Analysis

Phase II: Conduct interviews
Phase I: Quantitative Portion of the Study

The two-part MCS-II was administered during the second half of the spring 2014 semester to 42 elementary preservice teachers enrolled in a mathematics methods course. Immediately after Part I (measuring preservice teachers’ mathematics self-efficacy) was administered and returned, Part II (measuring preservice teachers’ actual mathematical ability) of the MCS-II was administered. In Part II, the preservice teachers were asked to actually solve the same problems presented in Part I. Having the preservice teachers complete Part I separate from Part II aligns with the method used in previous studies (Esterly, 2003; Pajares & Miller, 1994; Pajares & Kranzler, 1995; Pajares & Miller, 1995). Bandura (1986) cautioned that, because efficacy judgments are task-specific, a self-efficacy measure must assess the same skills called for in the performance task with which it is to be compared, and it must be administered as closely as possible in time to that performance. Figure 2 displays question #3 (Part II) of the MCS-II.

3. The measurement of $\angle R$ is 37°. If $\angle R$ and $\angle S$ are complementary, what is the measure of $\angle S$?

Figure 2: Sample question on the MCS-II

Data Analysis: Quantitative Portion

Once data were collected from Part I (rating mathematics self-efficacy) of the MCS-II, quantitative analyses were conducted to identify the preservice teachers with low levels of mathematics self-efficacy. For Part I of the MCS-II, each of the responses (A) through (E) was converted to numerical values for each preservice teacher. The
choice of (A): “No confidence at all” was converted to a value of 1, the choice of (B): “very little confidence” was converted to a value of 2, and so on, with the choice of (E): “complete confidence” being converted to a value of 5.

Once the data were converted to numerical values, an accumulated score was calculated for each preservice teacher on the 17 responses to the items on the MCS-II. Therefore, values on Part I of the MCS-II ranged from 17 to 85. For this study, preservice teachers earning a mean score of 3 or lower on Part I of the MCS-II were identified as having low levels of mathematics self-efficacy, and indicated they perceived their mathematics ability as low. Of the 42 elementary preservice teachers who completed Part I of the MCS-II, 14 of these preservice teachers received a mean score of 3 or lower and were therefore identified as having low levels of mathematics self-efficacy.

For Part II (which measures mathematical ability) of the MCS-II, a scoring rubric (see Table 4) was created to assess each preservice teacher’s performance on each of the questions.

Table 4

<table>
<thead>
<tr>
<th>Scoring rubric for Part II of the MCS-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 1 = no answer given or no conceptual understanding,</td>
</tr>
<tr>
<td>• 2 = grasps basic concepts but has limited mathematical ability,</td>
</tr>
<tr>
<td>• 3 = good conceptual understanding but struggles with the mathematics,</td>
</tr>
<tr>
<td>• 4 = complete understanding but may have inconsequential errors, or</td>
</tr>
<tr>
<td>• 5 = complete mathematical understanding with no errors.</td>
</tr>
</tbody>
</table>
Once all of the Part II questionnaires were completed and returned, the researcher and a faculty member in the Department of Mathematics independently scored Part II (assessing actual mathematical ability) of the MCS-II for each of the 42 preservice elementary teachers exclusively. The scoring rubric provided in Table 4 was used to calculate an aggregate score for each of these preservice elementary teachers. Similar to the numerical scale provided for Part I, values for Part II of the MCS-II also ranged from 17 to 85.

Table 5 shows the three levels of mathematical ability used for this study and how each preservice teacher was classified based on the accumulated score.

Table 5
Classification of Mathematical Ability

<table>
<thead>
<tr>
<th>Accumulated Score</th>
<th>Level of Mathematical Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>85 (5 × 17) – 68 (4 × 17)</td>
<td>High = 3</td>
</tr>
<tr>
<td>67 – 51 (3 × 17)</td>
<td>Medium = 2</td>
</tr>
<tr>
<td>50 – 17 (1 × 17)</td>
<td>Low = 1</td>
</tr>
</tbody>
</table>

A member of the Mathematics Department and I independently categorized each elementary preservice teacher using the intervals provided in Table 5. A code of 1 was given to a preservice teacher identified with low mathematical ability, a code of 2 for a preservice teacher identified with medium mathematical ability, and a code of 3 for a preservice teacher identified with high mathematical ability. After each of the two graders had independently assigned a code to each of the 42 preservice elementary teachers, an inter-rater kappa coefficient was calculated and found to be $\kappa = 0.851$. The
kappa coefficient indicates “almost perfect agreement” between the researcher and the faculty member regarding participants’ levels of actual mathematical ability (Landis & Koch, 1977).

Once participants’ mathematics self-efficacy score and mathematics ability score were calculated, these scores were used to categorize each preservice teacher as either: overconfident (perceived mathematical ability was stronger than actual mathematical ability), congruent (perceived mathematical ability matched actual mathematical ability), or underconfident (actual mathematical ability was stronger than perceived ability). The categorization of each preservice teacher was determined similar to the study by Hackett and Betz (1989) by computing mathematics self-efficacy/performance deviation scores ($D$-scores) by separately transforming scores on the mathematics self-efficacy (Part I of the MCS-II) and mathematics performance scales (Part II of the MCS-II) to standardized scores ($z$-scores) for all 42 participants, and then subtracting the standardized performance scores from the standardized mathematics self-efficacy scores. Mean $D$-scores were calculated for each preservice teacher; these $D$-score means are an index of the average difference on each item between self-efficacy and performance with regard to each mathematics problem. Based on Dowling’s classification system (1978), $D$-scores were classified into five categories and are displayed in Table 6. The resulting $D$-scores range from -2.00 (indicating underconfidence in performance) through 0 (indicating congruence between self-efficacy and performance) to +2.00 (indicating overconfidence in performance).
Table 6

Categorization of Preservice Teachers Based on D-scores

<table>
<thead>
<tr>
<th>D-score</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-score &gt; 0.8</td>
<td>Overconfident</td>
</tr>
<tr>
<td>0.4 &lt; D-score ≤ 0.8</td>
<td>Somewhat overconfident</td>
</tr>
<tr>
<td>−0.4 ≤ D-score ≤ 0.4</td>
<td>Congruent</td>
</tr>
<tr>
<td>−0.8 ≤ D-score &lt; −0.4</td>
<td>Somewhat underconfident</td>
</tr>
<tr>
<td>D-score &lt; −0.8</td>
<td>Underconfident</td>
</tr>
</tbody>
</table>

Table 7 displays the frequency of the categorization of the 42 preservice elementary teachers who completed the MCS-II.

Table 7

<table>
<thead>
<tr>
<th>D-score category</th>
<th>No. of participants (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overconfident (above 0.8)</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>Somewhat overconfident (from 0.4 to 0.8)</td>
<td>11 (26%)</td>
</tr>
<tr>
<td>Congruent (from −0.4 to +0.4)</td>
<td>21 (50%)</td>
</tr>
<tr>
<td>Somewhat underconfident (from −0.8 to −0.4)</td>
<td>5 (12%)</td>
</tr>
<tr>
<td>Underconfident (below −0.8)</td>
<td>4 (10%)</td>
</tr>
</tbody>
</table>

Phase II: Qualitative Portion of the Study

Each of the 14 preservice elementary teachers identified as having low levels of mathematics self-efficacy was invited to be interviewed; six responded favorably. The researcher obtained consent to record the interviews and reassurance was given to each
Before each preservice teacher was given the accumulated score from Part II of the MCS-II, they were asked to describe their mathematical content knowledge in general, as well as their performance on Part II of the MCS-II. To gain a deeper understanding of the beliefs the preservice teachers have regarding their mathematics ability and how it may affect their teaching effectiveness, a semi-structured interview protocol was developed using the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) as a guide. The MTEBI consists of 21 items: 13 items on the Personal Teaching Efficacy subscale and eight items on the Teaching Efficacy subscale (Enochs, Huinker, & Smith, 2000). The Personal Teaching Efficacy subscale addresses individuals’ beliefs in their individual capacity to be effective teachers. The Teaching Efficacy subscale addresses individuals’ beliefs that the learning of mathematics can occur regardless of external factors. Confirmatory factor analysis indicates that the two subscales are independent, adding to the construct validity of the MTEBI (Enochs et al., 2000).

Using the interview protocol (see Appendix C), each interview was approximately 20 – 25 minutes in length. The interviews were directed toward determining each participant’s perceptions of his/her mathematical skills and abilities and how their perceived mathematical ability may affect their teaching of mathematics, including their beliefs about their abilities to (1) get students to believe they can do well in mathematics, (2) motivate students who show low interest in mathematics, (3) provide alternative explanations or examples when students are confused, and (4) implement alternative strategies. In addition, interview questions gave participants the opportunity to discuss
their past experiences in mathematics during their elementary school years and how these experiences affected their personal beliefs about mathematics.

Because of the nature of the research questions, levels of the preservice elementary teachers’ mathematics self-efficacy were the only criteria used to select the participants for the study; age, race, and gender were irrelevant. To eliminate gender bias, each elementary preservice teacher is identified using a gender-neutral name: Alex, Chris, Hayden, Jordan, Pat, and Taylor. The $D$-score category for each of the six preservice elementary teachers is displayed in Table 8.

Table 8
Categorization of Participants (with low self-efficacy) who were interviewed

<table>
<thead>
<tr>
<th>Participant (pseudonym)</th>
<th>$D$-score</th>
<th>$D$-score category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chris</td>
<td>−0.045</td>
<td>Congruent</td>
</tr>
<tr>
<td>Alex</td>
<td>−0.637</td>
<td>Somewhat underconfident</td>
</tr>
<tr>
<td>Hayden</td>
<td>−0.438</td>
<td>Somewhat underconfident</td>
</tr>
<tr>
<td>Jordan</td>
<td>−0.995</td>
<td>Underconfident</td>
</tr>
<tr>
<td>Pat</td>
<td>−0.142</td>
<td>Congruent</td>
</tr>
<tr>
<td>Taylor</td>
<td>−0.523</td>
<td>Somewhat underconfident</td>
</tr>
</tbody>
</table>

Data Analysis: Qualitative Portion

To strengthen the reliability and validity of the study, each interview was recorded and immediately transcribed. Once the transcribed interviews were collected, an *a priori* code list was created based on concepts and ideas common in the literature.
and relevant to research questions two and three. Each code was given a description and
assigned a color (see Table 9).

Table 9

<table>
<thead>
<tr>
<th>Code Name</th>
<th>Color</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematical Ability</td>
<td>Yellow</td>
<td>One’s beliefs about his/her mathematical ability.</td>
</tr>
<tr>
<td>Past Experiences</td>
<td>Orange</td>
<td>One’s past experiences in mathematics during his/her elementary school years and how these experiences affected their personal beliefs about mathematics.</td>
</tr>
<tr>
<td>Motivate</td>
<td>Green</td>
<td>One’s beliefs about his/her ability to motivate students who show low interest in mathematics.</td>
</tr>
<tr>
<td>Performance</td>
<td>Blue</td>
<td>One’s beliefs about his/her ability to get students to believe they can do well in mathematics.</td>
</tr>
<tr>
<td>Alternative Strategies</td>
<td>Red</td>
<td>One’s beliefs about his/her ability to implement alternative strategies in the mathematics classroom.</td>
</tr>
<tr>
<td>Effective Teacher</td>
<td>Purple</td>
<td>One’s beliefs about his/her ability of being an effective mathematics teacher when they enter the classroom.</td>
</tr>
</tbody>
</table>

During the coding process, each code found in the transcribed data was placed on its correspondingly-colored note card. A card sorting technique was implemented to discover patterns within the data and was then used to answer each research question.

According to Stake (1995), the use of multiple data sources is paramount in case study research. The convergence of the interview data with the quantitative data from Part II of the MCS-II strengthens and validates the findings and adds a greater understanding of the beliefs preservice elementary mathematics teachers with low levels of mathematics self-
efficacy have about their mathematics ability and their beliefs of their teaching
effectiveness.

Participant Consent

This study was approved by the Institutional Review Board (IRB Number
20101009; see Appendix F). All participants are over the age of 18 and were informed
that their participation was voluntary and that they could choose to opt out whenever they
wanted. Before the implementation of the MCS-II, each preservice elementary teacher
was asked to sign an informed consent form for participation. The consent form (see
Appendices D & E) provided a description of the study, the participants’ role in the
study, and the confidentiality of the results if they were to participate. Once the
participants were selected for interviews (based on their scores from Part I and Part II of
the study), the signing of an additional consent was required. The consent for interview
form provided approximate time lengths for each interview, the nature of the questions
being asked, and the process for maintaining the preservice teachers’ confidentiality.
Each participant was informed that the primary researcher followed protocol in
maintaining sole possession, as well as the security of all data collected in this study.

Trustworthiness of the Study

Guba (1981) offered criteria that he believed should be used by qualitative
researchers to verify the trustworthiness of a study: (a) credibility, (b) transferability, and
(c) dependability.
To establish credibility, Guba suggests there is the development of an early familiarity with the culture of participating organizations. Since I have been teaching preservice educators for a number of years, I feel I have an adequate familiarity with the population in this study. Additionally, triangulation will be used to establish credibility of the study. Triangulation is the process of corroborating evidence from different types of data in descriptions and themes in qualitative research (Creswell, 2002). For this study, the use of interviews and the participant’s open-ended response from Part II of the MCS-II will help shed more light on the participant’s sense of perceived ability and how it may affect teaching effectiveness. To ensure credibility, tactics will be implemented to help ensure honesty in the informants. Each participant was given the opportunity to refuse to participate in the study, at any time. This was to ensure the participants being interviewed were genuinely willing to participate and were prepared to offer responses openly and freely. Each willing participant was informed that his/her responses would not affect grades in any of their courses. Finally, the researcher will provide a thick description of the phenomenon under scrutiny. To help the reader gain a better understanding of how preservice educators with low levels of mathematics self-efficacy describe their mathematical ability and their beliefs of their teaching effectiveness, a detailed description of the study will be provided, through the use of interviews and open-ended responses provided by the participants, to convey the processes throughout the course of the study.

Transferability measures the extent to which the findings of one study can be applied to other situations; i.e., the ways in which the results of a study could be applied
to a wider population. Since the findings of a qualitative project are specific to a small number of particular environments and individuals, it is impossible to demonstrate that the findings and conclusions are applicable to other situations and populations (Shenton, 2004). But, through a thick description of the phenomenon being investigated, readers will have the opportunity to compare the instances of the phenomenon described in this study with those that they have seen emerge in their situations.

After perusing the description within the research report of the context in which the work was undertaken, readers must determine how far they can be confident in transferring to other situations the results and conclusions presented (Shenton, 2004). This confidence in transferability can be established by providing to the reader the boundaries of the study. As mentioned earlier, once the transcribed interviews have been collected, an *a priori* code list was created based on concepts and ideas relevant in the literature. For each code (whether *a priori* or emerged from the data), a code list will be completed and will include a short description of the code, inclusion/exclusion criteria, and typical/atypical examples. In addition, for each interview, a tape index form will be completed including demographic information, a brief description of interview topics, and the transcribed interview.

