STUDENT HEURISTICS AND SUCCESSFUL IMPLEMENTATION OF
SELF-REGULATION STRATEGIES OF LEARNING: MIXED METHODS APPROACH

A thesis presented
by
Linda S. McSweeney
to
The School of Education
In partial fulfillment of the requirements for the degree of
Doctor of Education
in the field of
Education

College of Professional Studies
Northeastern University
Boston, Massachusetts
November 2013
Abstract

The lack of fourth grade student math achievement at the local and district levels has caused considerable concern for all stakeholders. The statistical representation of the achievement gap defined by socioeconomic levels and subgroup analysis has not provided a comprehensive representation of the reasons students fail to achieve. Research findings reflect an increased awareness that the disparity among groups can be influenced by students’ ability to direct their learning. This work offers an opportunity to examine and extend research findings to focus on students’ ability to manage their learning and actively direct the learning and assessment process.

The purpose of this mixed methods study was to explore the question that if students became the managers of their mathematical learning (using the method of self-regulation, analysis of meta-cognitive reflection, and self-assessment), would a measurable positive gain in mathematical achievement result? Application of a social cognitive lens would expand research to further examine the factors to which fourth grade students from different mathematical achievement levels attribute success or failure. The transformation from a teacher-directed assessment to a student self-assessment was implemented here by having students graph individual mathematical performance from formative assessments throughout one math unit. Currently, the teacher is grading student performance without instituting a self-assessment component within the math unit of study. For this mixed methods study, qualitative data was gathered from 23 students within a self-contained classroom. Participating students were asked to respond to questions that focused on self-regulation for learning, mathematical problem solving, and efficacy. Self-selected parent participants of students studied were asked to respond to questions that explored mathematical experiences, support provided, and influence of goal
setting. Additionally, the teacher participant was asked to share math training and background, perceived student changes during the study, and influence of goal setting. Quantitative data was gathered using a pretest-posttest non-equivalent groups design during an eleven-week unit of mathematical study.

The teacher-student dynamic within a math classroom yields valuable information regarding the implementation of self-regulated strategies and performance levels. Clearly, it is within the dynamic exchange of ideas and understanding of each student’s construction of knowledge, self-regulated strategies, and self-assessment that solid evidence can be ascertained to pinpoint factors that can potentially narrow the mathematical achievement gap. The prime research questions for this investigation are: 1) To what factors do students from different achievement levels attribute their successes or failures? and 2) What effect would a self-assessment tool have on student performance?

Keywords: self-regulation for learning, self-assessment, efficacy, mathematics, elementary students.
It is with heartfelt gratitude that I wish to express my thanks to the key partners in this journey to improve my educational practices and intellectual development through this project. My research has been an incredible experience that will remain an important part of my professional practice. It is my hope that other scholars will find benefit and use this study to extend research. This project has affirmed my commitment and motivation to consistently seek evidence-based instructional practices that can help all children obtain academic excellence.

Along this journey, I have had the amazing opportunity to work with a number of dedicated and highly skilled professionals. First, I would like to thank my committee members, Dr. Francis Connor, Dr. Al McCready, and Dr. Stacey Kaminski. As my mentors and advisors they were the driving force that kept me focused and self-reflective, always wanting me to strive for thoughtful reflection and providing constructive feedback that was invaluable. There were times when I felt that this work was difficult and arduous in relation to all that was happening in my life professionally and personally. Yet, each advisor was there to encourage and guide me by gently pushing and probing to make me realize that this study was worthy of scholarly consideration and should be done.

I deeply appreciate the students that so willingly shared their thoughts and insights into the learning process. They were truly motivational and a joy to work with as I completed each round of interviews. Additionally, I thank the master teacher and parents who willingly shared their perceptions and understandings.

A special thank you goes to my husband, Michael McSweeney, who loved me, encouraged me, and expressed his pride in each of my accomplishments big or small. For him there was much sacrifice of time and attention that he lovingly accepted. He did his best to make
it easy for me to focus on this project by carrying a majority of the familial responsibilities to lighten my load. The work would not have been completed without his generosity of time and flexibility. I also want to acknowledge my children, John and Sara, for understanding my focus on this work. There were many missed family gatherings and missed vacations so that this work could be completed. Thank you and I love you. Finally, a thank you to my parents, Ivan and Jeanne Kolarik, who modeled what hard work and commitment can accomplish.
# TABLE OF CONTENTS

ABSTRACT .................................................................................................................. 2

ACKNOWLEDGEMENTS ............................................................................................. 4

CHAPTER 1 - INTRODUCTION

  Statement of Problem .............................................................................................. 8
  Significance of the Problem ...................................................................................... 13
  Practical and Intellectual Goals ............................................................................ 15
  Research Questions (Summary) ............................................................................ 16
  Contents and Organization .................................................................................... 17
  Theoretical Framework ......................................................................................... 18

CHAPTER 2 - LITERATURE REVIEW ........................................................................ 28

  Historical Perspective: Achievement Gap ........................................................ 29
  Learning Strategies ................................................................................................ 37
  Students’ Roles in the Learning Process ............................................................... 43
  Self-regulation of Learning .................................................................................... 45
  Self-regulation of Learning and Application to Mathematics ......................... 46
  Self-efficacy for Self-Regulated Learning ............................................................. 49
  Literature Review Conclusions .......................................................................... 51

CHAPTER 3 – RESEARCH DESIGN .......................................................................... 53

  Methodology .......................................................................................................... 53
  Site and Participants ............................................................................................... 56
  Data Collection ....................................................................................................... 58
  Data Analysis .......................................................................................................... 61
Reflective Strategies.................................................................64
Validity and Reliability..........................................................64
Researcher Biases.................................................................68
Reactivity.............................................................................71
Protection of Human Subjects..............................................72
Conclusion............................................................................73

CHAPTER 4- REPORT OF RESEARCH FINDINGS.........................75
Methodology.........................................................................76
Analysis of Study Participants and Profiles............................77
Qualitative Data Collection Procedures and Key Findings........77
Student Interviews...............................................................81
Parent Interviews................................................................106
Teacher Interviews..............................................................117
Quantitative Data Collection Procedures and Key Findings......130
Discussion of Findings.........................................................136
Summary of Key Findings.....................................................138

CHAPTER 5 –DISCUSSION OF RESEARCH FINDINGS..................144
Implications of Findings.......................................................145
Limitations of Study............................................................148
Recommendations for Future Research.................................151
Conclusion............................................................................155

REFERENCES.......................................................................159

APPENDICES.......................................................................171
Chapter 1

Statement of Problem

Mathematical achievement and subsequent growth gains as evidenced in both high stakes testing results and formative assessments demonstrates an achievement gap that impedes student’s success in attaining the necessary skills to build a solid math foundation. Mathematical knowledge and achievement are the cornerstones of a solid educational experience for students and are necessary in the ever-changing dynamics of a technological global environment. “As information becomes ever more quantitative and as society relies increasingly on computers and the data they produce, an innumerate citizen today is as vulnerable as the illiterate peasant of Gutenberg’s time” (Steen, as cited in Van De Walle, Karp and Bay-Williams, 2010 p. 9). Analysis of testing data for this rural southeastern elementary school in Massachusetts indicates that math achievement for fourth grade students continues to fall below state proficiency levels. To protect the identity of the research participants and confidentially of this public school, “Alpha Elementary School” (AES) was used. The protection of confidential information and rights of the participants were strictly adhered to and the identity of the school was changed to ensure confidentially. The AES is a public school located in a rural southeastern Massachusetts community. A fourth grade classroom was selected for research in order to offer a natural setting for collection of both qualitative data and quantitative data in this mixed methods study.

The state testing data noted in this study is a true representation of annual state assessment results and has been used to identify current testing trends. All Massachusetts public school testing results for fourth grade students can be downloaded from the Massachusetts Department of Education website (http://www.doe.mass.edu).
The AES state assessment data indicates that in 2006, 64% of the fourth grade students who participated were not math proficient. The 2007 data reveals that 62% were below proficiency level. The 2008 data indicates that 57% of the fourth grade students did not demonstrate math proficiency on the Massachusetts Comprehensive Assessment System (MCAS), and the 2009 data indicates that 53% fell below proficient levels. The 2010 data reveals that the negative trend persisted with 65% of the students below proficiency levels. The most recent 2011 data shows that 52% of the students were below the proficiency level. Although there were gains, the fluctuation of results indicates that student performance is not meeting the necessary benchmark to make adequate gains. Should this trend continue, the necessary gains in Adequate Yearly Progress (AYP) will not be achieved, and the AES will risk falling into “needs improvement status” (Retrieved from Ed. Gov. U.S. Department of Education, 10/17/11, www.2.Ed.Gov/policy/elsec/leg.esea02/index.html) as designated by the 2002 No Child Left Behind Act (NCLB).

Further exploration into the 2008 MCAS data indicates that the percentage of all students averaging 2 or above on math open response items was 51%, compared to the state average of 61%. A student’s ability to score “2” indicates that written responses and corresponding problem analysis fall short of securing the full credit of 4 points. This suggests that students are having difficulty expressing (in written form) their thinking processes, problem solving skills, and understanding of math concepts. The 2009 data reveals that 89% scored 2 or above in comparison to the state average of 82%. The 2010 data further demonstrates a decline of 62% compared to 72% for the state average. Most recent results indicate a positive gain of 76% compared to 73% for the state average. These results affirm that AES students continue to demonstrate a performance fluctuation and a discrepancy scatter. This scatter indicates that
students are not consistently progressing to increase scores from one test administration to the next test administration. The declining trend and fluctuation in student performance remains a major area of concern and has sparked an urgent need to examine opportunities within the teaching and learning dynamic to improve students’ verbal and written expression of math thinking, problem solving strategies, and understanding of mathematical concepts.

A recommendation from the Massachusetts Board of Elementary and Secondary Education’s Task Force on 21st Century Skills (2008) highlights the issue: “All students need to acquire 21st century habits of mind, such as conjecturing, visualizing, analyzing complex choices, estimating, exploring, justifying, finding connections, and constantly asking, ‘Why?’ The task force indicated that there is no better place to do that than in a well-taught mathematics classroom” (p. 15). If students can effectively meet the learning growth patterns needed to acquire the recommended 21st century skills, then it is projected that a complex array of inter-relational and intra-relational skill development will be required. Inter-relational variables are evident in the external factors that might influence students’ performance. For the purpose of this study, these factors are identified as ‘low income’ and ‘subgroup identification.’

In accordance with the federal No Child Left Behind Act (NCLB), the Massachusetts Department of Elementary and Secondary Education issues AYP determination for students with disabilities and have an Individualized Education Program (IEP), students with limited or formerly Limited English proficiency (LEP/FLEP), economically disadvantaged students, and students in racial and ethnic minority subgroups: African American/Black, Asian or Pacific Islander, Native American, and White. (Massachusetts Department of Education, 2006, p. 18)

Socioeconomic factors (SES) as defined by the 2002 No Child Left Behind Act (NCLB) and in accordance with the Massachusetts Department of Education and federal guidelines include economically disadvantaged students and students in racial and ethnic minority groups. Low income status is defined by a student’s meeting any one of the following criteria: eligibility for

Evan (2005) argues that, “Skin color, ethnic status, poverty -- none of these, by themselves, determine students’ performance. There are black and Hispanic students everywhere, including those whose families are poor, who succeed impressively” (p. 583). The premise of this study is to address the need to go beyond traditionally defined student categories and, instead, to explore other, intra-relational factors that may contribute to improvements on assessment measures. Ramirez and Carpenter (2005) aver, “The practice of lumping together data from all students of color-even data from divisions within a single group—is a mistake that is bound to produce poor policy choices and poor educational practices” (p. 602). By examining AES fourth grade students’ mathematical performance through a social cognitive lens, it is proposed that the information garnered may extend the research to determine whether this achievement gap can be effectively narrowed. A social cognitive lens is here defined as the interplay of social and cultural conditions and its effect on learning. Students are proactively involved in their learning and can influence what happens through control of their thoughts, actions, and feelings. A further exploration of the intra-relational factors such as: Zimmerman (2000) self-regulation of learning; Marzano, (2009) goal setting and high-yield strategies; Gardner (1993) multiple intelligence and learning styles; Mueller and Dweck (1998) fluidity of intellectual growth; and Bandura’s (2002) work on personal perceptions emphasize the necessity of delving more deeply into the internal processes of the learner to make achievement gains. The aforementioned scholars examine an individual’s ability to internalize and implement processes to strengthen the construction of knowledge and subsequent skill development. The extant
research and theory informed this inquiry with potential indicators as to why AES students might not be achieving adequate mathematical gains. This research investigation could disclose possible solutions and help identify ways to narrow the achievement gap.

“Barry J. Zimmerman proposed that learners have the capacity to engage in a cyclical self-regulated learning process in which they establish standards, set academic goals, regulate beliefs and motivation, select learning strategies to be used, monitor their academic progress, and self-evaluate their progression” (Bembenutty, 2008, p. 9). Robert J. Marzano (2009) offers a framework to enhance the investigation of student learning through the medium of goal setting. “Keeping Track of My Learning” (KTML) is a self-reflective charting of skill acquisition providing students with a “voice” and insight into learning (Marzano, 2009, Formative Assessment and Standards-Based Grading. [PowerPoint slide 10]. Retrieved from website: www.iObservation.com). This practitioner/scholar intends to use the instrument denoted in Appendix A for examining fourth grade students’ ability to set a mathematical goal, to self-assess, and to determine performance. This self-directed and self-regulated tool allows students with different academic profiles to chart their learning on the same metric.

As a researcher, further investigation is needed to go beyond high stakes testing and teacher-directed assessment protocols to explore the possibilities that can change the mathematical decline, as previously noted. Shifting the locus of teacher control to students as managers of their learning and implementing self-assessments as part of the unit of study has the potential to deepen student understanding of why they succeed or fail to grasp math content. For this reason, a move into the theoretical realm of cognitive science seems necessary; specifically, further research should focus on student self-regulation methods. Zimmerman (1990) indicates, “Self-regulated learners are distinguished by (a) their awareness of strategic relations between
regulatory processes or responses and learning outcomes and (b) their use of these strategies to achieve their academic goals” (p.5). Usher and Pajares (2008) similarly argue, “Such students act as agents, proactively engaged in their own development and authors of their academic present and future” (p. 443).

The problem of practice led this researcher to hypothesize that if students become the managers of their mathematical learning (using the vehicle of self-regulation, analysis of metacognitive reflection, and self-assessment), then a measurable positive gain in mathematical achievement will result. Flavell (1979); Zimmerman (1990); Bandura (1997); Silver, Strong and Perini (2000); and Dweck (2010) all assert that meta-cognition is not just thinking about thinking, but also thinking about one’s own cognitive processes in a self-reflective manner.