In qualitative research, dependability is synonymous with reliability. Reliability poses the question, if the study were repeated, in the same context, using the same methods and with the same participants, would similar results be obtained? Many qualitative researchers believe obtaining dependability is problematic in a qualitative study because of the ever-changing nature of the phenomenon being studied. In order to
address the dependability issue more directly, the processes within the study should be reported in detail, thereby enabling a future researcher to repeat the work, if not necessarily to gain the same results (Shenton, 2004). Therefore, providing a sound research design, a proper implementation, and a detailed collection of data should provide dependability of the study.

Subjectivity Statement

I was a teaching assistant in the Department of Theoretical and Applied Mathematics while working on my master’s degree in Applied Mathematics and taught a course entitled Mathematics for Elementary Teachers. This gave me my first experience in working with preservice mathematics teachers.

When I first began teaching the Mathematics for Elementary Teachers sequence the materials for the course came solely from a textbook and the only method of instruction was direct lecture. I naively assumed instruction in mathematics content would be sufficient to prepare these students to adequately handle the mathematics expectations required of them to be elementary school teachers. Yet, despite my efforts, most students still struggled with the mathematics content. Their struggles revolved around a perceived lack of mathematical ability, high levels of mathematics anxiety, and their lack of mathematics self-efficacy. An epiphany occurred during an exam when a student who was working on a problem raised her hand to ask if her solution was correct. Observing that she had done the work perfectly, I asked her, “What is your gut telling you about your solution?” She responded, “I know it’s wrong!” This response, coming from a preservice elementary teacher who would soon be responsible for teaching
mathematics to children, brought me to the realization that her knowledge wasn’t the issue; instead it was her level of mathematics self-efficacy. This encounter led me to investigate the correlation between mathematical ability and mathematics self-efficacy.

Assumptions of the Study

1. The participants of the study have been admitted into the College of Education and are pursuing a degree in Elementary Education.

2. The participants’ responses to the questions on the instrument as well as the interview questions are honest.
CHAPTER IV

RESULTS

In this study, the relationship between preservice elementary teachers’ perceived mathematical ability and actual ability was quantitatively examined via the MCS-II. Those preservice elementary teachers who identified themselves as having low levels of mathematics self-efficacy were interviewed in order to gain a deeper understanding of the beliefs in their mathematical ability and on being an effective mathematics teacher when they enter the classroom.

Quantitative Analysis

Of the 42 elementary teachers who participated in the study, 14 identified themselves as having low levels of mathematics self-efficacy on Part I of the MCS-II. Since the study focuses solely on preservice elementary teachers with low levels of mathematics self-efficacy, only those 14 participants who identified themselves as having low levels of mathematics self-efficacy on Part I of the MCS-II were asked to take part in the qualitative portion of the study.

The first research question examines the relationship between the perceived mathematical ability and the actual mathematical ability of preservice teachers with low
levels of mathematics self-efficacy. Specifically, the purpose of this question was to see how closely, if at all, the perceived mathematical ability of elementary preservice educators with low levels of mathematics self-efficacy matches their actual mathematical ability.

As shown in Table 10, of the 14 preservice elementary teachers who were identified as having low levels of mathematics self-efficacy, none of the participants was in the overconfident range, approximately 14% of them were in the somewhat overconfident range (indicating their perceived mathematical ability was stronger than their actual mathematical ability), approximately 36% of them were in the congruent range, and 50% of them were in the underconfident range (either somewhat underconfident or underconfident).

Table 10

Frequency of Confidence Levels of the preservice elementary teachers with low levels of mathematics self-efficacy (n=14)

<table>
<thead>
<tr>
<th>D-score category</th>
<th>No. of participants (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overconfident (above 0.8)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Somewhat overconfident (from 0.4 to 0.8)</td>
<td>2 (14%)</td>
</tr>
<tr>
<td>Congruent (from −0.4 to +0.4)</td>
<td>5 (36%)</td>
</tr>
<tr>
<td>Somewhat underconfident (from −0.8 to −0.4)</td>
<td>4 (29%)</td>
</tr>
<tr>
<td>Underconfident (below −0.8)</td>
<td>3 (21%)</td>
</tr>
</tbody>
</table>
Qualitative Analyses

Of the 14 elementary teachers who identified themselves with low levels of mathematics self-efficacy, six agreed to be interviewed. Research questions two and three incorporated interviews that allowed these six preservice elementary teachers to offer an individualized perspective of their mathematical content knowledge and how this knowledge may affect their teaching of mathematics. Ideally, I would have liked to interview the two preservice elementary teachers categorized as overconfident, two that were categorized as congruent, and two that were categorized as underconfident. Unfortunately, the two elementary preservice elementary teachers that were categorized as overconfident declined to be interviewed. As mentioned in Chapter III, levels of the preservice elementary teachers’ mathematics self-efficacy were the only criteria used to select the participants for the study. Table 11 provides a review of the gender-neutral names given to each preservice elementary teacher and their respective $D$-score.

Table 11
Categorization of Participants (with low mathematics self-efficacy) who were interviewed

<table>
<thead>
<tr>
<th>Participant (pseudonym)</th>
<th>$D$-score</th>
<th>$D$-score category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chris</td>
<td>−0.045</td>
<td>Congruent</td>
</tr>
<tr>
<td>Alex</td>
<td>−0.637</td>
<td>Somewhat underconfident</td>
</tr>
<tr>
<td>Hayden</td>
<td>−0.438</td>
<td>Somewhat underconfident</td>
</tr>
<tr>
<td>Jordan</td>
<td>−0.995</td>
<td>Underconfident</td>
</tr>
<tr>
<td>Pat</td>
<td>−0.142</td>
<td>Congruent</td>
</tr>
<tr>
<td>Taylor</td>
<td>−0.523</td>
<td>Somewhat underconfident</td>
</tr>
</tbody>
</table>
The interviews were directed toward determining each participant’s perceptions of his/her mathematical skills and abilities and how their perceived mathematical ability may affect their teaching of mathematics, including their beliefs about their abilities to (1) get students to believe they can do well in mathematics, (2) motivate students who show low interest in mathematics, (3) provide alternative explanations or examples when students are confused, and (4) implement alternative strategies.

Below are the profiles of the six preservice elementary teachers, along with a quote that encapsulates each preservice elementary teacher’s point of view about mathematics.

Chris: “I just wish it was more enjoyable.”

The first profile was that of Chris, with an overall $D$-score categorizing him/her as “Congruent” in his/her mathematics content knowledge. This indicated that Chris’s perceived mathematical ability matched his/her actual mathematical ability. Table 12 gives an overview of Chris’s perceived versus actual mathematical ability.

Table 12

<table>
<thead>
<tr>
<th>Domain</th>
<th>Level of perceived ability</th>
<th>$D$-score category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations and Algebraic Thinking</td>
<td>Some Confidence</td>
<td>Somewhat Underconfident</td>
</tr>
<tr>
<td>Numbers and Operations</td>
<td>Very little/Some confidence</td>
<td>Congruent</td>
</tr>
<tr>
<td>Measurement</td>
<td>No/Very little confidence</td>
<td>Somewhat Overconfident</td>
</tr>
<tr>
<td>Geometry</td>
<td>Very little confidence</td>
<td>Congruent</td>
</tr>
</tbody>
</table>
At the start of the interview, when the researcher placed a blank MCS-II survey in front of Chris, he/she rolled his/her eyes. When asked why, he/she replied, “You’re talking to a non-math person here. I’m terrible at it”. As seen in Table 12, Chris had “Some Confidence” in the Operations and Algebraic Thinking and the Numbers and Operations domain. Chris’s $D$-score indicated he/she was “Somewhat Underconfident” in his/her ability in the Operations and Algebraic Thinking domain. Identifying patterns were included in this domain and although Chris indicated he/she had “Very little/Some Confidence” in the ability to identify patterns, he/she received the highest possible score on each of these questions.

Chris’s $D$-score indicated he/she was “Congruent” in his/her mathematical ability in the Numbers and Operations domain. When asked about performing operations with fractions, Chris stated, “I would need a recap on fractions.” Chris went on to say,

Yeah. I mean, if I was able to learn this stuff all over again, it might help me. It just wasn’t enjoyable for me. I wish it was more enjoyable. So, I don’t mind doing it, if I was [sic] to learn all over again. Cause [sic] they don’t touch base on the fraction stuff. That’s like grade school stuff…they don’t teach that in high school anymore…it’s more algebra stuff.

His/her discomfort with fractions was seemingly well-founded; on every question dealing with fractions on the MCS-II, Chris received the lowest score of 1, indicating no conceptual understanding.

Within the Measurement domain, Chris had rated him/herself as having “No/Very little confidence.” Yet, during the interview, Chris said he/she started out as a nursing student and had to “figure out measurements and things for pills” and therefore felt very comfortable within the domain. His/her $D$-score indicated he/she was “Somewhat...
“Overconfident” in his/her ability. Since Chris did not attempt any of the measurement questions on the MCS-II, he/she received the lowest score of 1 of each of them.

In the Geometry domain, Chris indicated he/she had “Very little confidence” in his/her ability; this was confirmed by his/her D-score. When asked about questions dealing with angles, Chris said he/she felt okay with answering them, but wasn’t sure about reflex angles. Although Chris did attempt each of the questions on the MSC-II dealing with angles, he/she received the lowest score of 1 of each of them.

When asked to rate his/her overall mathematical ability, Chris stated, “It would be low as of now just because I have not taken a math course since…probably three years.” When asked the first word that comes to his/her mind when he/she hears the word mathematics, Chris said, “That I’m bad at it.” Chris went on to explain that his/her lack of mathematical ability was the fault of his/her incompetent teachers. The following conversation transpired:

*Chris:* I had a bad experience during my grade school and high school years. It was just terrible. I just didn’t like my teachers. I think that was the big factor that it played. I was one of those struggling students in math and they made me feel pretty stupid, so I was [like] too embarrassed to try. I never had a good experience in elementary school. It’s all based on the teacher in math. I think that’s…[pause] they were just nasty. I don’t know why, but it just made learning not that enjoyable for me.

*Researcher:* So, you kind of had negative experiences in most of your math courses?

*Chris:* Yeah, except for my second grade teacher. I would say she was probably the best.

*Researcher:* The best?

*Chris:* Yeah, I felt comfortable with everything she was teaching me and I remember she was nice and she didn’t make me feel stupid.

*Researcher:* But the other ones, you felt…they made you feel…
Chris: And it was just…I think they were just trying to get through the content but they just kept moving on whether the people were struggling or not. They were like, “If you’re not doing alright you can stay in class” and the other ones, they would ship us out to the “brown house”…and that was always me. It just made me feel dumb and dumbed me down. And I was embarrassed to…[Chris stops.]

After a very long pause, Chris ended this part of our conversation with a heavy sigh, saying, “Yeah. I just with it was more enjoyable.”

Chris mentioned the negative experiences in his/her elementary school years as a “huge factor into why I wanted to become a teacher.” He/she knows his/her confidence in mathematics is low and fears this lack of confidence will negatively influence his/her teaching. When asked to describe the areas (excluding content knowledge) where he/she will excel as a math teacher, Chris could not come up with an answer. All he/she said was, “You got me on that one. I’m not sure I can answer that one.” However, when asked where he/she might struggle as a teacher, Chris quickly responded, “I think actually trying to teach these kids as a whole class…actually doing the math.” Later in the interview, he/she said,

I haven’t taken it [math] in so long; I don’t remember how to do half of it…which is hard. That’s going to be an issue for me. Going back to me not able to teach these kids or being able to help them, or if they ask me a question and I don’t know how to address it…I think this is my biggest struggle and fear…that I’m teaching them wrong and the parents are going to come back and be like…[Chris stops.]

Concerning this lack of content knowledge and his/her fear of possibly not being able to teach his/her future students the content required, Chris was asked if he/she thinks he’ll/she’ll be able to motivate students who show low interest in mathematics. Chris responded,
Yeah, I think I’ll be able to do that [be]cause I know I was one of those students that struggled and I’ll just have to work with them more. It would just be more one on one that they would need; and I would have to make it more fun in the classroom. It would just be boring, sitting there doing problems…maybe add some games into it. Because I remember on the chalkboard…that was all we were doing…was [working on] problems. It was terrible.

Chris believes the mathematics method course he/she is currently taking is helping him/her create lesson plans that seem to make math more fun. Chris said he/she could definitely see himself/herself incorporating many of the activities that the class created in the mathematics method course when he/she begins teaching in the classroom. However, Chris stated that he/she had a very difficult time creating the lesson plans because the Common Core Standards were “just too tough to understand; they’re very complicated.”

In addition to him/her believing the Common Core Standards are difficult to understand, Chris believes “they try to cram in too much in students now-a-days and if they don’t get it, they just move on.” When asked to elaborate on his/her thoughts regarding the need for teachers to move on, the following conversation occurred.

*Researcher:* I mean, what are you going to do when you’re going to have to move on and some of the students still don’t “get” it?

*Chris:* Yeah, it’s not a good feeling at all…that’s how I was; cause if you don’t get it and you keep moving on, you’re not going to be able to go back to the basics…you’re in trouble.

*Researcher:* It feels like it snowballs, right?

*Chris:* Yeah. Well, I struggled when I was in grade school, it just followed me and I just didn’t understand it.

Because Chris struggled with mathematics in grade school, Chris felt his/her confidence in mathematics weakened. As a teacher, Chris understands the importance of building
I think I can. I mean, once I start getting into the swing of things. Cause right now it’s really difficult. I’m terrified of student teaching, but I guess you learn once you start doing more of it.

Here, Chris believes repetition and more exposure to the content will build his/her confidence in mathematics.

Chris says he/she will feel very comfortable using manipulatives in his/her future classroom because he/she feels it’s the best way to learn a concept when seeing it for the first time. However, he/she also feels he/she will need to gain more confidence solving problems on the board. Additionally, Chris believes he/she will able to implement different teaching strategies when students are having difficulty with certain concepts. He/she feels the mathematics methods courses he/she is currently taking are helping him/her with understanding how to implement alternate methods of teaching.

Toward the end of the interview, Chris was asked if he/she believes he/she will be an effective mathematics teacher. He/she replied,

Down the road, yeah. Starting, I think it’s going to be a process to get me there. Hopefully it will help me become a better math teacher. I’m going to have to get used to being able to answer students’ questions. It kind of terrified me when I was doing my observations, but I think I’ll be able to if I address it appropriately. But, I’ll have to work on my confidence. It’s something I’ll have to definitely work on. It’s hard though. Confidence plays a huge part. But over time it will be a [pause]...it will just grow on me because it will just be repetitive and I think I’ll be able to get the hang of it and feel more comfortable. If not, then I’ll be finding a different career [laughing]. I just had a bad experience growing up and I don’t want these kids to have what I had growing up. That’s why I want to be a teacher. I think it’s going to make me a better teacher. It definitely was a huge factor into why I wanted to do it; and I actually what to work in an urban school district because I think those kids need it the most. That’s my goal; we’ll see.
Based on the previous comment, Chris believes he/she will be able to be an effective mathematics teacher even though he/she identifies him/herself as having a low level of mathematics self-efficacy and admits to having difficulty with the content.

Jordan: “Math; Sometimes I like it, sometimes I hate it.”

The second profile was that of Jordan who had an overall $D$-score that categorized him/her as “Underconfident” in his/her mathematics content knowledge. This indicated that Jordan’s perceived mathematical ability was lower than his/her actual mathematical ability. An overview of Jordan’s perceived mathematical ability versus actual ability for each domain in the Common Core Standards is displayed in Table 13.

Table 13
Profile of Jordan

<table>
<thead>
<tr>
<th>Domain</th>
<th>Level of perceived ability</th>
<th>$D$-score category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations and Algebraic Thinking</td>
<td>Some confidence</td>
<td>Underconfident</td>
</tr>
<tr>
<td>Numbers and Operations</td>
<td>Some confidence</td>
<td>Congruent</td>
</tr>
<tr>
<td>Measurement</td>
<td>No/very little confidence</td>
<td>Underconfident</td>
</tr>
<tr>
<td>Geometry</td>
<td>Very little confidence</td>
<td>Congruent</td>
</tr>
</tbody>
</table>

In the Operations and Algebraic Thinking domain, Jordan indicated he/she had “Some confidence” in his/her mathematical ability. Based on the $D$-score, Jordan was “Underconfident” in his/her mathematical ability within this domain. Although Jordan indicated he/she had very little confidence in answering the six questions on the MCS-II within the domain of Operations and Algebraic Thinking, he/she received the highest
possible score of 5 on four of the questions and 3 on the remaining two. During the interview, when asked about his/her performance on the item that pertained to the operations with positive/negative integers, Jordan stated he/she found the operations of multiplication and division to be easier than that of addition and subtraction with negative numbers, saying, “Adding and subtracting with the negatives and positives is really confusing for me.” This was confirmed when Jordan correctly answered the multiplication and division problems, and incorrectly answered the addition and subtraction problems.

In the Numbers and Operations domain, Jordan had “Some confidence” in his/her mathematical ability and his/her $D$-score indicated congruency. When asked how he/she felt when solving the item on the MCS-II that involved operations with fractions, Jordan stated,

Um, I think that I was okay. I think I just couldn’t remember if you were supposed to…[pause]. When you flip it and then you multiply them, do you just multiply the bottom straight across or do you [like] find a common denominator and then do it? So, that part was confusing.

Even though he/she claimed to be confused, he/she earned a perfect score of 5 on the item.

In the Measurement domain, Jordan had “No/very little confidence” in his/her mathematical ability. His/her $D$-score indicated Jordan was “Underconfident” in his/her actual mathematical ability. Jordan’s score on the two items on the MCS-II within the Measurement domain was a 3 but, the fact that Jordan took the correct approach to solving these items, making only trivial errors, indicated that his/her actual mathematical ability was stronger than he/she perceived it to be.
In the domain of Geometry, Jordan had “Very little confidence” in his/her mathematical ability and his/her $D$-score indicated congruency. When asked how he/she felt about classifying interior angles as acute, obtuse, or reflex, Jordan responded,

I knew what these two meant [pointing to acute and obtuse], but [like] interior and reflex were kind of…those were confusing for me. Cause I was trying to think [pause]…Cause one of them means the same…or is that congruent? [Laughing] Jordan indicated that he/she did not feel comfortable with questions about geometry and his/her low scores of 1 and 2 on the two items within the Geometry domain bore this out.

Overall, Jordan rates his/her mathematical ability as medium. Jordan believes he/she can do the mathematics but struggles when asked to perform mathematical tasks on exams because he/she feels like he/she “freezes up and forgets how to do anything.” When asked for the first word that comes to mind when the word mathematics is mentioned, Jordan responded, “Hard.” Jordan stated he/she felt ignored in school and felt that many of his/her teachers rushed through the material. Because of this, Jordan felt he/she wasn’t able to learn the basics of mathematics. During the interview, Jordan mentioned he/she would even try to stay after school for help but felt his/her teacher was always trying to rush him/her out the door. “So, it was pretty rough,” Jordan stated.

There was one particular teacher Jordan enjoyed during his/her elementary school years. When asked to provide some of the qualities he/she saw in this teacher Jordan responded,

When he taught it [math], he would kind of teach it in a fun, light way that made it not so serious. So, I think that’s how I related to it more; and he made it more like a group teaching kind of thing. Just the way he explained things…he would go out of his way to take the time to explain it until everyone understood it; whereas other teachers would kind of [like] brush you under the rug if you didn’t understand it.
Jordan is hopeful that he/she will be able to implement the same type of teaching style when he/she begins teaching. In addition to teaching the content in a fun and light manner, Jordan believes he/she would like to do more hands-on activities, working with manipulatives and try to relate the mathematics to his/her students’ everyday lives.

Jordan would also like to incorporate a math project in her classroom. When asked for an example of a math project, Jordan brought up baking, saying,

> We can make something in class that day and then we would need so many of each ingredient and then they [the students] could convert it to whatever.

However, when asked about the areas where Jordan thinks he/she is going to struggle, he/she responded, “Probably the converting stuff, I’ll have to practice that a lot, cause that will be kind of hard to do, I think.”

Because of Jordan’s elementary school experiences in mathematics, Jordan believes he/she will be able to motivate students who show low interest in mathematics, saying, “I’ll be able to relate to them and say that I am not a huge fan of math either, but here are some ways to do math and ways to make it seem not so scary.” Jordan believes that someone having a good mathematical knowledge means the person can pick up on mathematical concepts very quickly and can learn the content the first time it is taught. This person can make mistakes, but small ones. When asked if Jordan believes he/she will be able to get students to believe they can do well in math, after a long pause Jordan responded, “I don’t really know.” Jordan believes it does not take a mathematical mind to do well in mathematics, and believes effort, as opposed to ability, can help in the learning of mathematics.
During the interview, Jordan was asked the extent to which he/she believes that what a person gets out of mathematics is from the quality of the teacher. She responded,

I think a lot of it comes from the quality of the teacher because if you are a really good teacher and you can really [like] slow things down just to make sure that everybody understands, then the students are going to be able to get a lot more out of it, rather than if you’re like “boom, boom, boom” and you just go through everything and they’re going to be lost by the end of the lesson.

To quantify her response, Jordan believes 90% is given to the quality of teacher and 10% would be that of effort on the student.

At the end of the interview, Jordan was asked if he/she will be an effective mathematics teacher. He/she answered,

I think just because I have struggled with it before and I’ve had good and bad teachers, so I’ll know [like] the right ways to help the children understand something rather than [stop]. Cause [sic] I’ve seen the bad ways, so I’ll know what to avoid and what to do to encourage them more.

Even though Jordan mentions he/she will know the right ways to help children understand, he/she does not provide any suggestions during the interview.

Alex: “Every student should be able to learn math.”

The third profile is that of Alex with an overall $D$-score that categorized him/her as “Somewhat underconfident” in his/her mathematical content knowledge. This indicates that Alex’s actual mathematical ability is stronger than his/her perceived mathematical ability. An overview of Alex’s actual mathematical ability versus perceived mathematical ability for each of the four domains in the Common Core Standards is displayed in Table 14.
Table 14

Profile of Alex

<table>
<thead>
<tr>
<th>Domain</th>
<th>Level of perceived ability</th>
<th>$D$-score category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations and Algebraic Thinking</td>
<td>Much confidence</td>
<td>Congruent</td>
</tr>
<tr>
<td>Numbers and Operations</td>
<td>Some confidence</td>
<td>Underconfident</td>
</tr>
<tr>
<td>Measurement</td>
<td>No/very little confidence</td>
<td>Congruent</td>
</tr>
<tr>
<td>Geometry</td>
<td>Very little/some confidence</td>
<td>Underconfident</td>
</tr>
</tbody>
</table>

In the Operations and Algebraic Thinking domain, Alex indicated he/she had “Much confidence” in his/her mathematical ability. Based on the $D$-score, Alex showed congruency. During the interview, Alex claimed, “Anything that’s more equation based, like number one or two [on the MCS-II], those are my forte.” For the questions on Part I within the Operations and Algebraic Thinking domain where Alex selected “Complete confidence”, he/she received the highest score of 5. In addition, for the questions on Part I within the same domain where Alex selected “Very little confidence,” Alex received the lowest possible score.

In the domain of Numbers and Operations domain, Alex indicated he/she had “Some confidence” in his/her mathematical ability. His/her $D$-score indicated otherwise. Alex’s $D$-score indicated she was “Underconfident” in his/her actual mathematical ability. Here, his/her actual mathematical ability was stronger than his/her perceived ability. Within this domain, Alex indicated he/she had “Complete confidence” in only one of six items on the MCS-II. This item contained operations with whole numbers. For the remaining five items within this domain, Alex rated him/herself as having “Some
confidence” or lower. The remaining five items contained fractions and/or decimals. Out of the five items previously mentioned, Alex received the highest possible score on four of them. Alex stated, “I’m pretty good with fractions,” but believes he/she missed many of the items containing fractions.

In the domain of Measurement, Alex indicated he/she had “No/very little confidence” in his/her mathematical ability. His/her D-score showed congruency, confirming this lack of confidence in his/her ability. Alex’s comments during the interview suggest that mastery of this domain is only a “matter of recall.” When asked on his/her thoughts about converting within the metric system, Alex responded,

> Again, [it’s] something I remember doing, but I can’t remember how to do it. I know it’s all about moving the decimal point. [It’s] just the fact of whether it was a 10 or a 100 place. It was just something I would have to remember…but do I remember doing it? Yeah, I would just have to go back over it.

Although Alex did attempt the two items on the MCS-II within the Measurement domain, he/she received very low scores on both; a score of 1 and 2, respectively.

In the domain of Geometry, Alex indicated “Very little/some confidence” in his/her mathematical ability. But, the D-score categorized Alex as “Underconfident,” indicating that his/her actual mathematical ability was stronger than his/her perceived mathematical ability. During the interview, Alex laughingly proclaimed, “Yeah, angles and I don’t get along. We’re not friends.” But, when Alex was informed that he/she got the angle questions correct, he/she was extremely surprised, saying, “I’m shocked!” Of the two items on the MCS-II pertaining to the Geometry domain, Alex received the highest score of 5 on one item and a score of 3 on the other item.
Overall, Alex rates his/her mathematical content knowledge as “medium to almost borderline low,” stating that having two mathematics content courses so early in the education program didn’t help, because mathematics content is never talked about again in the program. According to Alex,

You know, they [education courses] try to do more project-based things and not [like] doing actual mathematics equations and things like that. So, it’s been a while.

Alex believes the project-based activities he/she is learning in the education program are helpful for teaching children mathematics because they make the learning of mathematics fun. In fact, fun is the first word that comes to Alex’s mind when asked about his/her feelings toward mathematics. Alex likes working through problems to find the answers, knowing there is an answer to a problem and trying to work towards it. When asked if he/she sees a purpose for mathematics, Alex stated,

I think math is used every day…in more ways than you would even think right off hand, if you truly sit back and think about it. You know, you go to a grocery store and you have a budget for that week…that’s all math. As a child, if you’re given an allowance…say, you have 20 dollars a week…I mean, what are you going to spend it on? You can’t spend over that [amount]. Savings, same thing…you’re adding to your savings. You use it every day.

Alex also feels he/she is a visual person when learning mathematics. He/she believes watching the teacher do problems on the board did not help him/learn mathematics while in school. Alex’s favorite teacher in his/her elementary school years was his/her second grade teacher because of the teacher’s approach to teaching. His/her teacher had the students write each problem presented on the blackboard on a separate sheet of paper and had them follow (along with the teacher) the steps and procedures to solve the problems.
In addition to having the students work on the problems themselves, Alex’s teacher solved many problems using multiple approaches.

When asked to describe the areas where Alex thinks he/she will excel as a mathematics teacher, he/she stated,

Um, I think the multiple approaches…just because I myself learned better that way. Giving options, making it fun versus, ‘Here, just do these 20 problems and we’re not going to stop until these 20 problems are done.’ Basically, making math fun and thinking of new ideas of presenting the material versus a story problem that would be hard to read through. How can you make that less challenging for students…I think I’ll be good at that.

Possibly strengthening his/her opinions on multiple approaches was his/her negative experiences in third grade. Alex was asked about his/her least favorite teacher in elementary school and to elaborate on some of the qualities he/she saw in this teacher. Alex responded,

She was just like, if you don’t do it her one specific way, it was wrong. She would show you how she would want it done and if you didn’t do it that way…[stopped] Even if you would have ended up with the same result, it was like, ‘Oh, you didn’t do it the way you were supposed to do it.’

This experience must have had an impact on Alex because he/she plans to incorporate multiple approaches when he/she teaches mathematics.

One area Alex believes he/she will struggle with deals with the students who think they “know everything or might think they know everything.” Alex thinks he’ll/she’ll have a hard time making it more advanced than what he/she is supposed to be teaching. He/she also fears that he/she will not know how to teach the material being presented to his/her classroom, but feels that he/she will be well prepared before he/she teaches the material. When asked if Alex believes there will ever be a time when he/she
will not be able to answer a student’s question, he/she replied, “Yes, for sure.” However, Alex stated that he/she is not afraid to ask other students in the classroom for their approach to solving the problem.

When asked to what extent Alex believes he/she can get students to believe they could do well in mathematics, Alex responded,

Um, it’s just something where they have to look at it as, “You might not understand this part of it now, but maybe the next part you’ll be super great at and it might connect the dots.” Um, even if you have to skip one part to go to the next, that might be the way that they think. So, they might grasp this, then all of a sudden the light bulb goes off and now they have all of the pieces. It’s kind of backwards scaffolding, in a way.

Alex also believes he/she will be able to motivate students who show low interest in mathematics. He/she believes the education class he/she is currently in “has greatly helped with that.”

When asked about the teaching and learning of mathematics, the conversation below occurred.

*Researcher*: Okay. If you, as her teacher, were to say that Mary’s mathematics knowledge is good, what does that mean to you? That if someone had a good mathematical knowledge…

*Alex*: Not that they get everything right, but that they have an understanding of, um, what it means to add two things together…what it means to, you know, read a word problem and maybe you have to work backwards to solve. So, maybe just missing small things while doing the math, but understanding the general idea of how you get from (A) the problem, to (B) the solution.

*Researcher*: Are there kids who just don’t “get it”?

*Alex*: [quickly] No. I think, if you teach it the right way, every student should be able to learn math.
Researcher: Okay. This leads us to our next question. To what extent do you think what a student gets out of mathematics depends on the quality of the teacher?