**Significance of the Problem**

The educational community and national trends solidly indicate that an academic gap in mathematics between student aggregate performance and subgroup performance is evident. This gap is indicated in statistical data generated by standardized testing results both across the nation and in local school districts. The concern is how to narrow the mathematical performance gap to enable all students to achieve at high levels. At the local level, the investigation into this problem would help to answer the question why this is happening and what alternatives could be explored. A focus on external factors, like those of poverty levels and subgroup identification, does not offer enough information to conclude that academic achievement gaps exist primarily due to aspects beyond students’ control. The Massachusetts Proficiency Gap Task Force (2010) found the following:

Massachusetts has significant achievement gaps, and this is no honor. In 2009, our gaps were similar in magnitude to those of the rest of the nation for black and poor students, and substantially greater for Hispanic students as indicated in the US Department of Education’s National Center for Education Statistics.
There is growing evidence from scholars and researchers that the link between poverty and other external influences cannot adequately explain the achievement gap. “In mathematics, we know that high-achieving countries succeed not by using particular methods but by finding ways to engage students in sustained efforts to grapple with mathematical ideas and relationships” (Stigler and Hiebart, 2009, p. 32). This research project examines students’ ability to manage their learning, assess performance, and actively direct the learning and assessment process – thereby strengthening academic achievement and narrowing the achievement gap.

Secondly, the lack of student math achievement at the local and district levels in comparison to state results should cause substantial concern. Specifically, at Alpha Elementary School, the underperforming designation has brought negative attention from parents, school committee members, and the general public to the school and its teaching practices. This problem is of educational significance primarily because of the potential negative repercussions that low achievement gains have on a child’s future educational success. It is proposed that low math performance levels adversely affect students’ educational achievement, self-esteem, motivation, and ability to grasp more complex content. Vukovic and Siegel (2010) longitudinal study indicates, “Mathematical difficulty can have serious consequences on job performance, employ-ability, and daily living…” (p.12). Dweck and Reppucci (1973); Lalley and Miller (2006); Zimmerman, Bandura, Martinez-Pons (1992) provide further evidence that performance influences motivation, persistence, and expectation of success in math and reading achievement.

The inability of AES fourth grade students to perform at proficiency levels, as defined by the Massachusetts high stakes testing and coupled with evidence from classroom assessments, creates a wider math performance gap. Evidence to further support the existence of an
achievement gap for Alpha Elementary School fourth graders is found in the results of the 2007 Trends in International Mathematics and Science Study (TIMSS) whereby, “Massachusetts 4th graders ranked second worldwide in science achievement and tied for third in mathematics” (p. 1).

Clearly, students’ ability to construct knowledge, employ problem-solving strategies, and assess performance could increase their understanding of learning, providing the impetus for increased skill development. There is evidence that implementation of self-regulation strategies is a very powerful learning and teaching tool. This application within the teaching and learning dynamic provides value added insight into students’ educational needs. Duckworth, et al. (1990) offers, “The teacher acts neither as a dispenser of knowledge nor as a ‘guide’ on a journey of knowledge, but as an interlocutor who encourages children to construct their own knowledge” (p. 186). Modifying the role of teacher as the sole instructor to the teacher and students as partners within the classroom is an important educational advance worthy of examination.

**Practical and Intellectual Goals**

Intellectually, this researcher is interested in looking through a student’s lens into the learning process in order to reveal valuable information that may translate into effective self-described instructional techniques. If student management of learning is effective and implementation of self-regulation strategies produces academic achievement, this would offer a teaching strategy that could be embedded in classroom instruction. Explicit instruction of self-regulation strategies prior to skill instruction may prove to be advantageous for mathematical progress. Ultimately, the goal of this study is to explore how fourth grade students from different mathematical achievement levels utilize self-assessment intervention, describe success and failure, and demonstrate achievement. It is this researcher’s desire to understand how
students might use goal setting, performance outcomes, and self-assessment to increase mathematical achievement. Finally, as the principal and instructional leader within an elementary school, this research informs my work.

**Research Questions (Summary)**

The proposed research questions have been guided by the investigation of the social cognitive theory:

- To what factors do students from different mathematical achievement levels attribute their successes or failures? Self-regulation and the theoretical frame of cognitive science may provide insight into what attributes could influence successful patterns of academic achievement.

- What effect does the self-assessment tool “Keeping Track of My Learning” (Marzano, 2009, slide 10) have on AES 4th grade student performance? Self-regulation and mega-cognitive analysis would present important information to investigate students as managers of their learning.

Additionally, the work that has been done by literacy researchers offers insight into student learning outcomes. These findings have resulted in an attempt to document what good readers do in order to become fluent and master comprehension of texts. Important to this study would be to determine self-described factors that can offer information as to what good math students do in order to achieve fluency and master problem solving. Pressley and Afflerback (1995) share,

Good reading is made up of a set of highly complex, well-developed, and well-practiced skills and abilities. Particularly, impressive is the way in which good readers actively and consciously coordinate these skills and strategies before, during, and after reading text. (p. 5)
Conversely, “Poor readers typically do not think about or reflect upon what they have read. The cumulative effect of these difficulties is that poor readers often lose confidence in their ability to read” (Texas Education Agency, 2002, p. 7). Guided by this literacy research, the above proposed research questions might provide significant insight into students’ mathematical thinking, construct of epistemology, and show what achievement might look like for students performing at different levels.

**Contents and Organization**

The organization and structural framework of this work is established in such a way as to provide an understanding of each student’s construction of knowledge, employment of self-regulated strategies, and self-assessment methods that contribute to improved academic success. Here, the theoretical framework has informed this investigation by sharply focusing on three distinct areas: social cognitive influence on student learning, the impact and underlying tension created by ineffective environments on student acquisition of skill development, and self-regulation of learning (including the ability of students to manage their learning by means of self-assessment). The questions brought forth in the literature review have guided the inquiry by delving deeper into three thematic units of analysis which include: the evolution of the achievement gap in the United States, a focus on students’ application of learning strategies, and the results of self-assessment to improve mathematical proficiency. This analysis connects the proposed problem of practice to a broader context that enables this research to refine and extend knowledge of students’ mathematical achievement. The primary considerations in this research are 1) the idea of the student as a central focus and 2) the influence of variables impacting mathematical achievement levels. The influence of classroom dynamics and self-regulation on learning outcomes has been carefully noted here. This mixed methods study focuses on fourth
grade students and their ability to set goals, problem solve, and accurately self-assess; therefore, it is believed that an instrument that measures mathematical performance through self-reporting will provide more precise information and a clearer view into students’ implementation of self-regulated strategies.

Finally, the mixed methods study, using concurrent procedures, will offer the advantage of collecting both qualitative and quantitative data, thus strengthening research results. Concurrent mixed methods may be defined as “those in which the researcher converges or merges quantitative and qualitative data in order to provide a comprehensive analysis of the research problem” (Creswell, 2011, p.14). The qualitative data, collected through interviews, reveals a natural language description and offers insight into how AES fourth grade students view their mathematical learning and capabilities. The quantitative data examines measureable mathematical pretest and posttest results. This information extends findings beyond limited economic and subgroup analysis to explore students as managers of their learning and the effect of this shift on academic achievement. The investigation of the proposed research questions further refines social cognitive theory and attributes that can be linked to mathematical achievement.

**Theoretical Framework**

The analysis of social cognitive theory complements this mixed methods study by the exploration of qualitative data gathered through students’ perceptions and self-assessment and quantitative data derived from pretest and posttest examinations. Concurrent procedures provide a deeper understanding of students’ math performance and the effects of self-assessment using a social cognitive lens. Fraenkel, Wallen, and Hyun (2012) explain the mixed methods research advantage as “by using multiple methods, researchers are better able to gather and analyze
considerably more and different kinds of data than they would be able to using just one approach” (p.11).

Bertrand (2003) explains, within the social cognitive theory dynamic, “Focus is on the influence of social and cultural interactions on learning mechanisms on construction of knowledge, pedagogy, and didactics” (p. 153). The social cognitive framework offered through the comprehensive work of Bruner, Bandura, and Vygotsky provides additional and poignant insight into the problem of practice under investigation.

The extant research supports the importance of discovery, interest, and curiosity to deepen a child’s learning. Bruner (1960) enhances the concept of social cognitive learning by indicating that “the technique of discovery, is that the child generates information on his own, which he can then check or evaluate against a source, getting more new information in the process” (p. 51). When looking into the classroom setting and attempting to understand the indicators associated with students’ acquisition of learning, social-cultural interaction and student engagement are important considerations. This body of theoretical work offered by the aforementioned research provides a solid foundation to explore the qualitative aspects of this study. Identifying the factors that enhance learning and seeking quantifiable evidence in pretest and posttest results enhances this research study.

Using social cognitive theory as a springboard, the researcher contends:

- Effective teachers practice and acknowledge Dweck’s (2006) and Gardner’s (1993) assertions that intelligence is not a fixed state and that cognition is too complex.

- Effective teachers apply the principles of social matrix to lesson design that allows for experimental learning, as first described by Vygotsky’s (1962) work,
and apply the principles of social matrix to lesson design that allow for experiential learning.

- Effective teachers apply Bruner’s (1960) work by stimulating critical thinking through formulating questions that push students to think at high levels.
- Effective teachers incorporate Bruner’s (1960) and Gardner’s (1993) premises by designing lessons to enhance learning styles to help students construct learning.
- Effective teachers examine Bandura’s (2002) work by investigating students’ personal perceptions and the impact they have on learning.
- Effective teachers acknowledge Zimmerman’s (2000) and Bandura’s (1997) work by including self-regulation of learning and fostering students’ self-observation, self-judgment, and self-reaction.

Techniques of teaching, problem solving, inquiry, refinement of previous knowledge, transformation into a new form, and checking to “test” the alignment have been described by Bruner (1960) as the act of learning. Through the researcher’s practical experience and extensive classroom observations, it has become increasingly apparent that lessons are developed in variety of ways with teaching methodologies differing greatly from instructor to instructor. This researcher is troubled, however, by one-dimensional lesson designs that fail to differentiate different learning styles and patterns of learning.

In his seminal work, Gardner’s (1993) Multiple Intelligence Theory expands the construction of knowledge to include multiple intelligences and their relationship to performance results, which move beyond the limited socioeconomic and subgroup argument. The Multiple Intelligence Theory demonstrates the importance of acknowledging intelligence as multi-
dimensional and not limited to a single way of perceiving information or constructing knowledge. Gardner (1993) has defined and categorized eight intelligences to include: verbal-linguistic, logical-mathematical, visual-spatial, musical-rhythmic, bodily-kinesthetic, interpersonal, intrapersonal and naturalist. A well-crafted lesson that incorporates music, movement, peer to peer interactions for processing content, discovery and exploration of content, graphic organizers to logically sequence information, and visuals to present content with a self reflection component are examples of the multiple intelligence theory in action. An important consideration for the teaching and learning dynamic is the teacher’s ability to offer instruction that meets the needs of each student, while using various modes of intelligences to stimulate discovery and interest. As Willis (2007) argues, “When lessons are adapted for multiple intelligences, the content is more likely to be personally meaningful to students and to connect to their relational memories for successful patterning and long-term retention” (p. 60). A strong indicator that may assist in answering the question as to why there would be differing results in student achievement on predominately paper and pencil tests can be found in the application of Multiple Intelligences Theory. “The understanding that schools ought to inculcate is virtually invisible on such instruments; quite different forms of assessment need to be implemented if we are to document student understanding” (Gardner, 1991, p. 134). A student’s ability to demonstrate achievement through their area of intelligence and use of self-assessment tools has the potential of offering greater insight into mathematical understanding and performance. Furthermore, Dweck’s (2006) growth mindset is the belief that one’s abilities can be developed through perseverance and dedication and is not determined solely by an Intelligence Quotient (IQ) number. Humans have, it seems, not only the capacity for continuous growth but also the capability of taking advantage of continuous opportunities to expand their knowledge. Research
and supposition presented by Dweck and Mueller (1998) offer further evidence of the influence self-efficacy beliefs have on the learning process.

Research indicates that when teachers do not actively involve students as partners in the educational process and acknowledge students’ learning styles, it is problematic. “Education must begin with the solution of the teacher-student contradiction, by reconciling the poles of the contradiction so that both are simultaneously teachers and students” (Freire, 2002, p. 57). Social cognitive theorists argue that without the fluidity of instructional roles, there would exist a severe chasm that could influence the construction of learning. There is, in fact, rich evidence presented by social cognitive theorists and progressive thinkers that suggests that a child must actively participate in the teaching and learning dynamic in order to succeed. The potential for students to become the managers of their learning and incorporate self-regulation of learning strategies can be advantageous and meaningful for mathematical performance. It can open the door for students to have a better understanding of their abilities, reinforce a growth mindset, and find satisfaction in the results of their effort and achievement. Bruner (1960) indicates,

One of the least discussed ways of carrying a student through a hard unit of material is to challenge him with a chance to exercise his full powers, so that he may discover the pleasure of full and effective functioning. Good teachers know the power of the lure. (p. 50)

Duckworth (1990) asserts that, “Teachers can help students learn how to conduct studies, communicate their thinking and direct and evaluate their learning. Students can be the curious and active creatures they naturally are” (p. 20). Teachers are critical in creating the shift from teacher-directed evaluation and guiding students on the path of self-evaluation. Students do not naturally come to the classroom with the capacity to evaluate their skills. Reeves (2000) argues that the schools of today educate more students with more challenges to a higher level of learning than at any other time in the past 100 years. “The fact that the same school system -
indeed the same school building sometimes houses both our failures and our successes makes it difficult to analyze what works and what doesn’t” (p. 8). Students need to experience the process of evaluation, understand what works, and use effective strategies to succeed. It is evident that more information must be gathered to determine what is causing some students to succeed and others to fail within the same classroom. The evaluation process and subsequent results may be the missing link to help ascertain what works and what areas need further investigation. A social cognitive lens offers even greater insight into a student’s self-described variable that could influence learning and might ultimately result in achievement gains. The quasi-experimental design with a non-equivalent groups design augments this mixed methods research allowing for the measurement of progress and determination of change. Mertens (2005) noted, “It involves administering the treatment to the experimental group and comparing performance on the pretest-posttest using a non-equivalent groups design” (p.137).

Creswell and Plano Clark (as cited in Creswell, 2009) indicates that mixed methods research, “is more than simply collecting and analyzing both kinds of data: it also involves the use of both approaches in tandem so that the overall strength of a study is greater than either qualitative or quantitative research” (p. 5). An individual student’s ability to use self-regulation strategies can be a variable indicating greater academic achievement when self-assessing, and understanding this also helps researchers move beyond socioeconomic conditions and subgroup categorization. This can lead to a greater comprehension of why one student is successful, and another may fail to achieve.