Alex: It’s always about the quality of the teacher…and that’s in any subject. It’s how you teach it. If you teach it in a way that kids can’t understand, you’re going to be there a long time to make them understand. But, if you learn the students and learn how they learn, you can teach them anything.

Researcher: If you were to put a percentage on it? What would you say? What percentage depends on the quality of the teacher?

Quantifying Alex’s response to this question, he/she said 90% depends on the quality of the teacher, with “Ten percent is [the] kids wanting to learn.”

Alex believes he/she will be able to implement alternative teaching strategies in the classroom and also feels very comfortable being able to provide alternate explanations or examples if one of his/her students seems confused with a particular mathematics concept. In addition, Alex feels very comfortable using manipulatives when teaching mathematics. During the interview, Alex stated that at first he/she was very leery using them, but the math [content] course she completed at the university taught him/her how to use them correctly. Because of this course, he/she feels very comfortable using manipulatives.

Finally, when asked to complete the statement, “I think I will be an effective mathematics teacher because…”, Alex responded,

Multiple ways of teaching it, knowing the students, to see how they learn individually. Also, if they’re not seeing it one way, move on to the next, they’ll eventually come through. And, also, I believe a lot in students teaching other students. I mean, even in classes now-a-days, if I take a class, I’m working with other college students…my peers, you know. And I think that starts from elementary school all the way up. We speak the same language…if you’re in the same age group…same thing with elementary students.
Alex believes that “every student should be able to learn math.” Based on Alex’s comments, he/she believes that knowing each of his/her student’s individualized way of learning mathematics will accomplish this undertaking.

Pat: “Math is scary”

The forth profile is that of Pat with an overall $D$-score that categorized him/her as “Congruent” in his/her mathematical content knowledge. This indicates that Alex’s actual mathematical ability matches his/her perceived mathematical ability. An overview of Pat’s actual mathematical ability versus perceived mathematical ability for each of the four domains in the Common Core Standards is displayed in Table 15.

Table 15
Profile of Pat

<table>
<thead>
<tr>
<th>Domain</th>
<th>Level of self-efficacy</th>
<th>$D$-score category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations and Algebraic Thinking</td>
<td>Some confidence</td>
<td>Congruent</td>
</tr>
<tr>
<td>Numbers and Operations</td>
<td>No confidence at all</td>
<td>Underconfident</td>
</tr>
<tr>
<td>Measurement</td>
<td>No/very little confidence</td>
<td>Somewhat overconfident</td>
</tr>
<tr>
<td>Geometry</td>
<td>Much/complete confidence</td>
<td>Congruent</td>
</tr>
</tbody>
</table>

In the domain of Operations and Algebraic Thinking, Pat indicated he/she had “Some confidence” in his/her mathematical content knowledge. Pat’s $D$-score showed congruency. Of the six items on the MCS-II within the Operations and Algebraic domain, Pat indicated he/she had “Complete confidence” solving two of them. Pat received the highest possible score of 5 on these two items. For the remaining four items,
Pat indicated he/she had “Some confidence” solving them. Pat received the lowest score of 1 on three of the four items and a 2 on the remaining item.

In the domain of Numbers and Operations, Pat indicated he/she had “No confidence” in his/her mathematical content knowledge. Pat’s $D$-score indicated he/she was underconfident in his/her actual mathematical ability. Of the six items on the MCS-II within the Numbers and Operations domain, Pat indicated he/she had “No confidence at all” on five of them. Of these five items, Pat received the lowest possible score of 1 four of them, and the highest possible score of 5 on one of the items. The item Pat received a score of 5 (and indicated he/she had “No confidence” solving) dealt with the operations of fractions. During the interview, Pat was asked if he/she felt comfortable with fractions. He/she replied,

Not yet. I’m trying to get the concept in my head, but yeah, I think it’s just that it’s been so long since I’ve done this stuff…so, basically trying to reteach myself so I can teach kids how to do it.

When asked how he/she felt solving the problem on the MCS-II where he/she indicated he/she had “No confidence at all” solving yet received the highest score, Pat replied,

Yeah, it was scary. I mean, all I had to do was put the 6 over the 1, but then to divide it is difficult. I can do addition and multiplication with fractions, but dividing it is a little scary.

Pat believes he/she can only perform operations with fractions if he/she was able to use a calculator.

In the Measurement domain, Pat indicated he/she had “No/very little confidence” in his/her mathematical ability. Pat’s $D$-score categorized him/her as “Somewhat overconfident” in this domain. This indicated Pat’s perceived mathematical ability was
stronger than his/her actual mathematical ability. Of the two items on the MCS-II within the Measurement domain, Pat indicated he/she had “Very little confidence” on one of them, and “No confidence at all” on the other. For both items, Pat received the lowest score possible of 1, leaving them blank and drawing question marks.

In the Geometry domain, Pat indicated he/she had “Much/complete confidence” in his/her mathematical ability. Pat’s $D$-score showed congruency. In fact, of the two items on the MCS-II within this domain, the level of confidence he/she selected on Part I matched the score he/she received on Part II.

Pat’s overall feelings toward mathematics is that “It’s a little scary” because he/she is “just not familiar with it.” When asked if he/she would feel comfortable teaching mathematics, Pat responded that he/she would not. He/she elaborated saying,

I don’t feel completely confident, especially with third grade…which is terrible, because as a third grader, I would want my teacher to be completely confident.

Pat is studying to be certified to teach pre-kindergarten to grade three. Pat stated he/she didn’t have good experiences in mathematics during his/her elementary school years. Pat was asked if he/she had any good math teachers during his/her elementary years and he/she quickly responded,

No, I didn’t. I hated it…and I don’t want my kids to be like that. I think it was because it was so boring. They would just give us worksheets and it wasn’t…it didn’t incorporate. I don’t remember using manipulative at all when I was in elementary school. So, it was just really hard. It seemed kind of abstract to me…to think about it like that.

Pat felt many of his/her teachers in grade school “weren’t really high quality teachers.”
When it comes to teaching, Pat believes he/she will be able to bring many positive qualities into the classroom. When asked to describe the areas he/she will excel at as a math teacher, Pat said,

Um, I feel like I’m not too quick to turn answers down. If somebody gives me the wrong answer, I want to know why they came up with the answer. So, I’ll know what they’re thinking and how they’re going about doing these problems so I can help them, you know, get back on the right track… instead of just, ‘Nope, that’s wrong. Who else can help them out?’ And give kids time to answer questions and not expect them to come up with it right away. Because I was a student who had to think about it longer than everyone else, and by the time I came up with it, the answer is already given and then they’d be moving on to the next problem and I’d be like, ‘I don’t even know how to do that last problem’. So, I just want to be patient and give them time to figure things out.

And when asked about the areas Pat thinks he/she will struggle, Pat responded,

Probably with the material. [Like] if kids come up with different ways that I haven’t… cause I’m not really intelligent when it comes to math, so if I have a really gifted student in third grade, who has all these questions and is coming up with different ways that are probably right, I feel like…[pause] I’m going to have to know my stuff.

In his/her response to “having to know his/her stuff”, Pat believes he/she will understand the material over time, once he/she has gained experience. Pat believes once he/she knows the grade he/she will be teaching, he/she can just focus on the content presented in that particular grade, because “knowing four grades worth of stuff and being really experienced in all of it” will be challenging.

Regarding the art of teaching, Pat is a firm believer in using manipulatives in the classroom. During the interview, Pat said he/she feels very comfortable using them because he/she believes them building confidence. Pat said he/she is a visual leaner and feels “I learn so much better from them because I can see it”. When asked about manipulatives building confidence in learning mathematics, Pat replied,
I do. Especially with the younger kids who don’t have a lot of experience with math…especially in kindergarten and first grade. They only will be going to school for one or two years, so I think it’s important to get them started young…that math isn’t scary, that you really have to learn it and so by building that confidence, I feel they’ll do better.

Pat said that depending on the content, he/she believes he/she will be able to implement alternative teaching strategies in the classroom. Pat believes this is important because having children see multiple approaches to solving problems will build confidence, which he/she believes is very important for students to see during children’s early years of schooling. Unfortunately, if Pat was asked to teach third grade material, “I feel like going into the lesson I’d have to think about different ways that we can do it, and I don’t know if I could just do it right out of the back of my mind.”

When asked about the importance of the quality of the teacher and to what extent he/she believes that what students get out of mathematics is based on the quality of the teacher, Pat said “it is really, really crucial”. This statement led to me asking if Pat believes he/she will be an effective mathematics teacher. He/she responded,

I think for the most part, yeah. I mean, I’m going to have to…before I go into the classroom, I want to review all of my math, just in general, as I will do with social studies and science and that type of thing. I think it will be easier once I know what grade I’ll be teaching, but I still…I don’t feel completely confident, but I feel like once I know the material, I can review it and I can be effective.

As with other responses from the preservice teachers interviewed for this study, Pat does not feel confident in his/her mathematical ability but still believes he/she will be an effective mathematics teacher.
Taylor: “Everything has some component of math in it”

The fifth preservice elementary teacher interviewed was Taylor, whose $D$-score classified him/her as “Somewhat underconfident” in his/her mathematical ability. This $D$-score implies that Taylor’s actual mathematical ability was stronger than his/her perceived mathematical ability. An overview of Taylor’s actual mathematical ability versus perceived mathematical ability for each of the four domains in the Common Core Standards is displayed in Table 16.

Table 16

<table>
<thead>
<tr>
<th>Domain</th>
<th>Level of perceived ability</th>
<th>$D$-score category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations and Algebraic Thinking</td>
<td>Much confidence</td>
<td>Underconfident</td>
</tr>
<tr>
<td>Numbers and Operations</td>
<td>Some confidence</td>
<td>Congruent</td>
</tr>
<tr>
<td>Measurement</td>
<td>Very little confidence</td>
<td>Somewhat underconfident</td>
</tr>
<tr>
<td>Geometry</td>
<td>Some confidence</td>
<td>Congruent</td>
</tr>
</tbody>
</table>

Taylor indicated he/she had “Much confidence” in his/her perceived mathematical ability in the domain of Operations and Algebraic Thinking. However, the $D$-score implies that Taylor’s actual mathematical ability is stronger than his/her perceived mathematical ability. When choosing his/her level of mathematics self-efficacy on Part I of the MCS-II, Taylor never selected “Complete confidence.” However, on five of the six items within the Operations and Algebraic Thinking Domain, Taylor received the highest possible score of 5. For the item on which he/she did not receive the highest
score, Taylor left the question blank. In fact, when asked how he/she felt solving this question, Taylor responded, “Yeah, I don’t think I did too hot on this one.” During the interview, Taylor stated that he/she felt comfortable solving problems within this domain but, based on his/her $D$-score, appeared to lack the confidence.

In the domain of Number and Operations, Taylor indicated he/she had “Some confidence” in his/her perceived mathematical ability and Taylor’s $D$-score showed congruency. Of the six items within this domain, Taylor indicated he/she had “Some confidence” on five of them. Of these five, there was only one question where his/her level of perceived ability matched his/her actual mathematical ability; the remaining four were divided evenly, with two having the highest score and two having the lowest score. Operations with fractions are within this domain and Taylor said he/she felt “…okay with them, but I had some difficulty when inverting and multiplying them.”

Within the domain of Measurement, Taylor indicated he/she had “Very little confidence;” the $D$-score indicated that he/she wasn’t too far off in his/her perception. When asked, during the interview, about converting within the metric system, Taylor said, “I’m terrible at those.” He/she had already indicated “No confidence at all” on Part I of the MCS-II and then received the lowest score on Part II of the MCS-II. On the other hand, on Part I of the MCS-II, when asked to measure the area of a two-dimensional figure using nonstandard units of measure, Taylor indicated he/she had only “Some confidence” in his/her mathematical ability, but then went on to received the highest score possible on this item on Part II of the MSC-II.
Within the domain of Geometry, Taylor indicated he/she had “Some confidence” in his/her mathematical ability and his/her $D$-score showed congruency. In fact, for both items within this domain, Taylor indicated he/she had “Some confidence”. On one of the items Taylor received the highest score and on the second item, he/she received the lowest score. For both questions, Taylor indicating his/her lack of confidence was with his/her inability to remember definitions, stating

Yeah, like I literally don’t know how to do that [pointing to one of the geometry questions]. I was terrible at it in school. Sorry I shut down on you. I just got frustrated. I was the last person in the class to work on it [the MCS-II] and I was just…I don’t know. It drained me.

Interestingly enough, Taylor received the highest possible score on the first 10 items of the MCS-II. However, he/she received the lowest possible score on five of six remaining items. When asked if there was a reason for this, Taylor said that when he/she got to the Geometry question labeling interior angles, he/she “just got frustrated and shut down.”

Taylor mentioned that mathematics was his/her favorite subject in school and believes his/her current lack of confidence comes from not performing mathematical tasks in a long time. Taylor stated he/she had a positive experience in elementary school with his/her second grade teacher. Although this experience was not math related, Taylor believes the qualities he/she saw in this teacher not only inspired him/her to go into teaching, it also helped model him/her into the type of teacher he/she wants to be. Taylor said this teacher “cared about the students.” This caring went further than just the students doing well in the classroom. Taylor personally remembers his/her teacher attending extracurricular events to show support, stating, “She cared about you as a person and not just another kid in her class.” Although Taylor could not recall any
positive experiences in mathematics, he/she could remember a negative experience from a teacher in sixth grade. When the teacher walked around the room to assist students while working, the teacher would make corrections using a pen.

One thing I really hated that my math teachers did was when they write on my paper in pen. Because that would be my paper that I had to turn in, and so it really bothered me, because it was [like] showing that I couldn’t do it.

Other than this one negative experience, Taylor continued to mention his/her liking of mathematics throughout the interview.

Influenced by his/her second grade teacher, Taylor wants to do his/her “best to reach every kid.” Taylor mentioned that he/she’s been in some classrooms where students were highly unmotivated when working on a specific task, no matter what the teacher did. Taylor stated that he/she is going to try his/her best to keep students motivated in the classroom, but is very nervous that he/she will not know what to do if “I can’t reach someone.”

As a mathematics teacher, Taylor believes he/she will excel as a mathematics teacher. Taylor stated he/she feels comfortable using manipulatives in the classroom as well as introducing multiple approaches to students who are having difficulty with a particular mathematics topic. When asked to describe the areas he/she was going to excel at as a mathematics teacher, Taylor stated,

I think one of the main things is that I know a lot of people have said that math is abstract to kids and that is why they don’t like it. It [math] makes them feel uncomfortable. So, even just making up a story to go along with the problem…to put people in the problem so it’s more familiar. So, I’ll try to do stuff like that. And using manipulatives…I don’t think there’s anything wrong with using manipulatives. If you solved the problem, you solved the problem. I don’t care how you get there. So, um, I mean like, eventually they would need to move
away from the manipulatives cause they would need to understand the concept, but to start with it…it’s never a bad thing.

Later in the interview, Taylor brings up the use of manipulatives again. When asked if he/she was a “fan” of using manipulatives, Taylor stated that he/she understands the problem that some people have with them, but if used the right way, they could be effective. Elaborating on the “right way”, Taylor stated,

You don’t want a kid stuck with it [manipulatives] and solely rely on them. You want them to kind of start with them, but then move on…to be able to do things mentally, or even like writing it out. So, I understand that, but…I don’t know. I think, to get the basics, it’s okay…as long as you’re growing.

Overall though, Taylor stated he/she feels very comfortable using manipulatives in the classroom.

During the interview, Taylor mentioned he/she understands that teaching will be challenging in the beginning. One of the fears he/she has is a student correcting him/her while he/she is doing a problem on the board. This fear could stem from Taylor’s sixth grade teacher making corrections directly on his/her paper. Another concern Taylor has is trying to motivate students. When asked about being able to motivate students who show low interest in mathematics, Taylor stated,

I mean, I would try my best. Like, if they liked a sport, I would try to relate it to that somehow, or…I mean everything has some component of math in it, I’m sure I could figure that out. So, just like relate it to them. And also, I just know to work with their parents…ask their parents what they are interested in at home…what do they like to do.

Here, Taylor believes including students’ outside interests into the mathematics classroom may help unmotivated students.
Concluding the interview, I asked Taylor if he/she thinks he/she will be able to teach mathematics effectively. Taylor said,

Yes. I think I’ll be an effective math teacher because I will try to motivate my students, find out what’s interesting to them. I will try to relate to them and not just care about their grades, but also of them as a person…to know that they are wanted in the classroom. I’m going to be patient so they can come up to me as many times as they need. Also, I will be willing to give them as many examples as they need and use alternative teaching methods as well as manipulatives…whatever it takes. I don’t care how long it takes for them to learn it, we’ll work on it together as long as it needs to be worked on.

Based on Taylor’s response, it is apparent that the positive and negative experiences he/she had in elementary school have shaped the type of teacher he/she wishes to be.

Hayden: “I’m going to be an effective math teacher; if I need to be.”

The sixth preservice elementary teacher interviewed was Hayden, having a $D$-score classifying him/her as “Somewhat underconfident” in his/her mathematical ability. This $D$-score implies that Hayden’s actual mathematical ability was stronger than his/her perceived mathematical ability. Table 17 gives an overview of Hayden’s perceived versus actual mathematical ability.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Level of perceived ability</th>
<th>$D$-score category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations and Algebraic Thinking</td>
<td>Some confidence</td>
<td>Somewhat underconfident</td>
</tr>
<tr>
<td>Numbers and Operations</td>
<td>Some confidence</td>
<td>Congruent</td>
</tr>
<tr>
<td>Measurement</td>
<td>No/very little confidence</td>
<td>Underconfident</td>
</tr>
<tr>
<td>Geometry</td>
<td>Very little/some confidence</td>
<td>Somewhat underconfident</td>
</tr>
</tbody>
</table>
In the Operations and Algebraic Thinking domain, Hayden indicated he/she had “Some confidence” in his/her mathematical ability. Based on the D-score, Hayden was “Somewhat underconfident”. Of the six questions on the MCS-II within this domain, Hayden never indicated he/she had “Complete confidence” solving. When asked to solve these six questions, Hayden received the highest score of 5 on four of them and received the lowest score of 1 on the remaining two questions. During the interview, Hayden stated he/she felt more confident solving the algebra questions rather than the questions dealing with geometry and measurement.

In the Numbers and Operations domain, Hayden indicated he/she had “Some confidence” in his/her mathematical ability. Based on the D-score, Hayden’s showed congruency. The MCS-II contains six questions within this domain. Hayden received the highest score of 5 on only one of the questions. Of the remaining five questions, Hayden received a score of 3 or lower. Operations with fractions are within this domain, and Hayden stated he/she feels confident with fractions. However, on the last question on the MCS-II, dealing with operations using fractions, Hayden received the lowest score of 1. When I brought this to his/her attention, Hayden stated,

Yeah. You know what…I think I was so burned out at this point. I mean, my brain was like fried and I didn’t really try. I can do it though.

Therefore, Hayden claims to be able to perform operations with fractions, but uses the excuse of his/her “brain being fried.”

Within the Measurement domain, Hayden indicated he/she had “No/very little confidence” in his/her mathematical ability. Hayden’s D-score indicated he/she was “Underconfident” in his/her mathematical ability. For both of the measurement questions
presented on the MCS-II, Hayden rated his/herself as having “No confidence at all” on Part I of the MCS-II. When asked to solve these questions, Hayden received a score of 4 on one of the questions and a score of 3 on the other. The question Hayden received a 3 on dealt with unit conversions. He/she understood the concept of moving the decimal point, but unfortunately didn’t move the decimal enough spaces. When asked how confident he/she felt answering the unit conversion question, Hayden replied that he/she did not feel confident, stating that the only way he/she could solve these types of problems would be to “google them.”

In the domain of Geometry, Hayden indicated he/she had “Very little/some confidence” in his/her mathematical ability. Hayden’s $D$-score indicated he/she was “Somewhat underconfident” in his/her mathematical ability. There are two questions on the MCS-II within this domain. For one of the questions, Hayden’s confidence matched his/her mathematical ability. For the second geometry question, Hayden indicated he/she had “Some confidence” answering. In fact, Hayden received the highest score of 5 on this question. When asked if he/she felt confident labeling angles, Hayden responded with an emphatic, “NO!” Hayden indicated he/she felt comfortable with some of the definitions (acute and obtuse), but was unclear of other definitions (reflex and interior).

Regarding mathematical ability, Hayden rated him/herself as “medium” on a scale of low-medium-high. When asked about this rating, Hayden referred to the MCS-II.

Because with this test, like the beginning page I was like, “I got this,” and I kept going. Then I was like, “I’m not getting this” as the test went on. Hayden indicated he/she feels comfortable with algebra, but stated, “Like, I’m probably done after Algebra.” On the contrary, Hayden does believe if he/she was able to “refresh
my memory and actually tried and sat down and solve steps, I’d be able to do it.”

Unfortunately, he/she stated, “Winging it like I did [on the survey], I wasn’t so confident.”

Hayden will be certified to teach kindergarten through grade twelve. He/she has never taken a mathematics education course and has only completed a College Algebra course to complete the general education requirement for mathematics. When asked the first word(s) that comes to mind when he/she hears the word mathematics, Hayden responded, “It stresses me out.” Hayden claimed that he/she could see how mathematics is useful, but feels that the learning of mathematics is pointless after a certain grade in school.

We were having this conversation yesterday, because I have math once a week [talking about his/her mathematics methods course Hayden took in the Spring 2014 semester] and in sixth grade you’re handed a calculator. So, all that stuff you’ve learned up to that point is kind of useless [be]cause you don’t have to have it in your memory. Again, plug it into your calculator, and all that other small steps, you don’t have to do anymore.

When I asked Hayden what he/she meant by the “small steps”, she responded,

Yeah, the small techniques to build on. My teacher [the instructor of the mathematics methods course] did long division yesterday and none of us knew how to do it. She [the instructor] had to sit up on the board and she was like, ‘Are you guys serious?’ We said if we could use our calculators we could do it. The last class I took was College Algebra from my freshmen year in college and I used my calculator for everything.

After making these comments, I asked Hayden if he/she believes it’s important for his/her future students to know procedures, i.e., to know the “small steps.” He/she did agree but could not elaborate. After a long pause, I continued with the interview.
Hayden couldn’t remember too many positive or negative experiences during his/her elementary school years regarding the learning of mathematics. Hayden did mention that he/she remember liking math, particularly fractions. In addition, Hayden remembered liking completing times tables. He/she mentioned liking the competition and trying to finish first. Hayden couldn’t remember any negative experiences in mathematics during his/her elementary school years.

During the interview, I asked Hayden to describe the areas he/she feels he/she will excel as a mathematics teacher. Hayden responded,

“I’m going to make sure my students know procedure…know how to do it…have those sample questions that I always refer back to, and they will have the correct answer. I’m not going to let them struggle and not get the correct answer and keep moving on and keep failing and not learning from their mistakes. I’m going to make sure, ‘here’s what you did wrong and here’s how we’re going to fix it’ type deal.

In Hayden’s previous comment, he/she mentioned procedure wasn’t that important because students are given a calculator at a certain grade. Interesting enough, in the comment above, Hayden is going to make sure his/her students know procedure.

When asked to describe the areas Hayden thinks he/she may struggle as a mathematics teacher, Hayden is fearful of not catching students that are failing. “I don’t want to leave a student behind and then have them…I feel like once you are behind, it’s so hard to keep up in math.” Hayden continued,

So you don’t want to…so once you’re behind, you can’t really catch up and then your confidence in math is down. So, that will be hard…if I don’t catch it [identifying student who are failing] as a teacher, that’s going to be horrible for my students.
In addition to this fear, Hayden is fearful he/she will not know the content when it comes
time to teaching. He/she mentioned, “I’m going to try to act confident,” and believes
he/she is not going to be perfect the first year teaching, but is sure that he/she will be able
to “pick it up” after his/her first year teaching. Hayden commented,

Not know the content. That is my biggest fear. Going up to the board and
blanking or getting the wrong answer in front of my students…that would be just
so embarrassing; and then they lose confidence in me too, you know? Like,
‘He/she can’t get it right, I can’t do it either.’ You know? Like, that worries me.

Although Hayden’s fear of not knowing the content is evident based on his/her statement
above, he/she believes learning the content will become “easier” after being in the field
for a couple of years.

Hayden stated he/she feels very confident using manipulatives and is planning to
implement them in the classroom when he/she begins teaching. In addition, Hayden feels
confident being able to implement alternative teaching strategies in his/her mathematics
classroom. Haden believes the experiences he/she had with her mathematic teachers in
the past has made him/her want to implement multiple approaches when teaching certain
topics. Because Hayden mentioned she might not feel confident with the content the first
couple of years teaching, I asked Hayden if he/she feels he/she will stick to the method
he/she is most familiar with when teaching a particular topic. Hayden responded,

I don’t think I’m going to do that because I hate when teachers do it. ‘Here’s the
way you do it.’ So, from my personal experience, I just feel like I would never do
it, just one way; because that’s not the way it worked for me and I know that all
students don’t learn the same way.

Hayden went on to say that because students don’t learn the same way, it may take
certain students longer to learn a certain mathematics topic than other students. He/she
believes that some students will just have to work a little harder at particular topics if they
“really want to learn math”. Because of this, Hayden believes much of student learning
comes from the quality of the teacher. I asked him/her to elaborate on some of the
qualities teachers of mathematics should have by asking Hayden if he/she feels able to
get his/her future students to believe they can do well in mathematics. The following
conversation occurred:

Hayden: Um…that’s a tough one. Don’t bash them for a wrong answer; and
don’t just mark an answer wrong with a big X. You should say, “Oh, you did
these steps right, but let me show you where you went wrong.”

Interviewer: So, you build their confidence at the beginning and then…

Hayden: Yeah. Just don’t say ‘Wrong’ and then just shatter their confidence and
make them hate math. Say, ‘Oh, you were so close. Let’s see what we can do to
improve this.’

In addition, Hayden believes teachers need to know their students and their outside
interests. He/she stated that a teacher needs to incorporate students’ interests into
mathematics problems to make them seem more interesting.

At the end of the interview, I asked Hayden if he/she has the belief to be an
effective mathematics teacher. He/she stated,

I think that over time I’ll become an effective teacher. I need to figure out what’s
going to work and what’s not going to work and I think that’s going to take time.
I think the first year or two is going to be rough. But I think that over time I’m
going to be an effective math teacher…If I need to be.

Even though Hayden believes the first couple of years are going to be difficult, he/he
firmly believes he/she will be an effective mathematics teacher.
Summary

Of the 42 elementary preservice teachers who completed Parts I & II of the MCS-II, 14 identified themselves as having low levels of mathematics self-efficacy. These 14 preservice teachers were the population of interest for this study. Based on the calculated $D$-scores of these 14 preservice teachers, two of them were identified as overconfident in their mathematical ability, five of them had shown congruency between their perceived mathematical ability and their actual mathematical ability, and seven of them were identified as underconfident in their mathematical ability. All 14 of these preservice teachers were invited to be interviewed; six agreed to participate in the interview process. Interviews were conducted in order to gain a deeper understanding of these elementary preservice teachers’ beliefs in their mathematical ability on being an effective mathematics teacher when they enter the classroom.

For kindergarten through grade three, there are four domains within the Common Core Standards: (1) Numbers and Operations, (2) Operations and Algebraic Thinking, (3) Measurement, and (4) Geometry. Within the Numbers and Operations domain, based on individual $D$-scores, four of the six preservice teachers showed congruency between their perceived mathematical ability and their actual ability. The two remaining preservice teachers were identified as underconfident in their actual mathematical ability based on their $D$-scores. While indicating a level of confidence with operations with fractions, the preservice teachers still offered a caveat (i.e., “I can perform operations with fractions, but I would need a calculator,” or “I’m okay with them [fractions], but I had difficulty when dividing them”).
Within the domain of Operations and Algebraic Thinking, four of the six preservice elementary teachers indicated they had “Some Confidence” solving the items presented on the MCS-II, with the two remaining preservice elementary teachers indicating they had “Much Confidence.” The $D$-scores of the preservice elementary teachers indicated that many of them were underconfident in their actual mathematical ability within this domain. During the interviews, many of the participants stated they felt comfortable with pattern recognition and solving equations containing integers.

Five of the six preservice teachers indicated they had “No/very little confidence” when solving problems within the Measurement domain, with one preservice teacher indicating he/she had “Very little confidence.” Individual $D$-scores within this domain were across the board, indicating three preservice teachers were underconfident, two were overconfident, and only one $D$-score indicating congruency in actual mathematical ability. Converting within the metric system appeared to be the most difficult item within this domain, with half of the preservice teachers receiving the lowest possible score by leaving blank answers.

Within the domain of Geometry, the levels of perceived mathematical ability were scattered. For the most part, the $D$-scores indicated that each preservice teacher’s perceived mathematical ability matched his/her actual mathematical ability. A number of preservice teachers had difficulty with labeling angle measures, claiming they had forgotten the definitions of reflex angles, interior angles, etc.

Of the six preservice teachers interviewed, half of them expressed negative experiences in mathematics during their elementary school years, saying they felt ignored
in the classroom, felt left behind, felt that their elementary teachers treating them as if they were “stupid,” and felt the material was presented in a “boring” manner. These same preservice teachers felt the “quality” of their elementary teachers was not at a high level and felt their elementary teachers tended to rush through the material. The preservice teachers who stated they had positive experience in mathematics during their elementary school years mentioned their elementary teachers seemed to “make math fun” and that these teachers seemed to care about their students by incorporating outside interests into the mathematics problems presented in class.