Additionally, significant to the problem of practice is the relational intersection between mathematics teaching and learning and the indicators that can be dissected through student observations, interviews, and self-reflection. This analysis could reveal strong insight into
students’ self-knowledge. Initially, the work of Vygotsky (1962) considered the social-cultural effect on math learning. A teaching and learning strategy employed by teachers, and initially created by Ogle (1986), is the KWL chart which provides a structural framework for learning and actively engaging students in the dynamic interchange of ideas to construct knowledge. “The KWL chart encourages the activation of prior knowledge by asking students individually or in a group to identify what they already know about a topic and what they want to know” (Stronge, Tucker, Hindman, 2004, p.150). Analyzing the KWL (What I know, what I want to know, and what I learned) chart frequently used in the classroom is a good example of a teaching tool that provides a social-cultural frame for students’ understanding and peer interaction. Ogle (1986) created the KWL strategy to help students become actively involved in their learning. It is a simple chart that can be used to stimulate thought and discussion prior to, during, and after learning. When a teacher uses the KWL chart, students are asked to share prior knowledge of a subject to enable the teacher to structure the lesson with a better understanding of what background information has been learned. The sharing of this prior knowledge can enrich the lesson by bringing in different viewpoints and build upon the social-cultural frame that deepens understanding. The teacher’s solicitation of information at the onset of the lesson and the exchange of this information encourage a social-cultural dynamic as noted in the works of Vygotsky (1962) and Bruner (1960). The KWL strategy can stimulate the sharing of ideas and can address any misconceptions during the instructional phase. The final phase that determines what has been learned can be used to assess students learning and offer a wider range of information and understanding through peer sharing. A one shot test at the end of a unit of study or administered annually cannot offer this dynamic learning experience. Therefore, the current practice of high stakes testing and end of the unit testing limits the possibilities of gathering
qualitative data that can positively influence learning and prove to be a more effective assessment.

Bandura (1986) and Zimmerman (1989) identify several effective learning strategies acknowledging the interconnection of sub-processes in self-regulation, which include self-observation, self-judgment, and self-reaction. These identified processes interact with one another to both formulate and influence performance outcomes. In this study a feasible connection between students’ ability to manage mathematical learning and ability to implement self-regulated strategies extends this portion of current research. Looking at evaluation as a cyclical process, guided by the student’s own assessment, can be a powerful tool to capture what has been learned. This can allow the students to understand the changes that are needed, incorporate the self-regulated sub-processes, and repeatedly implement successful strategies to guide their work. Zimmerman (1989) provides a model of self-regulation of learning that has potential for success: “There is growing evidence of the importance of these three classes of self-regulatory processes on students’ academic performance” (p. 331). A teacher’s ability to recognize and stimulate the sub-processes through the use of various classroom strategies (i.e. offering students time to articulate their learning through conventional methods such as writing, assistive technology, listening to an audiotape of self-assessed goal setting, task completion, and performance) could make available value added tools to enhance performance.

Furthermore, Bruner (1960) acknowledges in his work how the mathematics curriculum is presented within the classroom. Important to curriculum design are the scaffolding elements and essential question formulations that can stimulate and spark inquiry within the learning process for children. A learning environment that encourages students to seek information, take risks, stimulate mental processes to further challenge and extend learning has the potential to
provide insight for this study. Thus, Bruner’s (1960) work has informed the researcher’s inquiry by carefully examining the importance of episodic learning patterns that enrich students’ construction of knowledge and spiral accordingly. This implication should entice administrators, teachers, and architects of curriculum to look critically at the clutter that fills textbooks and lesson plans. This curriculum clutter can muddy the learning process with textbook design that pressures teachers to complete all tasks in a rote manner rather than build deep understanding of mathematical concepts. Wiggins and McTighe (1998); Stigler and Hiebert (1999) affirm and Tomlinson (2003) asserts:

As knowledge and information grow at an unprecedented rate, it becomes increasingly clear that ‘coverage’ is an impossible educational goal. To this end, it is the role of educators to ‘uncover’ what is essential to know, understand, and be able to do in the disciplines. (p. 60)

Lesson pace, for example, often fails to allow for all students to acquire the understanding needed to process mathematical ideas effectively.

The relevant strengths brought forward by social cognitive theorists have been the evolution of their body of work and the significance it has had on current educational practices. Clearly, the path of this theory can be observed in classrooms whereby peer learning, cooperative learning, student discourse, differentiated instruction, and multiple intelligences are effectively woven into the fabric of teaching and learning. Cobb (2007) argues that this could also be a relevant weakness, due to the fact that a student-centered approach can be less structured than a teacher directed approach in which learning experiences are guided by the curriculum and textbook. The social cognitive approach “provides only limited guidance because the classroom processes on which design focuses are emergent phenomena rather than already established practices into which students are inducted” (p. 24). It is important to note that connection to an
individual’s self-assessed mathematical performance can be mediated and influenced by the social dynamic within each classroom environment.
Chapter 2

Literature Review

The purpose of this mixed methods study is to explore whether AES fourth grade students would become the managers of their mathematical learning when they use the vehicle of self-regulation, analysis of meta-cognitive reflection, and self-assessment. Using these tools, would a measurable positive gain in mathematical achievement result? Application of a social cognitive lens expands this research by using data to provide voice, lived experiences, and evidence of mathematical achievement to the body of work already in existence. Examination of the factors that fourth grade students from different mathematical achievement levels attribute to successes or failures informs instructional methods.

The theoretical framework structures the problem of practice by examining the student-teacher dynamic, intelligence as a fluid and malleable component in the learning process, and self-regulation as a discipline of goal setting and self-efficacy. Most importantly, this framework provided a mechanism to probe more deeply into reflective practices and meaningful instructional activities that can engage students and ultimately result in improvements on assessment measures. The following questions emerged for further consideration:

- What does the literature say about the evolution of the achievement gap in United States education?
- What does the literature say about student application of learning strategies?
- How does self-regulation of learning improve the achievement levels of students?
- How does student goal setting and application of self-assessment improve mathematical proficiency?
What does the literature say about self-efficacy for self-regulation and the influence on math achievement?

**Historical Perspective: Achievement Gap**

Educational reform movements have impacted public school systems in the United States and transformed the manner in which schools are evaluated and how student progress has been measured. How has this evolution and subsequent achievement gap analysis influenced student performance? The impetus of the reform movement in the latter half of the 20th century was closely tied to the highly publicized document titled: *A Nation at Risk*, issued by the U.S. Office of Education and released in 1983. A National Commission on Excellence in Education was formed by the then Secretary of Education, Terrel Bell, to study the quality of the educational system in the U.S. “The overall report, released in 1983, predicted the decline of the U.S. if education continued its downward spiral, sending shock waves throughout the country and triggering an unprecedented reform movement” (Smith 1996, p. 2). This document sparked a national debate, centering attention on ideas such as the “rising tide of mediocrity.” It also focused political attention on improving our nation’s schools and student performance. This was, however, not a new argument. In 1953, Arthur Bestor had already begun to herald the call for urgency with his influential book entitled *Educational Wastelands* and Rudolf Flesch followed shortly thereafter with *Why Johnny Can’t Read* in 1955.

*A Nation at Risk* (US Office of Education, 1983) was undoubtedly a response to published studies such as the one conducted by Harold W. Stevenson and James W. Stigler. In the early 1970s, they began a major study funded by the National Institute of Health and the National Science Foundation, which culminated in a front-page article that appeared in the New York Times. Their work included five major studies and resulted in a book that attempted to
answer the provocative questions about why our schools were failing and what we could learn about education from the Japanese and Chinese. The outcome was a startling revelation: that American education and our children were lagging behind other countries and that this decline was continual. The research was conducted in elementary schools in the United States, China, Japan, and Taiwan. *A Nation at Risk* served as a catalyst for a flurry of school improvement initiatives throughout the United States that came to be known collectively as the “excellence movement” (DuFour, DuFour, and Eaker, 2008, p. 33).

In 1991, President George H.W. Bush responded to the challenge by outlining the national education goals set by the nation’s governors, which targeted the year 2000 for full implementation. The goals for improving schools were as follows:

- Every child would enter the educational arena ready to learn.
- Dropout rates would be decreased.
- Adult literacy rates would increase.
- Our students would be number one in the world for math and science.

Stevenson and Stigler (1992) comment that to hear the goals stated so glibly with no reference as to how they would be attained startles us into facing the great gap between goal and accomplishment. With the commission of the Third International Mathematics and Science Study (TIMSS, 1995), funded primarily by government money from the National Center for Education Statistics and the National Science Foundation, there was an opportunity to gather data on how our teaching methods compared to that of Japan and Germany. Actual teaching was analyzed and summarized from observation of a video study directed at eighth grade mathematics classrooms. In 1994, Stigler and Hiebert, along with project staff, presented their findings to researchers and educators from Germany, Japan, and the United States. Using the
impressions and interpretations of the group, Stigler and Hiebert went back and analyzed the video again to further define and articulate what was revealed: “The teaching gap is not an abstract idea concocted by ivory tower researchers; the teaching gap is a set of real differences in the teaching methods used every day in typical classrooms” (Stigler and Hiebert, 1999, p. 29).

In 1994, President Bill Clinton continued to exert national pressure on our educational problems and signed into law “Goals 2000: Educate America Act.” The six goals outlined during the George H.W. Bush administration were included with two more added, which focused on the need for staff development and use of technology. “Finally, there seems to be emerging a true partnership among federal, state, and local educational entities and a commitment to improve the quality of United States education” (Sewall, 1994, p. 5). The national educational agenda focused attention on:

- Academic excellence and higher achievement
- State-directed education commissions to review policy and establish standards
- Court-adopted issues such as school financing to bring about greater educational parity

In the quest for improved educational performance and more rigid standards within the nation’s schools, state and local jurisdictions were considered the heart and center of true transformation and innovation. The 1993 Education Reform Act implemented in Massachusetts responded to the need for change through legislation. This act forced attention on educational improvement in the Commonwealth and provided the additional necessary resources. Districts were directed to:

- Improve the quality of instruction
- Increase student achievement
In response to the Education Reform Act of 1993, The Massachusetts Comprehensive Assessment System (MCAS) was implemented making graduation dependent on a passing score. “MCAS, along with the other components of the Education Reform Law was designed to strengthen public education in the Commonwealth and to ensure that graduates of Massachusetts public high schools were academically well-prepared” (Massachusetts Department of Education, 1999, p. 3). The stakes were high and school districts were forced to comply. School districts’ success and/or failure to meet Adequate Yearly Progress (AYP) were subject to local, state, and national publication of scores. The widening academic gap was reflected in an aggregate of all students tested and in an economically disadvantaged student subgroup and their lack of performance.

Acknowledgement of the public school weakness in closing the educational performance gap came in the form of a seminal legislative act known as No Child Left Behind (NCLB, 2002) enacted by Congress and signed into law by President George W. Bush. The fundamental principle of this legislative action was to close the achievement gap with accountability, flexibility, and choice. This targeted focus was to ensure that all children had an opportunity to obtain a high quality educational experience that would enable them to attain proficiency on high stakes test results. The major goals included:

- Ensuring that high quality academic assessments, accountability systems, teacher preparation and training, curriculum, and instructional materials aligned with state standards.
• Closing the achievement gap between high-performing and low-performing students, especially the achievement gaps between minority and non-minority students, and between disadvantaged children and their more advantaged peers

• Improving and strengthening accountability, teaching, and learning by using state assessment systems designed to ensure that students are meeting challenging state academic achievement and content standards and increasing achievement overall—especially for the disadvantaged

Darling-Hammond and McLaughlin (1995) argue, “The nation’s reform agenda requires teachers to rethink their own practice, to construct new classroom roles, and expectations about student outcomes” (p. 1). Anderson-Levitt (2003) questions, “Does true school reform happen at the level of global and national policies, or does real change happen at the level of classrooms and schools?” (p. 3). Taylor and Cox (1997) aver that reform happens at a deeper level, resonating throughout student construction of knowledge guided by strategic actions that strengthen self-efficacy. The opportunity for students to engage in a partnership with teachers rather than a stand-and-deliver pedagogical encounter will offer sustainability for transformation (Bandura, 2002; Zimmerman, 2000; Bruner, 1960; Vygotsky, 1962; Duckworth, 1987). A vibrant opportunity exists when students and teachers strategically work together to establish students as managers of their own learning. Here lies the possibility for information that will ignite the hope for the self-regulation of learning for students and a broader response to the achievement gap predicament that goes beyond the commonly articulated socio-economic and subgroup reaction. Through a social cognitive lens, a student’s voice can offer direction for refining research and extending evidence that can lead to a deeper understanding of not only
what students are thinking, but also how they may strategically shape academic achievement for themselves.

“If the foundation of an accountability system does not provide students with an opportunity to improve achievement, then the fundamental purpose of accountability has been ill served” (Reeves, 2000, p. 17). A true indicator as to which direction public schools will take in the next decade will be determined by what accountability systems are implemented and how willing individual schools are to take ownership of the systems they support. “Ownership can not be achieved in advance of learning something new. Ownership is a process as well as a state” (Fullan, 1997, p. 45). The paradigm shift from a teacher-directed classroom to student-directed learning space is fundamental. Singham (2003) affirms, “It is not hard to understand why good teaching reduces the gap. What happens in the classroom both in terms of what the teacher does and of the relationship that is created between the teacher and student is extremely important” (p. 589). It is within this dynamic exchange of ideas and understanding of each student’s construction of knowledge, self-regulated strategies, and self-assessment as a learner that solid evidence can be provided to narrow achievement gaps. The motivation for change will most likely occur through first asking students what they are thinking and, second, why they are applying specific strategies. Then, through careful analysis, the repetition of successful and significant learning may be noted.

John Dewey (1916/2001) asserts that the educational laboratory offers a forum for intelligent inquiry as a means to derive data. Therefore, it is essential to gather data in real time and analyze the students’ performance using multiple assessment practices and tools. According to Marzano (2007), “Individual classroom teachers must determine which strategies to employ with the right students at the right time” (p. 5). Additionally, directing the focus of instruction
toward the student’s role in epistemology can offer comprehensive insight into the learning process and stimulate internal inquiry and goal setting.

This researcher proposes that student voice and choice remain powerful mechanisms for the exploration of efficacy beliefs, regulation strategies, self-assessment, and links to achievement. This study intends to offer further insight into how students can engage in meaningful strategies that translate into measured academic gains. Pajares (2003) claims, “Judgments of personal efficacy affect what students do by influencing the choices they make, the effort they expend, the persistence and perseverance they exert when obstacles arise, and the thought patterns and emotional reactions they experience” (p. 140).

The literature questions under investigation are intended to penetrate more deeply into the academic achievement gap and the influence of variables that reach beyond socioeconomics and subgroups, thereby contributing to new knowledge in the field. Singham (2003) validates this claim, “The worst thing about much of the current discussion on how to eliminate the achievement gap is that it focuses on what should be done with minority students. This has the effect of making it look as if it is a minority problem” (p. 591). Careful analysis of factors that contribute to the academic achievement gap can be found in the mathematical problem solving and inquiry based learning that students demonstrate within the classroom. A comprehensive picture of students’ construction of mathematical learning, implementation of self-regulated strategies, and self-assessment that reaches beyond this limited accountability data shed further light on student academic gaps.

The studies described in this review reveal achievement gaps, instructional techniques, and attributes that influence student learning. The utilization of students’ perceptions of the learning process in relation to self-efficacy for self-regulation, analysis of meta-cognitive
reflection, and self-assessment captures a more detailed analysis of the construction of knowledge and performance. Hattie (2012) explains,

Those with high self-efficacy are more likely to see hard tasks as a challenge rather than try to avoid them, and when they have failure, they see them as a chance to learn and to make a greater effort or to look for new information next time. (p. 41)

This researcher theorizes that the careful and strategic matching of math content, teaching strategies, and differentiated instruction optimize math knowledge construction, motivation, and general understanding. Tomlinson (2001) affirms, “Teach for success (by encouraging, providing support, guiding planning, delineating criteria, and so on) so that the seemingly unattainable moves are within the learners’ reach” (p. 13). Pajares (2003) acknowledges a similar concept claiming, “Students’ self-beliefs as a principle component of academic motivation is grounded on the assumption that beliefs that students create, develop, and hold to be true about themselves are vital forces in their success or failure in school” (p. 140). Schunk (1989) further indicates, “The belief that one can apply a strategy to improve learning instills in learners a sense of personal control over achievement outcomes, which raises self-efficacy” (p. 14). Examination of the internal and outcome variables that contribute to the complexities of the learning process is significant to this research. Donnelly (2008) validates this, contending that there is a need for “…a more student-centered approach towards teaching” (p.207).

Zimmerman (2000), however, cautions that “the fact that almost all people are capable of self-regulation does not mean that all students actually do take effective charge of their own learning” (p. 83). By carefully examining the components of self-regulated learning through the social cognitive frame, educators can develop effective strategies. These learning strategies will then, in turn, support students’ development of important skills and increase mathematical achievement. As Pajares (2003) argues, “As children strive to exercise control over their
surroundings, their first transactions are mediated by adults who can either empower them with self-assurance or diminish their fledgling self-beliefs” (p. 153). This study probes self-efficacy beliefs coupled with meta-cognitive reflection and self-assessment. Mundia’s (2012) mixed methods study notes, “Self-assessment and self-reflection are key ingredients in the process of active learning. By doing this repeatedly, students learn to take control and responsibility for their own learning and eventually gain self-discipline and self-direction” (p. 358). Ultimately, the research findings presented here construct through mixed methods, a vivid picture of students’ implementation of self-regulated strategies and determine quantifiable evidence of mathematical achievement.

Learning Strategies

The ability of students to enhance their learning experiences through self-discovery, employment and articulation of learning strategies denotes a connection between teaching and learning. What, however, does previous literature say about students’ application of learning strategies? Zimmerman (2000) indicates, “As a mediating variable self-efficacy has proven to be responsive to improvements in students’ methods of learning and predictive of achievement outcomes” (p. 89). This is a cyclical process that evolves with the use of self-regulation of learning. Zimmerman (1990) also acknowledges, “Self-regulated students proactively seek out information when needed and take the necessary steps to master it” (p. 4). In other words, when facing obstacles in learning, the self-regulated learner will find ways to succeed. An example of this phenomenon would be a child wrestling with a mathematical problem and the use of self-talk to process the steps needed to successfully solve the problem. With self-regulated learners, learned cycles of steps that have proven to be successful in the past are more often applied and support self-efficacy. Tomlinson (2003) explains, “Self-efficacy deepens the roots of self-
esteem: ‘Not only do people tell me I am worthwhile, I can actually see that I am’” (p.17). As self-application of self-regulation strategies increases, the frequency of application also increases, and leads to more positive feelings and motivates the willingness to take on challenges and learn.

Zimmerman (2008) studies the effects of student mathematical strategies and accuracy in solving problems. The findings support evidence that students undergoing strategy training improve accuracy. The inclusion of Marzano’s (2009) “Keeping Track of My Learning” to provide a guide for students to formulate and establish a realistic goal is essential to this current study.

The Lalley and Miller (2006) study reveals that employing pre-teaching and re-teaching strategies within the classroom yields different results in students’ math concepts, math problem solving, and math computation. “Self-concept significantly increased for the pre-teaching group but not the re-teaching group and these gains were limited to general ability and math ability” (p. 753). Mundia (2012) argues, “The success achieved through self-assessment and self-evaluation helps to boost a student’s self-confidence and self-esteem. In view of these advantages…It ought be taught to and practiced by students” (p.358). A student’s ability to effectively set realistic mathematical goals, self-assess, and accurately articulate noticeable performance gains has a bearing on this study as well. The study provides relevant information that could be added to the investigation of self-efficacy for learning and the influence of an intervention program.

Five researchers have investigated the effects of preventative tutoring on the mathematical problem solving of third grade students with math and reading difficulties. Fuchs, Seethaler, Powell, Fuchs, Hamlett and Fletcher (2008) describe tutoring as a method that enhances students’ ability to use self-regulation and learning strategies to improve mathematical
achievement. According to Fuchs et al. (2008), the findings “support the efficacy of the tutoring protocol for preventing word-problem deficits among third grade students with math and reading deficits” (p. 155). A limitation of this study, however, is that the strength of self-regulation on learning might be mediated by students’ achievement histories. This may be due to low achievers having difficulty in setting realistic goals, and this is an important element to consider for the proposed research. Zimmerman, Bandura, and Martinez-Pons (1992) explain, “Students’ beliefs in their efficacy for self-regulated learning affected their perceived self-efficacy for academic achievement, which in turn influenced the academic goals they set for themselves and their final academic achievement” (p. 663).

Schunk and Zimmerman (1997) maintain, “Self-efficacy beliefs (personal variable) influence achievement behaviors (choice of tasks, effort, persistence) in that efficacious students are more likely to choose to engage in tasks, expend effort, and persist to overcome obstacles and succeed” (p. 196). According to Mueller and Dweck (1998), it is evident that effort, choices, and persistence can positively influence students’ self-efficacy beliefs and performance. Bandura (2002) states, “Converging evidence from diverse lines of research verifies that efficacy beliefs contribute significantly to the quality of human functioning” (p. 271). Affirming the importance of self-efficacy, Cleary and Zimmerman’s (2006) mixed methods study that denotes that “goal-setting, self-monitoring, and self-reflection are key factors in developing empowered, self-determined individuals” (p.150). Therefore, examination of self-regulation strategies and influence on self-efficacy beliefs are also an important consideration.

The extant literature indicates that when teachers create opportunities for learning, students flourish. Under these conditions, the construction of knowledge occurs, critical thinking skills broaden, and enduring understanding develops. Students as managers of their learning and
achievement garner hope for sustained promotion and self-application of knowledge in a standardized and strategic way.

If the desire to improve is a key to build a true profession, then what is standing in the way? Some would say the answer is obvious - teachers do not have this desire, or at least they have not shown it. They continue teaching in traditional ways despite regular waves of educational reform. (Stigler and Hiebert, 1999, p. 171)

The research for this study uncovered a limited number of studies that indicated the motivation to change the locus of control from a teacher-directed approach to students as managers of their mathematical learning. Unless this kind of risk taking is encouraged and valued, it will not occur easily. Stigler and Hiebert (2009) argue that little has changed within the United States classroom. Teachers must learn “to monitor what students are experiencing, thinking, and learning during a lesson and be able to readjust their strategies” (p.36). Marzano (2009) further cautions, “Educators must always look to whether a particular strategy is producing the desired results to ensure a positive outcome” (p. 35).

Productive change is dependent on how well the students can find value in the concepts, ideas, and activities presented. Understanding student motivation is critical when planning learning opportunities for students. A mixed methods study conducted by Cifarelli, Goodson-Espy, and Chae (2010) asserts, “Knowing how students’ beliefs are associated with their problem-solving actions enables us to better anticipate the learning needs of students and develop appropriate instructional materials designed to address those needs” (p. 206). In other words, the degree of success felt by students will directly affect and determine if the skills will be learned, transferred, and applied in the classroom. Duckworth (1987) offers, “In Piaget’s terms, you must reach out to the world with your own intellectual tools and grasp it, assimilate it, yourself” (p. 7). Bandura (2002) cautions that “a low sense of efficacy to regulate one’s own motivation and learning activities bears importantly on intellectual self-development” (p. 281).
Marzano, Pickering, and Pollock (2001) conclude that “providing recognition for attainment of specific goals not only enhances achievement, but it stimulates motivation” (p. 59). Miller and Brickman (2004) argue, “Students who do not perceive school learning tasks as related to their own future goals are unlikely to have a sense of self-determination for performing those tasks” (p. 20).

A study by Kroesbergen, Van Luit and Maas (2004) looks at the effectiveness of explicit and constructivist approaches to mathematics for low achieving students in the Netherlands. The study’s findings offer information regarding the impact of explicit math instruction and the constructivist approach on supporting low achieving students. The correlation of previous assumptions linking intelligence to mathematical ability is weak. This study provided information and sparked interest in the attitudes of boys and girls regarding their ability in mathematics and effective strategy implementation. Additionally, math performance of students in the explicit instruction condition improved significantly - more than that of students in the constructivist condition. Therefore, it is important to note that the students exposed to a constructivist condition grounded in discovery, exploration, and examination of math content did not increase math performance.

LaRocque (1998) conducted a quantitative study using a causal comparative design, which suggests a cause-and-effect relationship on students’ perceptions of their classroom environment and the possible effect of these perceptions on math and reading achievement. The purpose of the study was to analyze the relationship between the social-psychological relationship of environment to both antecedent and outcome variables. Consequently, this study validates the importance of school environment in social science research. The extensive literature pertaining to the study of classroom environments provides persuasive evidence that
students’ perception of their learning environment accounts for appreciable variance in learning outcomes. The findings here substantiate the study by demonstrating how social psychology and learning can be interdependent with regard to the impact on student achievement in the domains of math and literacy. In sum, classroom design that encourages discourse, thinking aloud, peer learning, differentiation, and incorporates multiple intelligence is of great significance to this study. Extending beyond the group dialogue and framing the learning outcome to the student’s mega-cognitive engagement, self-regulation for learning, and self-assessment provides a valuable focal point.

Zimmerman (1990) states, “Self-regulated students proactively seek out information when needed and take the necessary steps to master it. When they encounter obstacles such as poor study conditions, confusing teachers, or abstruse textbooks, they find a way to succeed” (p. 4). An example of self-assessment within the classroom would be a writing rubric that enables the student to know what is expected to complete a task and to reflect on the task once completed. A student may internalize this process through self-talk as well as record the outcome using a rating scale. This meta-cognitive process enables the student to gauge performance without relying solely on teacher feedback. Effective self-assessment can provide a student with insight into the construction of learning and the ability to change strategies to provide a better outcome. This is an influential tool, which can be used to help students articulate their learning and adapt behaviors and strategies to gain positive results.

Self-regulated students, in fact, demonstrate a set of systematic strategies that distinguishes themselves including meta-cognitive, motivational, and behavioral engagement with learning tasks. Feedback is important and allows these students to remain flexible and use failure as a learning tool for increased achievement (Zimmerman, 1990; Zimmerman and
Martinez, 1986; Pressley and Afflerbach, 1995; Dweck, 2006: Duckworth, 1987; Wiggins and McTighe, 1998). Self-efficacy is “the capacity to exercise self-influence by personal challenge through goal setting and evaluative reaction to one’s one performance provides a major cognitive mechanism of motivation and self-directedness” (Bandura, 1999, p.28). Therefore, an individual’s self-efficacy belief and level of performance can influence outcome.

**Students’ Roles in the Learning Process**

Duckworth et al.’s (1990) study finds that “if conditions are right, students will also learn to choose their own goals, direct their own work, and evaluate their own explanations” (p. 15). Individuals, it seems, who perceive themselves as having a high level of efficacy are more likely to feel successful, to engage in more challenging tasks, and to be less deterred by failures or setbacks. Protheroe (2010) cautions, however, that “learners with low self-efficacy more typically avoid challenge, expend little effort and give up, and believe they are not in control of their learning” (p. 41).

Construction of knowledge and the understanding of mathematical learning outcomes as seen through the lens of students’ self-reflection, can engage student thinking, inquiry, and problem solving. William Walter Kendall (1991) examines mega-cognition and the effects of student self-reporting of mathematical errors. Insight into mega-cognitive processes and self-reflection are evident in students’ journals. The findings of this study indicate that the implementation of a learning log enables students to become more aware of their thought processes and enhances self-efficacy.

Nurturing conditions within the classroom that support student learning as fluid and capable of growth directly influences self-efficacy. A key factor that enables students to achieve, despite socioeconomic or subgroup identification is a learning environment that explicitly
teaches and fosters self-regulation strategies. According to Cifarelli, Goodson-Espy, and Chae (2010), instructional opportunities enable “students opportunities to share and defend their ideas for solving particular problems prior to actually solving them help students develop self-advocacy and contribute to a proactive sense of agency. Students need support to develop as self-regulated problem solvers” (p.205).

Schunk and Zimmerman (1997) assert, “Social learning experiences can be planned and organized by teachers and parents to accelerate children’s self-regulatory development” (p. 205). Through self-regulation and self-assessment, students are more likely to try to disentangle difficult learning. Dweck (2010) indicates, “Students with a growth mindset are more likely to respond to initial obstacles by remaining involved, trying new strategies, and using all the resources at their disposal for learning” (p. 17). Successful implementation of resources can lead to a solid influence on academic achievement. Bulter and Winne, (1995), Carver and Scheier (1990), and Zimmerman (1989) affirm that self-regulated learners are flexible and do not simply perform these tasks once, but continually make adjustments as necessary.

Dweck’s (2006) growth mindset supposition provides further evidence of the influence self-efficacy beliefs have on the learning process. Dewey (2001) indicates, “The mind is essentially a process—a process of growth and not a fixed thing” (p. 62). “It’s interesting that those with the growth mindset seem to have the talent to identify their weaknesses and strengths” (Dweck, 2006, p. 11). Students who challenge themselves and work through weaknesses to enhance their performance are able to implement a cycle of successful strategies and effectively self-assess. Bruner (1960); Bandura (1997); Zimmerman (2000); and Marzano, Pickering, and Pollack (2001) concur that individuals can develop the ability to strengthen self-awareness and
improve knowledge acquisition through self-assessment, mega-cognitive analysis, and implementation of effective strategies.

**Self-Regulation of Learning**

How does self-regulation of learning improve the achievement levels of students? What does the literature reveal about self-regulation and self-efficacy and the impact on student learning? The emphasis on accountability and standards disproportionately overshadows the significance of student regulation of learning and self-assessment as a means of closing the achievement gap. This missing link could expand the conservative and highly published view that the achievement discrepancies are fundamentally associated with economic levels and subgroups. Research questions in this study extend beyond this point of view and seek answers that encompass students’ engagement in their learning process. The explicit teaching of the self-regulation of learning processes offers a potential mechanism that can engage learners in assessment at an early age in their academic career and influence outcome. “Vygotsky viewed self-regulation as a generalized trait or stage of competence that children develop by the early elementary grades” (Vygotsky 1962/1978 as cited in Schunk and Zimmerman, 1997, p. 198).

Marzano (2009) identifies “student feedback as an effective instructional strategy in the teaching and learning dynamic” (p. 34). Margolis (2005) affirms that “graphing and self-monitoring improve learning and are easy to learn if procedures are explicit” (p. 227). Clearly, employing a self-directed and self-regulated tool allows students with both low and high achievement profiles to formally chart their learning, apply feedback, and influence achievement. Zimmerman (2000) cautions, “Efficacious students were better at monitoring their working time, more persistent, less likely to reject correct hypotheses prematurely, and better at solving conceptual problems than inefficacious students of equal ability” (p.87).
The mixed methods research presented here extends beyond observation and teacher talk to include a student’s self-assessment and quantifiable data to examine student performance. Throughout the literature review, what has become most apparent is that no single factor or label can adequately offer insight into the achievement gap without investigating student self-assessment. Franke, Kazemi, and Battey (2007) contend, “Mathematical conversations that center on students’ ideas can provide teachers a window into students’ thinking in ways that students’ individual work cannot do alone” (p. 237).