All of the six preservice elementary teachers who were interviewed believe they will be able to motivate students who show a low interest in mathematics; many of them stating that they would need to incorporate students’ outside interests into many of the mathematics lessons to try and lessen the “scariness” of a problem. However, they did not offer ideas on how they might bring this about. They also believe incorporating their students’ outside interests into the mathematics classroom will foster learning. In addition, some of the preservice teachers indicated that their past negative experiences may possibly help them in motivating students because they feel they would be able to relate to their students’ experiences.

All of the six preservice teachers stated they that after having used manipulatives they will feel comfortable using them in their classroom, with some of them mentioning they think manipulatives could build confidence. In addition, all of the six preservice teachers believe they will be able to implement alternative teaching strategies in the
classroom. Many of them believe allowing students to see different approaches could build confidence as well.

Many believe they will excel at understanding their students and their learning; some suggesting that their past negative experiences in mathematics will help them relate to the students who appear to be lagging in the understanding of the content. Many mentioned they plan on taking their time in class, making sure every student understands the material before moving on to the next topic. Four of the six preservice teachers believe their biggest struggle in the mathematics classroom will be their lack of mathematics content knowledge. Others expressed concerns about pedagogy, believing they will not know how to teach the mathematics. At the conclusion of each interview, the preservice teachers were asked if they believe they will be an effective mathematics teacher. Each responded positively, with half of the preservice teachers stating that it may take time. These teachers felt with repetition and more exposure to the material over time, they would feel more confident teaching mathematics.
Elementary school teachers play an important multi-faceted role in the education and development of children. In addition to managing the classroom, holding parent/teacher meetings, and attending workshops/conferences, elementary school teachers must develop and present lesson plans to effectively teach a diverse student population a variety of subjects such as mathematics, reading, science, and social studies. In the area of mathematics, research has shown that elementary students who are presented with a limited view of mathematics by their elementary school teachers are unlikely to be interested in mathematics in their future years (Reys & Fennel, 2003). Elementary teachers’ beliefs about mathematics and/or their level of mathematics self-efficacy, which has been shown to be a strong predictor of mathematical ability, contribute to the mathematical robustness, or lack of, that is presented to their students. In this study, I examined the beliefs of preservice elementary teachers with low levels of mathematics self-efficacy regarding their mathematical ability. In addition, I explored how having low levels of mathematics self-efficacy might affect preservice elementary teachers’ teaching effectiveness.
In Chapter V, I present the findings of this study as they relate to the research questions about whether or not the perceived mathematical ability of preservice elementary teachers with low levels of mathematics self-efficacy matches their actual mathematical ability, how they describe their mathematical ability, and their beliefs regarding being an effective mathematics teacher.

Quantitative Findings

Research Question #1: How closely, if at all, does the actual mathematical ability of elementary preservice teachers with low levels of mathematics self-efficacy match their perceived ability?

The first research question addressed the relationship between the actual mathematical ability and the perceived mathematical ability of preservice elementary teachers with low levels of mathematics self-efficacy. Specifically, I sought to see how closely, if at all, did the actual mathematical ability of elementary preservice teachers with low levels of mathematics self-efficacy match their perceived mathematical ability?

Part I (measuring mathematics self-efficacy) and Part II (measuring mathematical ability) of the MCS-II was administered to 42 preservice elementary teachers enrolled in a mathematics methods course offered in the College of Education.

Of the 42 preservice educators who participated, 14 were self-identified as having low levels of mathematics self-efficacy based on the results from Part I of the MCS-II. $D$-scores for each of the 14 preservice elementary teachers were calculated to categorize preservice teachers as overconfident, congruent, or underconfident in their actual mathematical ability. So, for example, if a preservice elementary teacher was categorized...
as congruent, this implied the actual mathematical ability matched the perceived mathematical ability, *regardless* of the level of their mathematical ability. Of the 14 preservice elementary teachers self-identified as having low levels of mathematics self-efficacy, five were categorized as congruent. Thus, these five preservice elementary teachers identified themselves as having low levels of mathematics self-efficacy and their *D*-scores indicate they do indeed have low levels of mathematical ability. The *D*-scores for the remaining nine preservice elementary teachers indicated that their actual mathematical ability did not match their perceived mathematical ability, with seven being underconfident and two being overconfident in their mathematical ability.

Regarding the seven preservice elementary teachers who were categorized as underconfident, this categorization implies their actual mathematical ability is stronger than their perceived ability. Although these preservice elementary teachers might seem to be in a better position to become effective teachers than the preservice elementary teachers categorized as congruent, research suggests otherwise. Individuals who lack confidence in skills they possess are not likely to engage in tasks in which those skills are required, and they will exert less effort and persistence in the face of difficulty (Ouweneel, Schaufeli, and LeBlanc, 2014; Pajares and Miller, 1994; Skaalvik and Skaalvik, 2011). Preservice elementary teachers who have exhibited some ability in mathematics but who have low levels of mathematics self-efficacy may be less likely to put the effort into further developing their mathematics skills in order to become effective mathematics teachers.
Qualitative Findings

*Research Question #2: How do preservice elementary teachers with low levels of mathematics self-efficacy describe their mathematical content knowledge?*

To investigate this question, the four domains presented in The Common Core Standards for Mathematics were used. These Standards outline what students from kindergarten through grade twelve should understand and be able to do in their study of mathematics. The four domains that are emphasized in kindergarten through third grade are Operations and Algebraic Thinking, Numbers and Operations, Measurement, and Geometry. Elementary teachers are expected to confidently and competently prepare students who are completing third grade to (1) solve problems involving the four operations (addition, subtraction, multiplication, and division) and identify patterns in arithmetic; (2) use place value understanding and properties of operations to perform multi-digit arithmetic, and develop an understanding of fractions as numbers; (3) understand the concept of area, and solve problems involving measurement and estimation of intervals of time, liquid volumes, including using standard units of grams, kilograms, and liters, and masses of objects; and (4) be able to reason with shapes and their attributes.

In addition to matching perceived mathematical ability to actual mathematical ability across all of the four domains, I investigated the perceived mathematical ability versus actual mathematical ability within each domain for each of the six preservice elementary teachers who were interviewed. To answer research question #2, the six preservice elementary teachers were asked to describe their mathematical content knowledge.
knowledge within each domain. Note that at the time of the interviews, the preservice elementary teachers had not been informed of their categorization (underconfident, congruent, or overconfident) of their mathematical ability. They did not know they had been selected because of this self-identification of their low levels of mathematics self-efficacy.

In the Operations and Algebraic Thinking domain there were seven items on the MCS-II. The median score on Part I for the six preservice elementary teachers was 3, indicating they had “Some confidence” in their ability to solve problems within this domain. Mathematics self-efficacy levels were chosen by each preservice elementary teacher before they had attempted to actually solve questions on Part II of the MCS-II. During the interview process, many of the preservice elementary teachers stated they feel comfortable when asked to solve equations with integer values. They provided comments such as:

- “Anything that’s more equation based, those are my forte.”
- “Like [sic] I’m probably done after Algebra.”
- “I feel more confident solving algebra questions rather than questions dealing with geometry and measurement.”

Interestingly, when these preservice elementary teachers had solved the questions on Part II of the MCS-II connected to this domain, the achieved median score was 5, the maximum possible score. This suggests that the above comments made during the interviews might be more indicative of their actual math ability (within this domain) than their self-assessment of having only “Some confidence.”
There were six items on the MCS-II connected to the Numbers and Operations domain. The median score on Part I for the six preservice teachers within this domain was 3, indicating they had “Some confidence” in their ability to solve problems. The thought of performing operations with fractions seemed to cause some discomfort for many of the preservice elementary teachers, based on their comments.

Although many of them stated they could successfully perform operations with fractions, a caveat was always provided (i.e., “I can perform operations with fractions, but I would need a calculator,” or “I’m okay with them [fractions], but I had difficulty when dividing them”). On average, when solving the items on Part II of the MCS-II within this domain, they achieved a median score of 2.5, indicating the level of mathematics self-efficacy closely matched their actual mathematical ability. Item 11 of the MCS-II (asking participants to order rational numbers) was the most commonly missed question, with five of the six preservice elementary teachers receiving the lowest score of 1. The struggles mentioned by the preservice elementary in this study is consistent with the findings from the recent research coming out of the Center for Improving Learning of Fractions (Jordan, et. al., 2013; Siegler, et. al., 2013).

In the Measurement domain there were two items (measuring the area of a polygonal shape using nonstandard units of measure and converting within the metric system) on the MCS-II. The median score on Part I for the six preservice elementary teachers was 1.5, indicating they had “No/very little confidence” in their ability to solve problems within this domain. This median score was the lowest for the four domains. Comments regarding converting within the metric system (item 13 on the MCS-II) were
uniformly self-disparaging. Some preservice elementary teachers stated they did not feel comfortable with conversions because they “had no idea how to do them.” Others did not remember converting within the metric system in their mathematics content course. One preservice teacher stated that answering the question had “something to do with moving the decimal point,” but was unclear of the direction the decimal point was to be moved and/or the number of places the decimal point was to be moved. While this comment indicates some mathematical knowledge, it suggests that the preservice elementary teacher might be relying on patterns rather than a deeper understanding of the concept.

When asked, in Part II, to actually solve the items within the Measurement domain, the preservice elementary teachers achieved a median score of 1.5, the same median score as Part I. This demonstrates that the level of mathematics self-efficacy matched their level of mathematical ability. The fact that the score for both Parts I and II within the Measurement domain of the MCS-II were so low aligned with what I expected. On a local scale, I have observed that many preservice elementary teachers struggle with understanding the need for metric conversions as well as the skill for converting within the metric system correctly. Even at the global scale, “results of national and international assessments indicate that U.S. students of all ages are significantly deficient in their knowledge of measurement concepts and skills” (Chapman & Johnson, 2006).

Item 7 on the MCS-II, dealing with the concept of area, did not seem to give the preservice elementary teachers any difficulty based on the high scores they received when demonstrating their actual mathematical ability.
Within the Geometry domain, the preservice elementary teachers achieved a median score of 2.5 on Part I, indicating they had “Very little/some confidence” in their ability to solve problems within this domain. Both questions in this domain asked participants to identify and label angles. During the interview process, the comments about labeling angle measures were overwhelmingly negative, with one preservice elementary teacher laughingly proclaiming, “Yeah, angles and I don’t get along. We’re not friends.” They also stated that they were unable to recall definitions for interior angles and reflex angles. When asked, in Part II, to actually solve the items within the Geometry domain, the preservice elementary teachers achieved a median score of 2.5, the same median score as Part I. This demonstrates that the level of mathematics self-efficacy matched their level of mathematical ability.

Research Question #3: In what ways, if at all, do preservice elementary teachers with low levels of mathematics self-efficacy believe their mathematical content knowledge will affect their teaching of mathematics?

To address this research question, the preservice elementary teachers who volunteered to be interviewed were asked about their beliefs on being an effective teacher once they enter the classroom. These questions included their beliefs about their abilities to (1) get students to believe they can do well in mathematics, (2) motivate students who show low interest in mathematics, (3) provide alternative explanations or examples when students are confused, and (4) implement alternative strategies. In addition, interview questions gave participants the opportunity to discuss their past experiences in
mathematics during their elementary school years and how these experiences affected their personal beliefs about mathematics.

Of the six preservice elementary teachers interviewed for this study, all of them believe they will be effective mathematics teachers. The findings of this study were consistent with the research conducted by Bates, Latham, and Kim (2011). The authors found that the early childhood preservice teachers who scored low on the Basic Skills Test mathematics section felt just as confident in their abilities to teach and affect student outcomes as those preservice teachers who scored high. The authors concluded that the lack of difference between the two groups seemed to imply that having higher scores, in regard to mathematical performance, does not affect confidence in teaching mathematics or influencing students’ learning.

Four of the six preservice elementary teachers did mention that their lack of content knowledge might be problematic when they enter the classroom but believe that over time, with more exposure to the content, they will feel more confident in their mathematics content knowledge. One of the preservice elementary teachers stated he/she has a fear of not knowing how to teach the material when it comes time to teaching, but feels that he/she will be well prepared before he/she teaches the material. For the most part though, many of the teachers feel that they will be effective mathematics teachers over time. They believe the first couple years are going to be challenging, but with more experience in the classroom, understanding student learning, and more exposure to the material, they feel they will be effective mathematics teachers even though their level of mathematics self-efficacy is low. These results are consistent
with the literature. In Esterly (2003), each of the preservice elementary teachers interviewed said that what affected their sense of efficacy to teach mathematics was their knowledge of mathematics. Swars (2004) found that preservice teachers with low levels of efficacy perceive that they would be effective mathematics teachers only with much time, work, and effort.

All of the preservice elementary teachers who were interviewed believe they will be able to implement alternative teaching strategies and implement manipulatives successfully when they enter the classroom. In my experience as an instructor of preservice elementary teachers, I found that many students were reluctant to use manipulatives in the beginning because they believed they were a “childish” way to teach a mathematical concept. Over time, I saw that many of them began to value the use of manipulatives and were able to understand the “how” and “why” of some concepts through the use of manipulatives.

All of the preservice elementary teachers in this study plan on using manipulatives in their future classes because they believe the use of these teaching tools could build confidence in students’ understanding of mathematics. There is a significant body of literature showing that manipulatives are effective in students’ learning of mathematical concepts (Freer-Weiss 2006; Moyer 2001; Raphael and Wahlstrom 1989). Some commented that one of the strengths of using manipulatives is for the students who are visual learners; this “hands-on” approach may allow students to understand a concept that they couldn’t have understood otherwise. Regarding implementing alternative teaching strategies in their future classroom, all of the preservice elementary teachers
stated they feel comfortable, but did not elaborate during the interview on how they would do so. Many stated that they would feel comfortable depending on the mathematical topic.

Five of the six preservice elementary teachers mentioned facing negative experiences during their elementary school years; whether it was feeling ignored in the classroom, feeling “stupid”, feeling their teachers rushed through the material, or feeling their teachers’ pedagogical approaches were ineffective. One of the reasons these preservice elementary teachers believe they will be effective mathematics teachers stems from their negative experiences during their elementary school years; they believe they will have more empathy and the ability to relate to the struggles some of their future students might have with the content. However, the connections, if any, between empathy and its contribution to increasing the level of their mathematics self-efficacy and mathematical ability were never verbalized. These comments of relating to students who seem to have difficulty with the material are consistent with the findings from previous literature (Swars, 2004).

Another reason these preservice elementary teachers believe they will be effective mathematics teachers is because they believe they will be able to motivate students who show a low interest in mathematics. Some of the preservice teachers mentioned getting to know their students’ outside interests and integrating them into the lesson plans. Others mentioned doing less individual board work and incorporating more group work involving games. One of the preservice elementary teachers believes he/she will be able to motivate future students who are less motivated in math because he/she will be able to
relate to the students by saying, “I am not a huge fan of math either, but here are some ways to do math and a way to make it seem not so scary.” While disconcerting, this point of view is not uncommon among preservice elementary teachers (Bianco, 2013).

Conclusions

According to Bandura (1986), if individuals lack the belief they can achieve a particular goal (in this study, learning mathematics), the less likely it is that individuals will implement the actions to strive for the goal. It seems obvious that the earlier preservice educators are made aware of the effects of having low levels of mathematics self-efficacy, the more time they have to reflect on their beliefs about their ability to “do” mathematics and to possibly change these beliefs. Otherwise, it is possible that, as Ma (1999) noted about the in-service elementary teachers she observed, “Not a single teacher…would promote learning beyond his or her own mathematical knowledge” (p. 54).

In this study, I found that 14 of 42 preservice elementary teachers identified themselves as having low levels of mathematics self-efficacy. As my research showed, seven of the 14 preservice elementary teachers with low levels of mathematics self-efficacy have higher mathematical ability than they realize. However, self-efficacy has been shown to be a better predictor of future behavior than actual ability, because it can influence what individuals do with the skills and knowledge they possess (Pajares, 2003). The research of Pajares indicated that there is value in raising the level of mathematics self-efficacy in preservice elementary teachers who identify themselves as having low levels of mathematics self-efficacy. The preservice elementary teachers in this study
self-identified themselves as having low levels of mathematics self-efficacy, but believe they will be effective mathematics teachers when they enter the classroom, but only after time and much effort. In addition, these same preservice elementary teachers stated that they had negative experience during their elementary school years. Therefore, it can be generalized that there are, and potentially will be, novice elementary teachers that will enter the classroom with (a) low levels of self-efficacy, (b) a lack of mathematical content knowledge, and (c) a lack of awareness of what their negative experiences during their elementary years could potentially do to their future students.

This self-efficacy finding is contrary to prior research indicating a positive correlation between self-efficacy and ability. In fact, in this particular area of elementary mathematics teaching, this correlation does not appear to exist.

Yet, attempts to raise these levels of mathematics self-efficacy by merely having the preservice elementary teachers “do more math” might not be sufficient. Other well-designed interventions need to be implemented to allow preservice elementary teachers to recognize, challenge, and reflect upon their level of mathematics self-efficacy.

Implications

In considering possible interventions, Philipp (2008) suggests that teachers need two types of mathematical knowledge, one having to do with mathematics content knowledge (typically provided in a mathematics content course) and the other having to do with the understanding of how children reason about mathematics (which might be provided in a mathematics methods course). In the restructuring of a mathematics content course at San Diego State University, Philipp questioned what it is that these
preservice elementary teachers care about in relation to mathematics teaching and learning. He concluded that these students enter teaching because they care deeply about children and thus approached his redesign of the mathematics content course with the goal of having the teachers care about mathematics for the sake of the children they would one day teach. Philipp indicated that there is value in “blurring” the supposed boundary between a mathematics method course and a mathematics content course.

For instance, in his redesigned mathematics content course, Philipp has the preservice elementary teachers view elementary children’s written work and watch video clips of young children solving mathematics problems to demonstrate that the approaches children use are often different from the approaches that the preservice elementary teachers would have used. According to Philipp, “separating the learning of mathematics from the consideration of issues of mathematics teaching and learning is counterproductive to their development of mathematical content knowledge and to the development of their beliefs about mathematics teaching and learning” (p. 7).

Of the 14 preservice elementary teachers identifying themselves as having low levels of mathematics self-efficacy, six of them volunteered to be interviewed. Interviews were conducted to examine the beliefs these preservice elementary teachers with low levels of mathematics self-efficacy have about the connection(s) between their mathematics content knowledge and their mathematics teaching effectiveness.

Based on the responses from the interviews, it is not clear how much these preservice elementary teachers recognize that their low levels of mathematics self-efficacy may affect their teaching effectiveness when they enter the classroom.
Concerning the preservice teachers in Bates’ study in 2011, he commented that “Perhaps those who scored lower [on the mathematics portion of the Basic Skills Test] do not realize the importance of their ability to perform mathematically in being able to teach mathematics” (p. 331). Without hesitation, all six of the preservice elementary teachers stated they will be effective mathematics teachers. However, as the interviews proceeded, five of the six admitted their biggest fear about teaching mathematics is a lack of mathematics content knowledge. This study indicates that the preservice elementary teachers with low levels of mathematics self-efficacy perceive their mathematics teacher efficacy to be high. Yet, studies have shown that if the levels of preservice elementary teachers’ mathematics self-efficacy are still low when they begin teaching, they may have a tendency to implement teacher-directed strategies, such as direct instruction or reading and performing examples from the textbook (Czerniak & Schriver, 1994; Hoy, 2000). These types of instruction have been shown to be ineffective in promoting student learning (Jones, 2003). In addition, if they begin their teaching experience with low levels of mathematics self-efficacy, they may demonstrate a lower persistence assisting students who seem to have difficulty with certain mathematics topics (Pajares & Miller, 1994).

Hoy and Woolfolk (1990) and Hoy (2000) noted that it is not unusual for preservice elementary teachers to have a high level of optimism about their teacher effectiveness while taking their undergraduate coursework. However, this level of optimism about teacher efficacy declines during student teaching when these novice teachers are faced with the realities and complexities of the teaching task. According to
Hoy (2000), although student teaching does provide opportunities to measure one’s effectiveness as a teacher, “when it is experienced as a sudden, total immersion, sink-or-swim approach to teaching, it is likely detrimental to building a sense of teaching competence” (p. 6). Thus, it seems important to find effective ways to expose these preservice elementary teachers to some of the realities of actual teaching during their undergraduate coursework rather than waiting until they observe in-service teachers or begin student teaching.

During the interview process, all of the preservice elementary teachers stated they have complete confidence using manipulatives when they begin teaching. Many of them stated that the strength of using manipulatives is that they could build confidence for those students who are having difficulty with a certain mathematical topic. Manipulatives are introduced to preservice educators at an early stage in their educational program. In fact, at the university where this study was conducted, they are introduced to them before they are admitted to The College of Education. A possible reason for the preservice elementary teachers’ confidence in using manipulatives is because of the early exposure to them. If this observation is accurate, then early exposure to the realities of teaching mathematics to children by viewing elementary children’s written work and/or watching videos of children solving mathematical problems may raise the level of mathematics self-efficacy and sustain the level of optimism about their teacher effectiveness.

Examining the levels of preservice elementary teachers’ mathematics self-efficacy at an early stage in their educational program in order to identify those with low levels of
mathematics self-efficacy could also be beneficial in raising their confidence. Possibly administering a survey to preservice elementary teachers while enrolled in their mathematics content course could identify the ones with low levels of mathematics self-efficacy early. This survey could be similar to the MCS-II, where preservice elementary teachers are first asked to rate their confidence solving certain mathematics problems and then asked to actually solve the same problems. It is not clear to me whether or not students should know the categorization of their mathematical ability or their level of mathematics self-efficacy. It would be important to measure the levels of their mathematics self-efficacy by administering the two-part assessment a number of times throughout the proposed redesigned mathematics content course and their mathematics methods courses.

Currently, the mathematics content courses at the university where this study was conducted are purely mathematics courses, where preservice educators are re-introduced to mathematical content they had seen in their mathematics courses while in grade school. I suggest that other teacher educational programs implementing similar types of instruction should consider redesigning the mathematics content course. According to Philipp (2008),

As effective as these [redesigned mathematics content] courses are for enhancing the mathematical content knowledge of prospective elementary school teachers, I believe that they can be even more powerful if instructors help their PST [preservice teachers] see how the mathematics content of the course applies directly to the world of teaching (p. 23).
This research study suggests teacher preparation programs to consider ways to integrate methods and mathematics field experiences earlier in the program; perhaps even blocking the experiences concurrently, if the campus structure allows it.

Philipp and his colleagues found that the preservice elementary teachers who studied children’s mathematical thinking while learning mathematics developed more sophisticated beliefs about mathematics, teaching, and learning and improved their mathematical content knowledge (Philipp et al., 2007).

In this study, I also found that the negative elementary school experiences of five of the six preservice elementary teachers were very impactful. They made it quite clear that they didn’t want to see their students suffer similar experiences; they indicated that they will be effective teachers because of (rather than despite) these negative experiences. They also believe they will be able to relate to the students who appear to have some difficulties with mathematics because of what they had experienced during their elementary school years.

According to a study conducted by Brady and Bowd (2005), preservice elementary teachers identified two aspects of their previous experiences with formal mathematics instruction that had, in their opinion, contributed to the quality of their experience with mathematics: (a) the pedagogical techniques employed, and (b) the attitude of the instructor towards his/her students. These same aspects were seen in my study, with the preservice elementary teachers feeling ignored in the classroom, feeling “stupid”, feeling their teachers rushed through the material, or feeling their teachers’ pedagogical approaches were ineffective. Although the preservice elementary teachers
who were interviewed for this study felt that the negative experiences would make them better teachers, Brady and Bowd’s research indicated something quite different. They concluded, “the perception on the part of many respondents [who had gone through negative experiences in elementary school] that their mathematics education had not prepared them to teach the subject confidently [is] a condition that has the potential to be replicated in their students. If this cycle is to be broken, then further research and changes into the nature of mathematics education at a variety of levels of instruction need to be made” (p. 45).

Past negative experiences have made a powerful impact on these preservice elementary teachers, yet they believe they will be effective mathematics teachers over time. It is interesting to note that not one of them seemed to consider the possibility that, in the interim, they might be responsible for creating the same negative experiences for their students that they experienced in elementary school and disliked. Little research has been found that addresses the impact on elementary students that first year teachers who have been profoundly impacted by their own negative experiences will have. It is unclear how much the level of mathematics self-efficacy is related to these preservice elementary school teachers’ negative experiences. But, if, as the findings from this study suggests, it is important to raise the level of mathematics self-efficacy, a future study might explore the impact on mathematics self-efficacy of helping these preservice elementary teachers reflect on and reframe their negative experiences in positive, realistic ways (Clemson, 2008). In fact, in Philipp’s (2008) redesigned mathematics content course, in addition to having preservice teachers become more involved in the ways
children learn mathematics, he encourages his preservice elementary teachers to share their personal struggles with learning mathematics.

Future Research

The participants in this study were preservice elementary teachers having low levels of mathematics self-efficacy. As elementary school teachers, they will be required to teach a wide range of subjects, not just mathematics. It would be interesting to conduct the same study to preservice middle school and/or preservice high school teachers who have selected mathematics as one of their areas of concentration.

There is a need to interview preservice elementary teachers having high levels of mathematics self-efficacy and with differing levels of mathematical ability. Would similar themes emerge? Would the preservice elementary teachers with high levels of mathematics self-efficacy recall the same experiences, either positive or negative, from elementary school as did the preservice teachers in this study?

The participants in this study were not given their results from the MCS-II and therefore were not informed as to how they had been classified. It would be interesting to see how their perceptions of their mathematical ability or teaching effectiveness would have been impacted if they had known their classification before the interview began. Furthermore, would they have revised their comments if they had been given their categorizations at the end of the interview and were then asked to reflect upon that information?

It would be valuable to conduct a longitudinal study with these same participants to examine their levels of mathematics self-efficacy, content knowledge, and
mathematics teacher efficacy after one year in the classroom, and then after two years in the classroom.

The preservice elementary teachers from this study believe that it will take some time and effort before they are able to be effective mathematics teacher; but it is during these “apprentice” years that they are the most likely to be responsible for creating with their students the kinds of negative experiences that they had during their elementary years. Yet, none of them seems to be aware of the possibility of “doing to their students what was done to them.” As is clear from the interviews, this topic is significant and must be addressed early in the preservice teachers’ academic programs so they are made aware of the impact negative experiences may have on their students’ learning of mathematics in the future.

Research indicates that preservice elementary teachers who reported stronger beliefs in their capabilities to teach mathematics effectively were more likely to have more confidence in solving mathematics problems (Briley, 2012). Yet, the participants in my study expressed high confidence in their teaching ability even though they have little confidence in their mathematical ability. It was not clear to me if these preservice elementary teachers had reflected upon the inconsistency between their low confidence in their mathematical ability with their perception of high confidence in their teaching effectiveness. Future studies need to be conducted to determine if confidence alone is a predictor of being an effective mathematics teacher.
REFERENCES


Enon, J. C. (1995). *Teacher efficacy: Its effects on teaching practices and student outcomes in mathematics.* (Unpublished University of Alberta,


APPENDICES
APPENDIX A

PART I OF MSC-II

Email Address: ________________________

Directions: This survey is intended to measure your confidence level for solving various mathematical problems. You do **NOT** have to solve the problems.

Suppose you were asked the following 16 questions. Indicate how confident you are that you would give the correct answer to the question. For each question, circle the letter that expresses your **DEGREE OF CONFIDENCE**. Do not spend much time thinking about the problem - about 10 seconds per problem should be enough. Do **NOT** solve the problems.

1. Use the order of operations to evaluate the following expression:

   \[12 \times (8 - 6) - 15 + 27 \div 9 \times 2 + 9 \div 1\]

   (A) no confidence at all   (B) very little confidence   (C) some confidence   (D) much confidence   (E) complete confidence

2. Find the missing numbers for each equation.

   (a) \[4 + \square = -10\]   (b) \[-3 - \square = 7\]
   (c) \[-6 \times \square = 12\]   (d) \[-15 \div \square = -3\]

   (A) no confidence at all   (B) very little confidence   (C) some confidence   (D) much confidence   (E) complete confidence

3. The measure of \(\angle R\) is 37°. If \(\angle R\) and \(\angle S\) are complementary, what is the measure of \(\angle S\)?

   (A) no confidence at all   (B) very little confidence   (C) some confidence   (D) much confidence   (E) complete confidence
4. When a teacher counted her students in groups of 4, there were two students left over. When she counted them in groups of 5, she had 1 student left over. If 15 of her students are girls and she had more girls than boys, how many students did she have?

<table>
<thead>
<tr>
<th></th>
<th>(A)</th>
<th>(B)</th>
<th>(C)</th>
<th>(D)</th>
<th>(E)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>no confidence at all</td>
<td>very little confidence</td>
<td>some confidence</td>
<td>much confidence</td>
<td>complete confidence</td>
</tr>
</tbody>
</table>

5. Below are figures created using toothpicks.

```
  1st    2nd    3rd    4th
/ \            / \    / \   / \  \
```

(a) Draw the 5th figure.

<table>
<thead>
<tr>
<th></th>
<th>(A)</th>
<th>(B)</th>
<th>(C)</th>
<th>(D)</th>
<th>(E)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>no confidence at all</td>
<td>very little confidence</td>
<td>some confidence</td>
<td>much confidence</td>
<td>complete confidence</td>
</tr>
</tbody>
</table>

(b) Write directions for constructing the 8th figure so that someone who has not seen any of the previous figures could build the figure by following your directions.