**Self-Regulation of Learning and Application to Mathematics**

How do student goal setting and the application of self-assessment improve mathematical proficiency? Duckworth (1987) shares, “If teachers were encouraged to focus on the virtues involved in not knowing, so that those virtues would get as much attention in classrooms from day to day as the virtue of knowing the right answer it would make a significant difference in stimulation of intellectual thought” (p. 69). Students are more likely to take risks when given the opportunity to think about learning and time to wrestle with problem solving. Math teachers who make this explicit encourage students to develop self-regulation skills that can be used throughout the learning process. Van De Walle, Karp and Bay-Williams (2010) explain, “Students can learn to monitor and regulate their own problem-solving behaviors and those who do so show improvement in problem solving” (p.46). According to Duckworth, et al. (1990), “We need to avoid or reduce a fear of being ‘wrong,’ and encourage their delight at the unexpected. If conditions are right, students will also learn to choose their own goals, direct their own work, and evaluate their own explanations” (p. 15).

The social cognitive frame, paired with mathematical research, provides further investigatory information for this study. A study entitled “The Effects of Collaborative Learning
in Math on Sixth Graders’ Individual Goal Orientations from a Socioconstructivist Perspective” (Summers, 2006) investigates collaborative learning as a process that influences individuals’ social and achievement goals. The findings indicate that “within a collaborative classroom, a series of complex interaction systems typically exist in the social context. These shared opportunities may result in some form of influence as a function of proximity, time spent together, and perhaps a need to use peers as a source of information for one’s own behavior” (p. 277). The interactive exchange of ideas and examination of student self-regulation strategies provides important information. Summers (2006) asserts, “Cognitive goals set by individual group members depends on their personal achievement motivation goals and may contribute to the shared goals of the group” (p. 278).

Summers’s (2006) findings further reveal “Students in groups that collectively valued the academic goals of group work were likely to adopt individual motivational strategies associated with performance-avoidance goals over time. Students who reported low social intimacy in school tended to report high performance-approach goals, a relation that is consistent with the peer influence literature” (Berndt and Keefe, 1996 as cited in Summers, 2006, p. 285). The influence of others on math achievement and perception of learning is relevant to this study.

A smaller study conducted by Meyer and Turner (2002) uses a mixed methods approach to analyze teacher mathematical instructional practices and the influence of the learning environment. The researchers examined how teachers affect the development of self-regulation through modeling, social guidance, and feedback. The results of the study indicate how cognitive, meta-cognitive, and motivational processes in self-regulation are intertwined in social and emotional relationships. Meyer and Turner (2002) write “that much research has been undertaken to examine the individual differences among self-regulatory processes and minimally
explored the role of classroom context in supporting their development and enactment in real
classrooms” (p. 17). This study can add to the investigation by focusing attention on the student-
teacher dynamic within the classroom and student modeling of explicit learning strategies. Also,
this study’s concurrent data might offer meaningful insight into successful self-regulation
strategies that students implement to gain improved academic performance.

The findings of this study could offer teachers valuable information to develop lessons
that would encourage self-regulation for learning with subsequently increased student
achievement. Additionally, the students’ questioning and the results can be used to positively
impact motivation and social and emotional growth. Teacher statements are powerful and can
either encourage or frustrate a learner. The discourse analysis, as defined by a formal lengthy
discussion, would adversely impact this mixed methods study. This is not natural to the flow of
events in the AES classroom. It is complex and not indicative of a typical fourth grade
elementary school instructional format. However, it is imperative to note that students’
questions, interactions with peers, and interactions with the teacher can be strong indicators of
the acquisition of knowledge.

The investigation of qualitative and quantitative research findings throughout this
literature review reveals that mathematical achievement, instructional strategies, and
interventions influenced students’ perceptions and self-efficacy for self-regulated learning.
Notable is the work of Usher (2009), specifically her research questions and methods of data
collection. The research design offers a solid investigative path to support a mixed method
approach. The opportunity for students to explore their own thought processes and offer a
predictive construct is an important reflection for this researcher. The interplay between self-
efficacy, self-concept, anxiety, and task goal orientation could disclose how students perceive
their ability to direct outcome. Careful consideration of student thought processes and the ability to plan and implement strategies that would influence learning with a measurable outcome is evident in Usher’s research. These findings inform the present inquiry into students’ heuristics and how fourth grade students successfully implement self-regulation of learning. Investigating students’ goal setting strategies and documenting student “voice” through interviews demonstrates what is happening at the level of learning and addresses students’ perception of self-efficacy. This ultimately offers a framework for self-regulated strategies that effective math students repeatedly use and the noticeable gains that result.

**Self-Efficacy for Self-Regulation Learning**

Usher and Pajares (2008) assert that self-efficacy for self-regulated learning could inform and offer a predictive construct for academic task achievement. The study examines whether gender and grade level factors influence self-efficacy for self-regulated learning. A social cognitive lens was used to frame self-regulation as a meta-cognitive process that requires students to explore their own thought processes in order to evaluate the results of their actions and plan alternative pathways to success. These findings helped to frame the self-regulation beliefs that were used to investigate students’ self-regulatory strategies. The rationale for the study was to extend and refine the tenets of the Bandura (1997) and Zimmerman (2000) self-efficacy theory “that self-efficacy for self-regulated learning scores would be positively correlated with indexes of self-efficacy, self-concept, task goal orientation, and academic achievement and negatively correlated with indexes of academic anxiety” (Usher and Pajares, 2008, p. 446).

Usher’s and Pajares’s (2008) findings open the door for future investigation of self-efficacy for self-regulated learning. A goal of this study will be to examine how student belief
systems can guide epistemology and influence academic outcome to further refine and extend research. The cautionary signs that goal setting can be mediated by several variables are an essential component to this investigation. Selection of student participants will be based on the expectation of success, past histories of academic achievement, and ability to set realistic goals. For this study, the participants will not be randomly selected and will be part of an intact classroom. This will provide a defined group that is exposed to the same instruction throughout the study. Additionally, student belief systems are important for acquisition of skills and degree of confidence in their self-regulatory capabilities. This research can be best captured within the consistent environment that is available in a classroom. Usher and Pajares (2008) caution, “Students who lack confidence in their capability to self-regulate their learning are less likely to implement adaptive strategies, and they will more quickly give up in the face of difficulty” (p. 460). The findings indicated that altering low self-efficacy is essential to a student’s effective functioning and success.

Usher’s (2009) qualitative research investigation examines the heuristics student’s employ as they develop self-efficacy. The rules of heuristics can inform students with both high and low self-efficacy in the context of mathematic performance. A social cognitive lens and Bandura’s (1997) four sources that framed self-efficacy beliefs (as cited in Usher, 2009, p. 275) are used here to investigate students’ mastery experience, vicarious experience, social persuasions, and physiological or affective states. Usher’s (2009) study examines the influence of high and low self-efficacy, gender interpretation by African-American and white students, teacher and parent information to clarify children’s self-efficacy beliefs and identification of factors such as self-regulation that might be related to students’ mathematical self-efficacy beliefs (pp. 278-279).
The rationale for the study was to extend and refine the tenets of Bandura’s social cognitive theory. “On academic achievement, there have been few efforts to investigate the sources underlying these self-beliefs” (Pajares and Urdan as cited in Usher, 2009, p. 275). Qualitative and quantitative research in the area of sources has been limited and existing studies have focused on college students and adults. This research study under investigation can offer further exploration and the extension of these issues to elementary students.

Pajares and Urdan (2009) findings indicate a link between self-efficacy beliefs and students’ achievement levels. Consistency in theoretical claims indicates that students’ self-talk related to their beliefs about mathematics abilities. The combination of self-talk and self-modeling can be successful strategies when combined with a positive self-regulatory skill set. Students could successfully coach themselves through challenging mathematical problem solving by employing self-regulatory skills and, in doing so, find satisfaction and confidence in their mathematical capabilities. These findings open the door for future investigations into meta-cognitive analysis and the potential gains that students can achieve from envisioning their own success.

Teacher and parent interviews also offer a unique perspective into the complex environments in which self-efficacy beliefs are embedded into students’ attitudes and self-evaluation. This study will probe both the explicit and implicit messages given to students, and the insight derived from this will provide useful information for interpretation.

**Literature Review Conclusion:**

Although there are limitations and gaps highlighted in the presented studies, each offers an extension of the social cognitive theoretical construct to guide future research. By carefully examining the components of self-regulated learning, it is proposed that educators can develop
more effective strategies to help students acquire important skills and increase mathematical achievement. The paradigm shift from a teacher-centered focus to a student-centered focus is a window into the achievement gap. Clearly, the predominant focus on socioeconomic and subgroup analysis limits insight into the academic gap. Previous analyses, therefore, do not consider the growth potential that can be achieved by individual students and thus perpetuates a deficient model based on limited external factors. As a result, the affective factors that would lead to a more comprehensive analysis cannot be fully explained.
Chapter 3

Research Design

Guided by the theoretical framework, this study investigated the extent to which self-regulated strategies, coupled with self-assessment practices, were effective in addressing mathematical achievement gaps. The following questions framed this mixed methods research study:

1. To what factors do students from different mathematical achievement levels attribute their successes or failures?
2. What effect would the self-assessment tool “Keeping Track of My Learning” have on Alpha Elementary School fourth-grade student performance?

Review of the literature and prominent research studies demonstrated a need to extend beyond limited SES and subgroup analysis to explore students as managers of their learning and the resulting effect on academic achievement. Through the social cognitive lens, student self-described regulation strategies offered insight for refining research. This led to a deeper understanding of what students were thinking and how they strategically shape academic results. A student perspective revealed valuable information that translated into effective instructional techniques. If student management of learning was effective and implementation of self-regulation strategies produced math achievement, it would be a value-added strategy. Explicit instruction of self-regulation strategies prior to skill instruction would be advantageous for mathematical progress.

Methodology

This mixed methods study explored how a shift from teacher-centered control to students as managers of their learning influenced mathematics achievement. It was suggested that the
SES and subgroup variables used to define mathematical achievement gaps offered incomplete evidence as to why some students improved while others did not. The conventional definition associated with achievement gap analysis did not adequately capture the potential influence of self-regulation of learning, self-assessment, efficacy beliefs, and the relationships that these variables would have on mathematical achievement. This scholarly examination of student performance used both qualitative and quantitative data to extend knowledge beyond limited, high stakes testing results. Creswell (2009) specified, “There is more insight to be gained from the combination of both qualitative and quantitative research than either form by itself” (p. 203).

Application of Creswell’s nine characteristics of qualitative research framed the first research question. This was achieved by using “inductive data analysis, participants’ meaning, and emergent design allowing for the building of patterns and identification of themes while working collaboratively” (Creswell, 2009, p.175). The analysis of the qualitative data did help to discern if a possible link between self-regulation strategies, self-assessment, and math results was evident. Interviews were conducted with students, and the results of the interviews were then coded to determine emerging themes and relationships to goal setting, the influence of support, student performance, and self-efficacy. The interviews were used to document participants’ self-described factors that influence performance.

In order to strengthen the triangulation of data, the parents and the teacher of the participants were also interviewed. In the proposed study, participants interviewed were asked to indicate their beliefs as they related to self-regulation, efficacy, and link to achievement. All responses were then coded and placed in three to four categories as determined by the close alignment with the theoretical frame. An additional data source included the researcher’s
journal, which reflected the researcher’s experience during the study. As an anecdotal source, the journal was not be coded.

In this study, a pretest-posttest nonequivalent groups design was used to measure the relationship between the use of the self-assessment tool (independent variable) and pretest-posttest achievement test results (dependent variable). The quantitative data comprised the student scores from the Star Math test administered in September and February. A comparison of the achievement of the students using the self-assessment tool was made to the students not using the tool. A multiple regression test was applied to determine if a positive relationship of statistical significance in the pretest and posttest is evident. Cook and Campbell (1979) acknowledged, “This design is one of the more frequently used designs in the social sciences” (p. 99). The ability to work directly with students and gather information from qualitative and quantitative sources concurrently offered this researcher a rich opportunity to analyze the impact of the self-assessment tool.

This researcher was aware that there would be limitations when implementing a mixed methods study, due to the complexity of the data collection. The convergence of the two data collection methods would be a challenge to this research investigation. The researcher had carefully considered that student level performance data might suggest a predictor of successful math performance. In order to get the essence of the student’s math experience, both research questions were necessary and were important indicators of performance.

Threats to both internal validity and external validity were important considerations when looking at the quantitative data. Campbell and Stanley noted that internal validity answered the question, “Did in fact the experimental treatments make a difference in this specific experimental instance?” (1963, p. 5). For this reason, a consistent application of the intervention to all student
participants in the experimental treatment group at the same time was necessary. This researcher’s selection of two comparable Grade 4 classrooms was important to minimize the threat of internal validity. Additionally, this researcher needed to answer the external validity question as described by Campbell and Stanley, “To what populations, settings, treatment variables, and measurement variables can this effect be generalized?” (1963, p. 5). For this study, the selection of a pretest-posttest nonequivalent groups design allowed for data from pretest and posttest results on a standardized measure to be noted from two intact groups to compare testing results from one group using the tool and one group that did not implement the tool.

The mixed methods methodology was a solid match for this quasi-experimental study. The qualitative findings provided a deeper understanding of students’ self-knowledge and performance. The quantitative findings garnered statistical information that helped this researcher infer a link between the self-assessment tool and effect on the academic performance. According to Feuer, Towne, and Shavelson (as cited in Mertens, 2005), “When properly applied, qualitative and quantitative research tools can both be employed rigorously and together often can support stronger scientific inferences than when either is employed in isolation” (p. 294).

Site and Participants

The AES was located in a rural southeast Massachusetts community. The school had a relatively low mobility index, which reduced variability and fluctuation of participation in this study. A fourth grade classroom was the primary location. The researcher had familiarity and experience working with teachers and students in all fourth grade classrooms at the site. The school was a Title 1 targeted assisted school, funded through a federal grant to aid students in need of reading assistance. Title 1 schools were defined “as having a high percentage of children

At the time of the study, funding through Title 1 was not available for students needing math assistance. Children who attended the participating school live in a relatively homogeneous middle-class rural area with a SES range from very low to very high levels.

The socioeconomic identification of participants in this study was self-reported. Families sought eligibility by completing an application form. The application for free and reduced lunches was part of the introductory information sent to all students when they entered public schools. These forms were reviewed by the local school district, verification of eligibility was made, and families notified. The forms were available on the Massachusetts Department of Education website (www.doe.mass.edu). Student eligibility was based on income criteria set by the federal government. This information was considered in the study findings and was available at the conclusion of the research period.

Selection of student participants implementing the tool was based on enrollment in the same fourth grade classroom. Over the course of the study, the average age range of participants was 9-10 years. Participants’ profiles ranged from low to high mathematical proficiency on local formative and summative assessments. For this reason, it was important to consider that “Students within the classroom have a range of mathematical skills, understanding, intuition, interests, approaches to learning, and needs” (Burns, 2010, p. 22). A critical aspect of this study was selection of participants who would clarify and articulate their thoughts and construction of knowledge in a meaningful manner. This method allowed for evidence of self-knowledge and perception from a more advanced level than from lower elementary grade participants. The participants’ ability to verbalize thinking and choices was arguably more developed in a fourth
grade classroom than in the lower elementary grades through the greater availability of independent classroom opportunities. The Massachusetts Curriculum Frameworks, MCAS testing, Everyday Math core curriculum series, and standards-based report cards indicated that fourth-graders were expected to work independently for longer sustained periods to achieve and demonstrate mastery of content.

A teacher participant with a teaching profile of more than 10 years experience was recruited from one of six fourth grade classrooms. The comparison group classroom teacher had a similar profile. The selected teachers had demonstrated mastery skills through a professional evaluation process, had experience mentoring novice teachers, and had high student proficiency levels on MCAS results. Positive communication received from parents in written or verbal form regarding teaching methods and results was yet another useful indicator of mastery.

The parent participants were willing to engage in an open-ended interview to provide insight into external factors, including the level of parental support and assistance given to student participants. Parents were asked to share their math experience, efficacy beliefs, and perceived change in their child’s math performance prior to intervention and after intervention.

Finally, careful consideration was given to determine which classrooms would be prepared to meet the demands that a mixed methods study would place on staff, students, and parents. The designated classrooms function at a level that encouraged student participation and engagement. This was essential because it proposed to reduce the potential threats that would influence this study.

Data Collection

Multiple data sources were applied to build and develop a solid base of data through the “strategy of inquiry” (Creswell, 2009, p. 14). The proposed research questions aligned with the
selection of inquiry. The intended interview phase and subsequent graphing marked the potential for rich descriptors of student mathematical performance. Inquiry enabled a triangulation of data through interviews, student graphing, and student self-reflection with quantifiable evidence of student performance using a pretest-posttest nonequivalent groups design and application of a multiple regression test.

First, the three interviews served as the potential source for robust descriptive documentation. This researcher sought to understand the influence of self-regulation strategies on performance through participants’ narrative descriptors and results of quantitative data. Data collection took place during an 11-week period, which encompassed one unit of math. This provided a specific beginning and end of the research within the natural flow of an AES fourth grade math classroom.

Second, the quantitative data collection included the student’s fall STAR Math results prior to as well as after the implementation of the self-assessment tool. The STAR Math Assessment from Renaissance Learning was a norm-referenced test administered to all students in the fourth grade at AES and was a standard assessment practice for this school. “The final norming sample for STAR Math included approximately 29,000 students from 312 schools in 48 U.S. states. The reliability estimates were very high, comparing favorably with reliability estimates typical of other published math achievement tests” (McBride, 2011, p. 19). The composite scores of the STAR Math testing results for all fourth grade students were publicly available on the district website. Individual results were not publicly displayed; they were, however, available to teachers, parents, and administrators. To understand the impact of the self-assessment tool and to determine if results were statistically significant, it was necessary to run a multiple regression analysis.
Third, the qualitative data was coded using Zimmerman’s self-regulation model (1998), indicating the three sequential phases of forethought, performance, and self-reflection. Specifically, the three phases and the sub-processes were defined as follows:

Table 1

Three Sequential Phases: Self-Regulation Model

<table>
<thead>
<tr>
<th>Forethought</th>
<th>Performance</th>
<th>Self-Reflection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal Setting</td>
<td>Attention focusing</td>
<td>Self-Evaluation</td>
</tr>
<tr>
<td>Self-efficacy beliefs</td>
<td>Self-instruction</td>
<td>Attributions</td>
</tr>
<tr>
<td>Strategic Planning</td>
<td>Self-monitoring</td>
<td>Adaptivity</td>
</tr>
</tbody>
</table>

Note: From Zimmerman (1998).

Next, to check for accuracy and credibility and to strengthen analysis, a “member check was applied so that participants would judge the accuracy and credibility of the account” (Hancock and Algozzine, 2006, p. 86). All interview responses were reviewed with study participants to affirm accuracy and ensure that it captured the experience. This method helped to avoid error and to eliminate potential threats to the data.

Finally, Zimmerman (2000) cautioned, “The fact that almost all people are capable of self-regulation does not mean that all students actually do take effective charge of their own learning” (p. 83). By carefully examining the components of self-regulated learning, the goal here was to enhance instruction within the classroom to more fully engage students in their assessment process and strengthen learning outcomes. These findings had the potential to influence a shift from teacher locus of control to students as managers of their learning. Teachers could carefully embed these findings into instruction and encourage student awareness and employment of self-regulation for learning, ultimately increasing mathematical achievement.
Data Analysis

Systematic data analysis required diligence in the management of interviews, implementation of the self-assessment tool, and statistical calculations. Creswell (2009) asserted a step-by-step progression enabling the researcher “to see how one step leads to another” (p. 151) to develop salient data for successful study results. This researcher weeded out less significant information that did not align with the research questions and subsequent self-regulated strategies.

Precision while gathering and coding complex information and the identification of essential descriptive modifiers informed this inquiry. This analysis took place in a systematic sequence employing a logic model. KTML, aimed at improving students’ academic performance, involved a set of self-assessment activities performed during an extra 30 minutes in the school week. These activities provided time for student’s identification of their learning progress and articulation of their strategies (immediate outcome). The results provided evidence of increased understanding and satisfaction with the educational process on the part of the participating students and teacher (intermediate outcome). Eventually, the exercises and the resultant satisfaction would lead to noticeable gains, as well as evidence of self-regulation learning strategies by the students who would, in turn, demonstrate their knowledge with repeated patterns of successful strategies (ultimate outcome).

The quantitative data was collected in stages beginning with a Star Math pretest. Students in all fourth grade classrooms administered the Star Math test at the beginning of the school year. The results were collected and analyzed to determine student performance and instructional needs for each classroom. An introduction of the self-assessment tool was provided to one classroom, which students implemented after the pretest and prior to the posttest.
Students were asked to graph performance results using the self-assessment tool, with baseline data collected on three data points prior to the independent variable implementation and seven data points using the intervention. The results from the AES fourth grade class that implemented the self-assessment was compared to an AES fourth grade class that did not. The data underwent statistical testing using multiple regression to determine the magnitude of the effect of the self-assessment tool and statistical significance.

To obtain this research goal, a concurrent embedded approach was undertaken. The phases of operation included:

Phase 1: Initial interview with students, parents, and teacher

Phase 2: Pretest

Phase 3: Orientation and employment of a KTML self-assessment tool

Phase 4: Self-reflection with an open-ended inquiry process to formulate impressions and articulate both effective and ineffective self-regulated learning strategies

Phase 5: Posttest

Phase 6: Concluding interview of all participants

Phase 7: Results on the pretest-posttest using a multiple regression

In Phase 1, the data collected from the initial interview phase required the simplification, identification, coding, and synthesis of themes and patterns that would provide meaningful insight into the various attributes that influence students’ mathematical learning. The interview responses were then transcribed and analyzed. The categorization of this information into predominant areas and subsequent coding offered key evidence toward the study findings. These descriptors were reviewed, sorted carefully, and examined void of researcher’s bias. In Phase 2, a Star Math pretest was administered. Phase 3 included implementation of a self-assessment
tool, which was introduced with results that were collected weekly. Students were asked to determine mathematical results as aligned with goal setting. Each participant was asked to set a math goal as part of the self-assessment. Baseline data was collected prior to introduction of the KTML chart. The raw data was then converted into graphs and the change in performance during the math unit of study was collected. Phase 4 consisted of self-reflection with an open-ended inquiry interview process that provided a narrative description of the data collected during the implementation of the intervention. The data was analyzed in a similar descriptive format that was coded and examined for themes and patterns. Identification of any gaps in the alignment with self-descriptors was recorded. This researcher “seeks to understand the data from the views of participants” (Creswell, 2009, p.16). As Hancock and Algozzine (2006) recommended, “The goal is to understand the situation under investigation primarily from the participants’ and not the researchers’ perspective” (p. 8). The study participants’ prescribed self-regulation and mega-cognitive analysis would present important qualitative information to aid in the investigation of students as managers of their learning.

In Phase 5, a Star Math posttest was administered, and then in Phase 6, a post-study interview was focused on student, teacher, and parent perception of change and defining attributes that contributed to the success or failure of math achievement. The results from the data analysis were shared with the participants to affirm the participants’ acknowledgment of interpretation and accuracy. Corrections were calibrated to ensure data and themes were reflective of the descriptive narratives as transcribed by the researcher.

In Phase 7, a convergence of qualitative and quantitative data occurred at the performance level. The qualitative analysis indicated factors that students attributed to their mathematical performance and the quantitative analysis indicated if a statistical significant
difference was evident. Mixing the two methods allowed for a deeper investigation into students as managers of learning using self-regulation strategies and the potential impact on mathematical performance.

Data analysis using a concurrent embedded approach appeared was an effective methodology and offered the potential for a comprehensive picture to determine not just statistical data regarding performance, but also self-described performance and strategies implemented.

**Reflective Strategies**

This researcher invested in the reflective process by using field notes obtained through a weekly journal and observation protocol. These two strategies enabled the researcher to better understand the experience and influence of factors that affected the data analysis. Strategies of reflection captured both significant and anecdotal descriptors in observation notes and transcription, as well as provided intellectual processing of events that influenced participants and ultimately the research. These were anecdotal sources and were not coded. It was important to note any occurrences that would negatively or positively affect results. Exploration and examination of field notes and reflective journaling offered a unique opportunity to find connections and variables not captured in the interview process. The allowance of perspectives from both an emic lens, the “participants’ own words and concepts” (Maxwell, 2005, p. 97), and an etic lens, the “researcher’s concepts” (Maxwell, 2005, p. 98), provided rigor to this study, and a comprehensive analysis of the data.

**Validity and Reliability**

The importance and assurance of the validity and reliability of this mixed methods study was imperative and rooted in the quality of the data collection and analysis. Validity, as
described by Mertens (2005), “is a unified concept …[in which]… multiple sources of evidence are needed to support the meaning of scores” (p. 353). The instrument used for this study, the KTML chart, was part of the recommended strategies that Marzano (2009) had used to determine student growth, and achievement.

Reliability of this study furthered improved through the use of a summative standardized test. The STAR Math, for example, was administered to all fourth grade students at AES during the fall and winter terms of every school year. Reliability, as described by Fraenkel, Wallen, and Hyun (2012) “refers to the consistency of scores obtained, how consistent they are for each individual from one administration of an instrument to another and from one set of items to another” (p.154). Additionally, confirmation of accuracy was embedded and strengthened by the mixed methods methodology.

During the study participants were asked to review responses that address forethought, performance, and self-reflection to validate the accuracy of content. Miles and Huberman (1994) acknowledged, “The aim is to see processes and outcomes across many cases, to understand how they are qualified by local conditions, and thus to develop more sophisticated descriptions and more powerful explanations” (p. 172). In order to strengthen both validity and credibility, the following activities were essential for this study: classroom observations, participants’ accounts, interviews, observer field notes, affirmation of patterns and themes with participants, testing results, and the researcher’s reflective journaling.

Both external validity and internal validity were addressed in a mixed methods study. External validity, as defined by Cook and Campbell (1979), “refers to the approximate validity with which we can infer that the presumed causal relationship can be generalized to and across alternate measures of the cause and effect and across different types of persons, setting, and
times” (p. 37). The replication of performance using standardized assessment and the same math unit of study offered consistent measures throughout the study. Consistent implementation of the self-assessment tool throughout the study by all participants at the same time provided further evidence of external validity controls.

Next, internal validity, as defined by Cook and Campbell (1979), “refers to the approximate validity with which we infer that a relationship between two variables is causal or that the absence of a relationship implies that absence of cause” (p. 37). In this study, the independent variable was the intervention, and the dependent variable was the pretest-posttest results. The implementation of the self-assessment tool (goal setting) in relation to academic gains (graphing math results) served as a stable variable and a comparison to suggest if a positive relationship of statistical significance was established. The implementation of a pretest-posttest nonequivalent groups design demonstrated vulnerability due to differential subject characteristics that needed to be considered when analyzing the study findings. The use of repeated measures, baseline data, and measuring performance outcomes were strictly adhered to in the collection. The data collection identified a statistical relationship that will guide analysis and strengthen the findings of this study.

Fraenkel, Wallen, and Hyun (2012) specified two conditions that indicated construct validity:

- The characteristics that are measured by the instrument, and
- How well the construct explained difference in the behavior of individuals or their performance (p.148).

For this reason, it was important that the variables being manipulated were clearly defined. In the study, the variables that addressed the first research question referred to the implementation
of self-regulation strategies and performance of students. The second research question addressed the intervention and performance on a standardized test. The convergence of data occurred at the level of performance. This researcher determined whether students achieved a positive result on math performance when using the intervention with the description of their performance grounded in the theoretical framework.

Accuracy of student self-reporting and subsequent graphing data was calibrated with teacher account and observer notes. This follows Mertens’ (2005) requirement that, “Reliability should be calculated after every use” (p. 349). This was an integral component requiring this researcher have continual interaction with students and teacher to check and recheck accuracy of reported achievement gains on formative testing. The reading of performance data through an interrater agreement had been built into this study. Interrater agreement (Light, Singer, and Willett, 1990) is defined as “the consistency of ratings of the same stimuli” (p. 166). Member checks (Maxwell, 2005) was systemically employed throughout the study as “this is the single most important way of ruling out the possibility of misinterpreting the meaning of what participants say and do and the perspective they have on what is going on” (p. 111).

Lastly, Miles and Huberman (1994) indicated that when analyzing the findings, “Take a skeptical, demanding approach to emerging explanations” (p. 263). Butin (2010) stated, “Your goal is to enhance the trustworthiness of your research so you can describe and analyze your findings without having a skeptical and dubious reader over your shoulder” (p.103). The insurance of validity for this study relied on the researcher’s ability to present a chain of evidence that would solidly linked the research questions and would be replicated in other environments providing a rich description of students’ ability to manage their learning in order to
make mathematical gains. Ultimately, any statistical significance would forecast a viable way to narrow the achievement gap.

**Researcher Biases**

The identification and conscious awareness of the researcher’s personal biases would be conceptualized and noted to avoid interference with the study results. The familiarity with the site and availability of participants offered an advantage in conducting the study. This allowed for quick acclimation to the site and ease of trust from the study participants. The caution here was avoidance of any preconceived bias regarding student performance based on summative testing results. Additionally, it was imperative to remain alert and cautious to any preconceived ideas based on prior knowledge of students’ motivation and work ethic that would negatively influence the data coding and analysis. Emerging patterns and themes within the duration of the study remained grounded in the natural flow of events and not influenced by subsequent events or forecasts. Attention to detail and careful handling of the data was imperative. A conscious, subjective lens would be well documented in the reflective journal and considered when collecting each piece of evidence. Interview notes were carefully transcribed. Coding was meticulous and checked for accuracy by colleagues.