<table>
<thead>
<tr>
<th></th>
<th>(A)</th>
<th>(B)</th>
<th>(C)</th>
<th>(D)</th>
<th>(E)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>no confidence at all</td>
<td>very little confidence</td>
<td>some confidence</td>
<td>much confidence</td>
<td>complete confidence</td>
</tr>
</tbody>
</table>

6. The prime factorization of 308 is $2 \times 2 \times 7 \times 11$. Find the prime factorization of 1170.
7. Measure the figure shown below using the nonstandard unit of area shown in (a).

8. Ramon took a collection of colored tiles from a box. Amelia took 13 tiles from his collection. Kelko took half of those remaining. Ramon had 11 tiles left. How many tiles did Ramon start with?

9. Given the representation, what fraction is illustrated if represents the unit?
10. Given the polygon below:

![Polygon Diagram]

(a) Which interior angles, if any, are acute?
(b) Which interior angles, if any, are obtuse?
(c) Which interior angles, if any, are reflex angles?

<table>
<thead>
<tr>
<th>(A)</th>
<th>(B)</th>
<th>(C)</th>
<th>(D)</th>
<th>(E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No confidence</td>
<td>very little</td>
<td>some</td>
<td>much</td>
<td>complete</td>
</tr>
<tr>
<td>at all</td>
<td>confidence</td>
<td>confidence</td>
<td>confidence</td>
<td></td>
</tr>
</tbody>
</table>

11. Write the numbers below in order of increasing size.

\[
\frac{9}{20}, \quad 0.35, \quad \frac{19}{42}
\]

<table>
<thead>
<tr>
<th>(A)</th>
<th>(B)</th>
<th>(C)</th>
<th>(D)</th>
<th>(E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>no confidence</td>
<td>very little</td>
<td>some</td>
<td>much</td>
<td>complete</td>
</tr>
<tr>
<td>at all</td>
<td>confidence</td>
<td>confidence</td>
<td>confidence</td>
<td></td>
</tr>
</tbody>
</table>

12. Mike has 20 strips of wood molding that are each 70 inches long and 6 pieces that are each 28 inches long. He wants to cut all these strips so that each piece has the same length and no wood is left. What is the longest possible length that can be cut?

<table>
<thead>
<tr>
<th>(A)</th>
<th>(B)</th>
<th>(C)</th>
<th>(D)</th>
<th>(E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>no confidence</td>
<td>very little</td>
<td>some</td>
<td>much</td>
<td>complete</td>
</tr>
<tr>
<td>at all</td>
<td>confidence</td>
<td>confidence</td>
<td>confidence</td>
<td></td>
</tr>
</tbody>
</table>

128
13. Convert the following:

(a) $327.8 \text{ cm} = \underline{\quad} \text{ km}$

(b) $0.237 \text{ L} = \underline{\quad} \text{ mL}$

(c) $78.25 \text{ kg} = \underline{\quad} \text{ g}$

<table>
<thead>
<tr>
<th>(A)</th>
<th>(B)</th>
<th>(C)</th>
<th>(D)</th>
<th>(E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>no confidence at all</td>
<td>very little confidence</td>
<td>some confidence</td>
<td>much confidence</td>
<td>complete confidence</td>
</tr>
</tbody>
</table>

14. Calculate $8.21 \div 2.3$.

<table>
<thead>
<tr>
<th>(A)</th>
<th>(B)</th>
<th>(C)</th>
<th>(D)</th>
<th>(E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No confidence at all</td>
<td>very little confidence</td>
<td>some confidence</td>
<td>much confidence</td>
<td>complete confidence</td>
</tr>
</tbody>
</table>

15. In the figure below, the bold square represents the unit. $B$ is what fraction of the bold square?

```
A
B
C
D
```

<table>
<thead>
<tr>
<th>(A)</th>
<th>(B)</th>
<th>(C)</th>
<th>(D)</th>
<th>(E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>no confidence at all</td>
<td>very little confidence</td>
<td>some confidence</td>
<td>much confidence</td>
<td>complete confidence</td>
</tr>
</tbody>
</table>

16. Calculate $\left(\frac{3}{4} \div 6\right) + \frac{2}{3}$.

<table>
<thead>
<tr>
<th>(A)</th>
<th>(B)</th>
<th>(C)</th>
<th>(D)</th>
<th>(E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>no confidence at all</td>
<td>very little confidence</td>
<td>some confidence</td>
<td>much confidence</td>
<td>complete confidence</td>
</tr>
</tbody>
</table>
APPENDIX B

PART II OF MCS-II

Directions: This survey is intended to measure your problem solving ability for various mathematical problems. For each, circle final answers and please show all of your work.

1. Use the order of operations to evaluate the following expression:
   \[12 \times (8 - 6) - 15 + 27 \div 9 \times 2 + 9 \div 1\]

2. Find the missing numbers for each equation.
   (a) \(4 + \square = -10\)
   (b) \(-3 - \square = 7\)
   (c) \(-6 \times \square = 12\)
   (d) \(-15 \div \square = -3\)

3. The measure of \(\angle R\) is 37°. If \(\angle R\) and \(\angle S\) are complementary, what is the measure of \(\angle S\)?
4. When a teacher counted her students in groups of 4, there were two students left over. When she counted them in groups of 5, she had 1 student left over. If 15 of her students are girls and she had more girls than boys, how many students did she have?

5. Below are figures created using toothpicks.

1st | 2nd | 3rd | 4th

(a) Draw the 5th figure.

(b) Write directions for constructing the 8th figure so that someone who has not seen any of the previous figures could build the figure by following your directions. **Please be specific.**

6. The prime factorization of 308 is $2 \times 2 \times 7 \times 11$. Find the prime factorization of 1170.
7. Measure the figure shown below using the nonstandard unit of area shown in (a).

8. Ramon took a collection of colored tiles from a box. Amelia took 13 tiles from his collection. Keiko took half of those remaining. Ramon had 11 tiles left. How many tiles did Ramon start with?

9. Given the representation, what fraction is illustrated if \( \frac{1}{2} \) represents the unit?
10. Given the polygon below:

(a) Which interior angles, if any, are acute?

(b) Which interior angles, if any, are obtuse?

(c) Which interior angles, if any, are reflex angles?

11. Write the numbers below in order of increasing size.

\[
\begin{align*}
\frac{9}{20} & \quad 0.45 & \quad \frac{19}{42}
\end{align*}
\]

12. Mike has 20 strips of wood molding that are each 70 inches long and 6 pieces that are each 28 inches long. He wants to cut all these strips so that each piece has the same length and no wood is left. What is the longest possible length that can be cut?
13. Convert the following:

(a) 327.8 cm = __________ km

(b) 0.237 L = __________ mL

(c) 78.25 kg = __________ g

14. Calculate $8.211 \div 2.3$.

15. In the figure below, the bold square represents the unit. $B$ is what fraction of the bold square?

![Diagram of a grid with labeled sections A, B, C, D]

Answer: __________

16. Calculate $\left(\frac{3}{4} \div 6\right) + \frac{2}{3}$. 

134
APPENDIX C

INTERVIEW PROTOCOL

Interview Protocol

To examine participant’s perceived mathematical ability:
1. The Interview Consent form will be signed.
2. **A blank version of the instrument (used to examine participants’ mathematical ability) will be shown to each participant to remind them of the instrument.**
3. How do you feel with your overall performance on the questions?
4. Were there particular problems about which you felt highly confident after you solved the problem? Why did you feel confident?
5. Were there particular problems about which you felt less confident after you solved the problem? Why did you feel less confident?
6. How do you rate yourself “ability-wise” in mathematics? Low/Medium/High
7. On what evidence do you base your ranking of yourself?

To examine participants’ beliefs of mathematics and their possible teaching effectiveness:
7. What is the first word that comes to your mind when I say, “Mathematics”.
8. What are your overall feelings about mathematics?
9. How would you describe your experiences in mathematics during your elementary school years?
   a. Tell me about your favorite teacher in grade school.
   b. I’d also, if you’re willing, to know something about your least favorite teacher.
10. How do you prepare for a mathematics exam?
11. Would you rather do an assignment in mathematics or write an essay? Why?
12. Can you give me some examples of how mathematics is used in everyday life?
13. Describe the areas that you feel you will excel as a teacher.
14. Describe the areas where you think you might struggle.
15. Describe some of your fears about math? About the classroom? About teaching?
16. Do you feel you will be able to motivate students who show low interest in mathematics?
17. To what extent can you get your students to believe they can do well in mathematics?
18. If you, as her teacher, were to say that Mary’s mathematics knowledge is good, what does that mean to you?

19. Tell me about your views on the importance of your future students learning “math facts”/Gaining conceptual understanding?

20. I am going to ask you to describe some of your beliefs about mathematics as it relates to classroom learning.
   a. Does it take a mathematical mind to do well in math?
   b. Does effort (as opposed to ability) help in mathematics learning?
   c. Are there some kids who “just can’t get math?”
   d. What do you think about the statement that “Learning mathematics will take a long time”?

21. To what extent do you believe that what a student gets out of mathematics lessons depends on the quality of the teacher?

22. How do you feel about the statement, “If a student cannot understand something in a mathematics lesson quickly, it usually means he/she will never understand it”?

23. I am now going to ask you several questions about your beliefs about your use of instructional strategy abilities.
   a. How well do you think you will be able to implement alternative mathematics teaching strategies in your classroom?
   b. How comfortable do you feel using manipulatives when teaching a math lesson?
   c. How able will you be to provide an alternative explanation or example if a student of yours is confused with a particular mathematical concept?

24. Do you believe you will be able to teach mathematics effectively? Why or why not?

**Interview questions are based on the Teaching Self-Efficacy Scale and the Attitude Towards Mathematics Inventory**
APPENDIX D

CONSENT FOR PARTICIPATION (SURVEY)
Dear Participant:

My name is Lance Nelson. I am a doctoral student in the College of Education, Curriculum and Instruction program at the University of Akron. I would like to request your participation in a study that will explore mathematics efficacy and ability in preservice elementary teachers. Of particular interest to my study will be the perceptions preservice mathematics teachers have regarding their ability and how they could affect their teaching.

I am asking your permission to complete a survey measuring your mathematics confidence as well as your mathematical ability. If you agree to participate, please sign this form. Your participation in this study is voluntary, and you are free to withdraw from participation at any time. Any identifying information collected will be kept in a secure location and only the researchers will have access to the data. Participants will not be individually identified in any publication or presentation of the research results. Your signed consent form will be kept separate from your data, and nobody will be able to link your responses to you.

If you have any questions related to this study, you can contact me at (330) 972-6074 or ldn2@uakron.edu or Dr. Lynne Pachnowski at (330) 972-7115 or lmp@uakron.edu. If you have any questions concerning your rights as a participant in this study, you may contact the Institutional Review Board at (330) 972-7666.

Sincerely,

Lance Nelson

____________________________
Signature: ________________________________ Date: ________________________________

I agree to participate in the project exploring mathematics efficacy and ability. Lance Nelson has explained the purpose of the study and the procedures to be followed. I understand that I am free to withdraw at any time and to discontinue participation in the study without prejudice. Finally, I acknowledge that I have read and fully understand this form. I sign it freely and voluntarily. A copy has been given to me.
APPENDIX E

CONSENT FOR PARTICIPATION (INTERVIEW)
Dear Participant:

Thank you for completing the Mathematics Confidence Scale. The data you have provided will be valuable to my study. To gain a deeper understanding of preservice elementary educators’ ability and teacher efficacy in mathematics, I am asking permission for a personal interview.

The interview will last approximately thirty minutes. Questions are created to examine the perceptions you may have regarding your ability in mathematics and how it could affect your teaching efficacy. If you agree to participate, please sign this form. Your participation in this study is voluntary, and you are free to withdraw from participation at any time. Any identifying information collected will be kept in a secure location and only the researchers will have access to the data. Participants will not be individually identified in any publication or presentation of the research results. Your signed consent form will be kept separate from your data, and nobody will be able to link your responses to you.

If you have any questions related to this study, you can contact me at (330) 972-6074 or ldn2@uakron.edu or Dr. Lynne Pachnowski at (330) 972-7115 or lmp@uakron.edu. If you have any questions concerning your rights as a participant in this study, you may contact the Institutional Review Board at (330) 972-7666.

Sincerely,

Lance Nelson

---

I agree to participate in the project exploring mathematics efficacy and ability. Lance Nelson has explained the purpose of the study and the procedures to be followed. I understand that I am free to withdraw at any time and to discontinue participation in the study without prejudice. Finally, I acknowledge that I have read and fully understand this form. I sign it freely and voluntarily. A copy has been given to me.

Signature: ___________________________ Date: ___________________
APPENDIX F

IRB NOTICE OF APPROVAL

October 18, 2010

Lance Nelson
2596 6th Street
Cuyahoga Falls, Ohio 44221

From: Sharon McWhorter, IRB Administrator

Re: IRB Number 20101009 "A Study Exploring the Ways Preservice Elementary Educators with Low Levels of Efficacy Believe their Mathematical Ability Will Affect Their Mathematics Teaching Efficacy Using a Case Study"

Thank you for submitting your IRB Application for Review of Research Involving Human Subjects for the referenced project. Your application was approved on October 18, 2010. Your protocol represents minimal risk to subjects and matches the following federal category for exemption:

☐ Exemption 1 - Research conducted in established or commonly accepted educational settings, involving normal educational practices.

☐ Exemption 2 - Research involving the use of educational tests, survey procedures, interview procedures, or observation of public behavior.

☐ Exemption 3 - Research involving the use of educational tests, survey procedures, interview procedures, or observation of public behavior not exempt under category 2, but subjects are elected or appointed public officials or candidates for public office.

☐ Exemption 4 - Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens.

☐ Exemption 5 - Research and demonstration projects conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine public programs or benefits.

☐ Exemption 6 - Taste and food quality evaluation and consumer acceptance studies.

Annual continuation applications are not required for exempt projects. If you make changes to the study's design or procedures that increase the risk to subjects or include activities that do not fall within the approved exemption category, please contact me to discuss whether or not a new application must be submitted. Any such changes or modifications must be reviewed and approved by the IRB prior to implementation.

Please retain this letter for your files. This office will hold your exemption application for a period of three years from the approval date. If you wish to continue this protocol beyond this period, you will need to submit another Exemption Request. If the research is being conducted for a master’s thesis or doctoral dissertation, the student must file a copy of this letter with the thesis or dissertation.

☐ Approved consent form/s enclosed

Cc: Lynn Pachnowski - Advisor
Cc: Stephanie Woods - IRB Chair

Office of Research Services and Sponsored Programs
Akron, OH 44325-2102
330-972-7666 • 330-972-6281 Fax

The University of Akron is an Equal Education and Employment Institution
APPENDIX G

FACTOR ANALYSIS (SCREE PLOT)