Selection of a fourth grade teacher and comparison classroom teacher occurred based on parent confirmation of effective results and the researcher’s knowledge of the teacher’s background, experience, and employment of effective teacher practices as indicated by Marzano, Pickering, and Pollack (2001); DuFour, DuFour, and Eaker (2008); Stronge (2002); Strong, Silver, and Perini (2001); Duckworth (1987); and Tomlinson (2001). One of the fourth grade classrooms was assigned to implement the tool and a comparable classroom was selected. At the onset of the study, the researcher was aware of each student’s academic profile and SES status.
A bias held by this examiner that needed to be transparent was the belief that all students would learn and that employment of goal setting and a self-evaluation component added to the learning process enhanced achievement results (Marzano, Waters, and McNulty, 2005; Stronge, 2002; Zimmerman and Schunk, 1989; Zimmerman, 1990; Bandura, 2002). It was also important to disclose the belief that an effective teacher would produce a positive climate in which to learn and would affect student outcome. By selecting students from a master teacher’s classroom, there was a greater tendency toward more positive academic results despite the explicit employment of math goals, self-assessment tool, and student self-reflection. The experimental group attitudes influenced by the researcher’s spotlight on the implementation the self-assessment tool and student achievement would need to be considered. This focus had the potential to influence the students’ responses and benefit of change and improvement that would be indicated. The Hawthorne effect (Parsons, 1975) provided a threat to the internal validity of the study due to the introduction of the intervention and potential positive effect on student responses and performance. Additionally, as students in the experimental class knew that their classroom experience was part of a study, it was hypothesized that scores would improve by using the self-assessment tool. Furthermore, internal validity threat due to differential subject characteristics related to the teachers and their teaching methodology and credentials might occur despite the similarity of experimental group and comparison group. Therefore, it was apparent to this researcher that the focus needed to remain on students’ self-reported variables and upon the employment of learning strategies, which offered a student-centered picture of performance, efficacy, and change. The administration of the theoretical framework offered by Zimmerman (1998) exemplified in the three phases of self-regulation remained the backbone of this investigation. Staying true to the theoretical frame and aligning the goal setting with the current
mathematical unit of study offered an unbiased approach. Zimmerman, Bandura, and Martinez-Pons (1992); Bandura (1997); Burns (2010); Usher, and Pajares (2007), Usher (2009); Lally, and Miller (2006); and Frank, Kazemi, and Battey (2007) provided study results that helped to calibrate this study’s findings with emerging data patterns and themes, and potentially extend educational research.

Additionally, the ability of student participants to describe forethought, goal setting, and attributes might create bias due to a lack of data or erroneous reporting. This could create researcher bias in the form of unconscious misrepresentation of critical pieces of evidence. Participants’ failure to articulate effectively what they were feeling, seeing, and performing at the time of interview and data collection would result in an incomplete picture that would lead to inaccurate coding. As this study unfolded, it was important to consider the cautionary note described by Miles and Huberman (1998) as “elite bias” or “the over weighting data from articulate, well-informed, usually high-status informants and under representing data from less articulate, lower-status ones” (p. 263).

To avoid bias it was important to share preliminary results with a colleague who would have knowledge of this research and would provide, as Yin (2009) recommends, “alternative explanations and suggestions for data collection. If the quest for contrary findings can produce documentable rebuttals, the likelihood of bias will have been reduced” (p. 72). The perception of this researcher of the site, participants, and climate of learning might have caused unintentional bias that would not be readily apparent. Yin (2009) cautioned that “losing your perspective or your “bracketing” ability, being co-opted into the perceptions and explanations of local informants” (p. 262) should be avoided. Therefore, it was necessary to work with others to avoid
this shortcoming, as this would potentially cause the reporting of misleading results without the careful consideration of contrary evidence.

**Reactivity**

Unique to this mixed methods research study design and selection of study site was the familiarity of the researcher with the study participants. The researcher’s daily work incorporated and encompassed responsibility for student achievement, which was under investigation. The researcher was an observer within the classroom and would introduce a tool that focused on academic goals, which would directly influence the study outcome. Full disclosure would be provided to all participants and permission to conduct the study secured.

As defined by Creswell (2009), the inductive analysis process as defined by Creswell (2009) consists of “collaborating with the participants interactively, so that participants have a chance to shape the themes or abstractions that emerge from the process” (p. 175). This consideration remained an essential component of this study, as it would prove to be both beneficial and provided a deeper understanding for this research. Interviews probed more comprehensively based on prior knowledge of the site and influences that were not apparent to outsiders. This included the knowledge of the teachers’ teaching practices, assessment protocols, and feedback strategies. This information produced more effective interview questions for the participants and probed more deeply into feelings, perceptions, and results.

Understanding the environment and potential stressors lead to an inquiry-based approach that was more reflective and avoided time-consuming deviation from essential data acquisition. Maxwell (2005) argued, “What is important is to understand how you are influencing what the informant says, and how this affects the validity of the inference you can draw from the interview” (p. 109). A deep understanding of the potential influence of reactivity and reflection
on this research remained an ongoing process throughout this study. Procedures had been built in to minimize the negative threat of reactivity and captured its positive attributes. To anchor the study and to avoid the possibility of a potential validity threat, the researcher’s reflective journal and the collaboration with a colleague offered alternative interpretations.

**Protection of Human Subjects**

It was necessary to employ several procedural steps to ensure that protection was afforded all study participants. However, there was no known or obvious risk to participants. Ethical standards remained in place at all times throughout the study. The rights, needs, values, and desires of the participants were respected and remained a priority during the study implementation.

This mixed methods study included the participation of human subjects from children 9 or 10 years old to adults. It was therefore necessary to build into the study protection of all participants through full disclosure of involvement, sensitivity of human subjects’ developmental stages, and impact on academic performance. All participants in the study had parental consent; the child’s assent was also obtained. This researcher supervised all teachers at the study site; the focus of this study, however, was on students as managers of their learning and not evaluation of the teacher. Involvement in the study was not negatively impacted or enhanced by the employment of any participant. All study participants were advised of their right to withdraw from the study at any time without negative repercussions.

Participants were observed in their normal education environment and were asked to share their thoughts, perceptions, and opinions of their academic progress, and subsequent strategies implemented in the learning process. Parental permission was required, and students’ acknowledgement of their participation was secured. Interaction took place through the formal
process of open-ended interviews and indirectly through data analysis. Careful and meticulous coding was completed with all data. Member checks were implemented to test for accuracy and validity of results.

Finally, the Institutional Review Board (IRB) at Northeastern University reviewed the research design, and approval was obtained prior to the implementation of this study and any data collection. In addition, this researcher adhered to all board guidelines and ethical standards of Northeastern University. These procedures and guidelines were diligently applied to this research and findings.

**Conclusion**

The purpose of this study was to support the claim of the benefit of using self-regulation strategies, coupled with self-assessment practices, and the potential effect on mathematical achievement. If a strong positive relationship would be found when using the intervention, it would provide meaningful information beyond achievement gaps based on socioeconomic and subgroup categorization. If a positive correlation was evident in the performance results when students implemented self-regulation strategies, it provided valuable information to be shared with AES fourth teachers. Herein lied the possibility for information that can ignite the hope for self-regulation of learning and a broader response to the achievement gap predicament that would go beyond the commonly articulated socioeconomic and subgroup reaction.

Examining and analyzing the performance data of self-reported low-income students offered quantitative information that looked beyond SES and subgroup. Patterns of success would move students to think beyond labels and to understand that control of forethought, goal setting, and performance was within their grasp.

The quantitative data using a multiple regression analysis was an important aspect of this
study. This analysis helped to document the potential of performance gains when one AES classroom used the self-assessment and another does not.

Additionally, a path of evidence observed in classrooms whereby peer learning, cooperative learning, student discourse, differentiated instruction, and multiple intelligences were effectively woven into the fabric of teaching and learning was important evidence. It was important to note that a connection to an individual’s self-assessed mathematical performance would be mediated and influenced by the social dynamic within each classroom environment. This researcher gathered data to carefully investigate how students would successfully coach themselves through challenging mathematical problem solving by employing self-regulatory skills. In doing so, student’s satisfaction and confidence in their mathematical capabilities would provide further evidence of an exciting impetus for learning.

This research project was of educational significance primarily because of the potential negative repercussions that low achievement gains had on a child’s future educational success. Students, as managers of their learning, provided evidence to help identify elements that contributed to mathematical achievement gaps. It was proposed that student implementation of self-regulation strategies remained a powerful mechanism to explore efficacy beliefs and links to achievement. What had become more apparent from the literature was that no single factor or label would adequately offer insight into the achievement gap without focusing on a shift from teacher locus of control to students as managers of their learning.
Chapter 4

Report of Research Findings

Introduction

The purpose of this mixed method study was to gain a deeper understanding of how shifting the locus of teacher control to students as managers of their learning would impact mathematical performance and potentially narrow the achievement gap. Investigating how fourth grade students from different mathematical achievement levels describe self-regulation strategies and demonstrate achievement when using a self-assessment tool offered insight into the dynamics of student learning and student performance. A concurrent triangulation of data as applied to this research allowed for a well-validated study with both qualitative and quantitative evidence to answer the research questions under investigation.

The first section of this chapter identifies the factors that students described as influencing their learning. The social cognitive lens of Zimmerman’s Self-Regulation Model (1998), Table 1 illuminates students’ self-reported elements in relation to their mathematical learning. The second and third sections provide insight from the perspective of the social environment and the influence of others through parent and teacher interviews. The next section provides analysis of statistical data from the student’s performance results on STAR Math during the fall and winter. A comparison of mathematical performance was made using the scores of the AES fourth grade students implementing the self-assessment tool with a group of AES fourth grade students that did not. A multiple regression analysis was applied to the STAR Math performance results to determine if a statistically significant positive relationship could be established. A discussion of findings based on methods used and relevance to investigation of
each research question are found in each subsequent section. Lastly, a summary of key findings concludes Chapter 4.

**Methodology**

A mixed methods approach was implemented to address the two research questions under investigation. Using the qualitative design, this researcher addressed the primary question: To what factors do students from different mathematical achievement levels attribute their successes or failures? The design supported the application of a self-assessment tool by AES fourth grade students coupled with three semi-structured interviews for collecting qualitative data. The interview data captured the voice and self-reported insights of students who participated in the study. Additionally, the two interviews with the master teacher and self-selected parents explored the influence of others, perception of student confidence, and if a potential change in mathematical performance was evident. The master teacher and parent semi-structured interviews provided additional information pre/post administration of the self-assessment tool.

A pretest-posttest nonequivalent groups design to gather quantitative data was applied. This methodology deepened understanding providing a comprehensive picture of AES student mathematical performance. Quantitative data collection strengthened the analysis with a numerical interpretation concurrently with students’ self-reported performance. The application of multiple regression analysis addressed the second question: What effect would a self-assessment tool have on student performance? Throughout this chapter, quantitative statistical tables and qualitative figures represent both collections of data enhancing synthesis for clarity and yield a holistic picture of student performance to support the claim of benefit.
Analysis of Study Participants and Profiles

In order to ensure anonymity of participants, a number was assigned to each student and a pseudonym was used to identify the school. Student and parent interviews were conducted as a group without associating individual names with responses. The student interviews were conducted in a focus group format that included participants (n=23) from the same classroom. The group implemented the tool was comprised of eleven females and twelve males. One female student declined to participate. The comparison group data was available for (n=24) students that were of similar age and enrolled in a different AES fourth grade classroom. The comparison group was comprised of eleven females and thirteen males. To clarify further, there was a slight increase in the number of males in the group implementing the tool and number of males in the comparison group. The Star Math test was administered pre/post study to both groups. The result of the quantitative data collection was used to determine if the implementation of the self-assessment tool demonstrated a statistically significant positive relationship. This analysis addressed the hypothesis with the claim of evidence to determine if the self-assessment tool had an effect on student performance.

Data Collection Procedures and Key Findings Organized by Research Questions

Qualitative Data Collection Procedures and Key Findings

Qualitative data collection was defined by the first research question: *To what factors do students from different mathematical achievement levels attribute their successes or failures?* Students were asked a sequence of questions, Appendix B, to investigate if self-described factors and self-regulation affected AES students’ mathematical performance. Transcripts from the student interviews were audio recorded, transcribed, coded, and member checked by participants. Identifying themes were noted, documented, and gave voice to the students’ self-described
factors. Furthermore, the application of nine characteristics of qualitative research framed the first research question (Creswell, 2009, 175-176).

1. Natural setting with the collection of data in the field provided the backdrop for this study. This research study was conducted at the AES School. The classroom setting and environment where the students completed the self-assessment were familiar to the students. As the administrator of the building, this researcher had face-to-face contact with all participants on a daily basis throughout the 11-week study.

2. Researcher was the critical resource for collecting data, examining the self-assessment tool and student documentation, and interviewing all participants.

3. Multiple sources of data were collected from the participants, self-selected parents, and master teacher. Data collection included pre/post interviews with the teacher and self-selected parents (n=15) of the experimental group. In addition, data included interview results, which were coded and placed in categories guided by the theoretical lens noted in Table 1.

4. Inductive data analysis was conducted using the data collected from the interviews to build patterns and themes from the onset of the study. This researcher engaged in a back and forth process between the themes and the database, which helped to configure a holistic picture of student experience. Member checks were executed to ensure accuracy and credibility of the data throughout the various stages of the research.

5. Participants’ meaning was derived by working collaboratively with students and focusing on the meaning from the student perspective rather than from the researcher’s perspective.
6. Emergent design allowed this researcher to stay open to the shift that occurred during the qualitative phase by understanding the impact this research could have on the learning environment. It was important for this researcher to understand and stay focused on the factors that students described as affecting their learning and math achievement.


8. Interpretive inquiry was employed to provide a comprehensive analysis of meaning from multiple sources. The participation of parents, teacher, and the researcher’s interpretation was considered to provide a more in-depth analysis.

9. Holistic accounting was implemented by using multiple data sources. This strategy captured a complex picture of how implementation of self-regulation strategies could potentially address the mathematical achievement gaps beyond SES and subgroup variables. Looking through the social cognitive lens and collecting qualitative data collaboratively with participants offered this researcher an opportunity to extend the research. Shifting the locus from teacher control to students as managers of their learning by implementing a self-assessment tool offered the potential to deepen student understanding regarding the ability or inability to grasp math content.

Pursuing this further, a simple chart, Chart 1, outlined the procedures and the analysis that guided this research.

**Chart 1: Qualitative Data Collection**

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Theoretical Frame</th>
<th>Instruments</th>
<th>Participants</th>
<th>Timeline</th>
<th>Data Collection</th>
<th>Description of Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>What factors do students from different mathematical achievement levels attribute</em></td>
<td>Social cognitive lens with a constructivist view that derived</td>
<td>Interviewed participants asking open-ended questions that</td>
<td>Student (n=23)</td>
<td>11 weeks</td>
<td>Interview Data: Student’s pre/mid-point/post interviews</td>
<td>Reviewed all data to determine emerging themes and patterns for</td>
</tr>
</tbody>
</table>
The tenets of Bandura’s (1997) work and the influence of self-efficacy on performance, Zimmerman’s (1998) self-regulation strategies and their relationship to achievement, and Dweck’s (2006) assertion of a growth mindset and the positive attributes for learning were important factors that shaped the theme analysis. Following this further, the influence of others and the triadic interplay between self, environmental influences, and performance were noted as contributory factors for achievement. This information strengthened the analysis and provided a holistic picture rather than a one-dimensional view of AES students’ mathematical performance. Stronge (2002) affirms, “A partnership among school support programs, teacher, and parents form a triangle with the student in the center. In the triad, the teacher and the parents have the greatest contact with the child” (p.86). Schunk and Zimmerman (2007) acknowledge, “Parents and teachers are an important part of a student’s social environment that can influence human functioning, affect personal variables, and behavior. Specifically, “Students who receive

<table>
<thead>
<tr>
<th>Frame of the participants</th>
<th>Three-phases Self-Regulation Model Table 1</th>
<th>Self-selected parents of study participants (n=15)</th>
<th>Master teacher pre/post-interviews</th>
<th>inductive data analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meaning</td>
<td>explored self-regulation strategies, perception, change, and performance</td>
<td>Self-selected parents pre/post interviews</td>
<td>Identified patterns between the prescribed themes to establish a holistic picture; consolidated information and recorded Tables 2, 3 &amp; 4 and Figure 3, 4, 5, 6 &amp; 7</td>
<td></td>
</tr>
</tbody>
</table>
encouraging feedback from teachers may feel more personally efficacious and work harder to succeed” (p. 8). Moreover, Bandura (2002) states, “Social support raises perceived efficacy which, in turn, is accompanied by higher academic achievement and greater satisfaction…At the elementary school level, maternal, paternal, teacher, and peer support all contribute to children’s perceived academic efficacy” (p. 282).

The interplay of the social environmental influences was addressed through interviews with the teacher and the self-selected parents. The master teacher was interviewed and data collected offered perspective of experience, influence on student performance, perceived student efficacy, insight into instructional approaches that guided student learning, and potential effect of SES during the time of this study. Additionally, self-selected parents were interviewed to extend an understanding of perceived efficacy, change, and improvement at the final phase of the study. Two semi-structured interviews were conducted pretest/posttest with each and done separately. Quantitative and qualitative data was gathered concurrently, analyzed separately, and integrated at the level of performance. The fall STAR Math data collection established both a baseline and performance level prior to the implementation of the self-assessment tool.

Initial Student Interview: The student interviews consisted of open-ended questions, which explored perceptions, self-efficacy, and self-regulation strategies. The AES student responses to the interview questions, Appendix B, were coded; each was given a number to indicate frequency and reference to the following: forethought, performance, self-reflection, improvement, and change. During the initial interview, the students shared their feelings about math and how parents and siblings influenced mathematical skill development and understanding. The introductory interview questions established students’ feelings toward math. A majority of responses were within the realm of positive feelings with a strong indicator that
students were confident in their ability and saw themselves as capable math students. A student offered, “I think it [math] is really fun.” However, a few students expressed less positive feelings in the form of concern. One student noted the importance of math and yet appeared to display a concern that math needed to be done right. This student was less enthusiastic and indicated, “I feel like I can’t wait for this [math] to be over.” A similar response suggested, “I want to get the lesson because I don’t want to make a mistake on it.” This student expressed concern and fear rather than interest in the process of learning. Mathematical risk taking and learning from failure did not appear to be a positive option for this student. As Dweck (2006) affirms, this type of inflexible thinking can limit risk taking and one’s ability to respond positively to obstacles since “children with a fixed mindset want to make sure they succeed” (p.17). Students who express feelings of concern may convey less openness to risk taking and may believe that mistakes are not part of the learning process. A more traditional approach to mathematical instruction and learning appeared to be a more comfortable option for these students, whereby the teacher directs student responses in a formulaic approach that was prescribed and controlled by the teacher.

When AES students were asked about strategies and the implementation of self-administered factors that promote mathematical learning, a majority of students shared that working with others was part of a successful repertoire of strategies: “If, I’m with my parents or my brother or my whole family, we’ll try working on it [math problem] together, and sometimes when we are with a teacher, we’ll try it together, too.” Schunk and Zimmerman (2007) concur, “The notion of reciprocal interaction illustrates how people can affect their behaviors and environments with their thoughts and beliefs. Important processes that people use to exert control are their self-efficacy and self-regulation” (p.9). The social environment and familiar
role models are recognized as contributing factors to strengthen feelings of confidence. Students validated this by stating, “I usually don’t get stuck, I usually just go to my parents and we, my parents help me and we do it [math problem] together.” Lastly, a student indicated that working independently was a strategy that was effective. “I don’t usually share my math, well I don’t usually ask for help or anything because it’s kind of, I kind of like to be independent.” This student appeared to imply that independence in mathematical ability was a positive trait that fostered a successful outcome. The responses from students who expressed positive feelings and positive beliefs about their mathematical abilities and strategies suggested openness and hopefulness about their learning. The students who indicated concern and less positive feelings about math suggested a fixed mindset, in which they would be less likely to seek challenge and explore different strategies. Dweck (2008) cautions, “In the fixed mindset, everything is about outcome. If you fail - or if you’re not the best - it’s all been wasted. The growth mindset allows people to value what they’re doing regardless of the outcome” (p.48).

**Forethought:** Zimmerman’s Self-Regulation Model (1998), Table 1, as applied to this research, indicated that students were able to define each phase. First phase, forethought, includes goal setting, employment of strategies, and subsequent self-efficacy beliefs. A majority of AES fourth grade students acknowledged the importance of setting goals and the relationship to math achievement: “I set math goals for myself because if I don’t set goals then, I’m not going to really want to do math like say I wanted to pass a math test…” A majority of students responded to the question regarding goal setting suggesting that they were aware that forethought could have an impact on their academic performance and success. A student asserted, “If, I didn’t set goals in math, I wouldn’t really get as far as I am now.” Another student shared,
If I didn’t set goals for math, I would probably get zeros on all my tests cause you wouldn’t be like I want to get a 100. You would be like I don’t really care what grade I get I’ll just skip through this. I’ll just fall asleep.

Goal setting was expressed as a strategic step in learning whereby making incremental gains could result in the desired outcome. The majority of AES students expressed the intention of goal setting and the ability to make a connection between forethought and positive math performance.

Student responses suggested engagement in forethought as it applied to the second subset of forethought, self-efficacy beliefs with an influence on goal setting and, ultimately, mathematical performance. The students’ expression of efficacy in the form of feeling positive was evident in several responses. The ability to make a connection between goal setting and results was further confirmed by students. A student recalled, “I’ve set goals that like math tests and things that we do in the class daily and I usually do good when I set the goals.” Another student offered, “I set a goal and the goal I set was to do well in multiplication and now I’m doing really well in it.” Numerical goals and fixed targets were suggested as helping students achieve. One student piped in, “A goal that I set was to like when we have a math test to get at least 90 or higher.” An awareness of long range planning was suggested by indicating, “A goal that I set for myself was to get a pretty good score on MCAS (Massachusetts Comprehensive Assessment System).” Students acknowledged a positive connection with goal setting to impact their lives and long-range plan. Furthermore, students suggested an awareness and an understanding that the goals they employed would help them achieve, and, in so doing, forethought could provide benefit to future success. Thematic analysis supported that goal setting by AES students was defined by the importance of math as it relates to future success.
Further analysis indicated that students were able to voice math goals that aligned with performance expectations. Deductive thinking was evident in students’ ability to link forethought and performance. The impact of setting learning goals and the potential for a desirable outcome was affirmed by an AES student, “A goal I set for myself is that I’m going to try to get into college and get a job. To get into college you need to know math.” This cognitive recognition suggested the student’s ability to think beyond immediate math work denoting forethought was evident. Students’ responses implied that they were aware of goal setting strategies and the link to achievement. Several responses demonstrated the importance between learning goals and a desirable long-range connection. One student suggested and emphasized the importance of this connection by stating, “I set goals for myself cause if I don’t, then I’m not going to really achieve anything in life.” The AES student responses and analysis of the data suggested an awareness of the interplay of the factors described in Figure 1. Other students acknowledged, “If I didn’t set goals for math, my life would be going nowhere,” as well as, “I set my life goals like I set like what I want.” The mega-cognitive engagement suggested that students could direct their learning by the implementation of self-regulation strategies. Student responses demonstrated that Zimmerman’s Self-Regulation Model (1998) was indeed a cyclical process, with one component working to drive the next, and the experience of success fostered self-efficacy and motivation to continue the process. Zimmerman and Schunk (1989) outline the sub-processes of Self-Regulated Learning validating that these “are not mutually exclusive but rather interact with one another. While observing aspects of one’s behavior, one may judge them against standards and react positively or negatively” (p.8). The interplay of student beliefs, self-regulatory processes, and the reciprocal nature of that relationship are outlined by Schunk and Zimmerman (1989) and displayed in Figure 1. The arrow points in both directions showing the
dynamic nature of this model. Success of learning goals builds upon self-efficacy beliefs, which in turn can engage and motivate. Students’ learning experiences can shape reactions and can provide valuable feedback to the learner. Repeating the process as each new experience is encountered offers a cyclical feedback loop for student engagement and potential for successful self-regulation.

### Figure 1: Schunk and Zimmerman (1989) Social-cognitive model of self-regulated learning.

The third component and subset of forethought, strategic planning, was defined by the specific employment of math methods. The strategies described and implemented suggested very detailed application of problem solving techniques. The students acknowledged in their responses that several different strategies could be successful. Pursuing this further, it appeared that students had an understanding that not just one way of problem solving was required to develop skills and to be successful. Students’ willingness to engage in a variety of strategies to problem solve offered evidence that within the classroom environment the master teacher encouraged flexibility, critical thinking, and self-monitoring. This openness and encouragement enabled students to implement strategies that addressed individual learning styles and self-control. This instructional approach supported the claim that the master teacher was open to shifting the locus from a teacher-centered classroom to a student-centered learning environment.
The AES student responses appeared to imply that employment of self-selected strategies and problem solving methods were effective and subsequently provided positive results. Some specific methods that were used for problem solving were described as “lattice method, column-solves method, old fashioned way with the carrying, hard ones first” as well as process “think, write out a diagram, say it over and over, breaks.” Figure 2 highlights the differences and compares the core program used by AES students with traditional math. The Everyday Math program encourages students to implement a variety of strategies to problem solve and to explore with their peers alternative solutions. There is less emphasis on the traditional math approach of one standard procedure for each of the four basic operations of arithmetic. The diversity of strategies described suggested that AES students were aware of their learning style, exercised the ability to implement effective forms of problem solving, demonstrated control, and made choices which met their learning needs. The student responses included:

For math problems, I use a lot of the tricks that Everyday Math [core program used by all AES fourth grade students] has; What I find helpful is, like I need help on say a multiplication problem, I use the lattice method; If I have a problem with like multiplication, I use the column-solves method; If I need help with problem solving, I usually write out a diagram; If I’m having problems with an addition problem…I usually use the old-fashioned way with the carrying.

Figure 2: Major differences in Everyday Math [core program] as compared to Traditional Math.
Students’ ability to exercise control and implement effective strategies suggested the cyclical interchange as noted in Figure 1 and its viability as a framework for learning. The student directed actions suggested that AES students had the ability to implement self-regulation strategies and influence outcome. Following this further, control of their learning had the potential to yield success offering valuable feedback to make adjustments as needed. Gardner’s (1993) Theory of Multiple Intelligence confirms, “The problem-solving skill allows one to approach a situation in which a goal is to be obtained and to locate the appropriate route to that goal” (p.15).

**Performance:** The second phase of the Zimmerman’s Three Sequential Phases: Self-Regulation Model (1998), performance, was demonstrated by the administration of the self-assessment tool. The self-assessment tool allowed students to self-evaluate through the weekly graphing of math performance and progress toward self-defined goals. Using Marzano’s (2009) KTML graph, Appendix A, each student in the experimental group graphed their mathematical performance results. As suggested in Figure 1, Schunk and Zimmerman’s (1989) Self-Regulatory Learning Processes, students can use quantitative data to make judgments based on their performance and exercise control of their learning. AES students were able to observe quantitative evidence of performance by using the KTML graph. This self-monitoring process and the interpretation appeared to influence self-efficacy and build a pattern of success. As an example, one student shared self-efficacy beliefs and results, “I feel very confident when I set my math goals because I set math goals that are realistic for me to achieve.” Gardner (1993) highlights, “Self-monitoring helps students to take active responsibility for their own learning” (p.130).
**Self-Reflection:** The third phase of Zimmerman’s (1998) Model of Self-Regulation Table 1 noted self-reflection, which was captured in the AES students’ awareness that different strategies were needed to motivate and to encourage effort. Self-describing strategies noted by AES students suggested that implementation of self-regulation occurred; students made individualized choices implying control, and a desired outcome was achieved. As an example, one student stated, “If I get stuck on a math problem, I would skip it, go to the end and finish [the other problems] and when I check it [the problem], I try to do it again. If, I still can’t do it [the problem], then I’ll just estimate what [the answer] was.” Employment of targeted strategies enabled students to push through and wrestle with challenging material. Making adjustments based on self-assessment, Figure 1, suggested perseverance and its importance as a contributory factor of achievement. Students explained the process and implementation of self-selected strategies and shared:

If I get stuck on a math problem, I would skip it, go to the end and finish and when I check it, I try to do it again and if I still can’t do it, then I’ll just estimate what it was; If I get stuck on a math problem, I usually if my method isn’t working, I usually try a different one.

The majority of AES student responses indicated a pattern that allowed for redirection and return to the problem with a plan of action. Another student shared, “I usually skip it and do the rest of the problems and then go back to it and sometimes the other problems will give you the answer to that problem.” Students affirmed management of their learning by the expressed ability to assess the problem, implement self-regulation strategies which, included self-control with a viable plan of action. Zimmerman (1989) acknowledges that, “systematic observation of one’s own learning progress can produce positive self-reactive effects during student learning” (p.333). Following this further, Bandura (2002) asserts, “Whatever other factors serve as guides and motivators, they are rooted in the core belief that one has the power to produce desired
effects by one’s action, otherwise one has little incentive to act or to persevere…” (p.270). AES students explained perseverance as working through problems to produce a desired result. Student responses suggested specific actions that included:

What I usually do when I get stuck on a problem, is I usually read it a couple of times again and again and then I usually understand it better then I can do it; If I have been doing a lot of math problems like and my brain like is sort of down from doing all those math problems, I would normally like take a two-minute break and then go back…; and when I have problem solving ones, I usually draw a picture and then after I finish a hard problem I take a two-minute, one minute, 30 second break then I get back on the work.

These self-reported methods suggested that students were able to assess their learning, make judgments, and react with an effective strategy, indicating a stream of actions that were self-controlled and self-monitored by the students.

Figure 2 outlines the flow and fluidity of essential attributes as described by students. The identified attributes of learning appeared to work together to structure the learning dynamic that was student controlled and self-managed. The successful implementation of each element
appeared to foster patterns of mathematical success. Analysis, therefore, as representative of the qualitative information collected and recurrent themes, Figure 2, answered the first research question under investigation: *To what factors do students from different mathematical achievement levels attribute their success or failure?*

**Self-Efficacy:** According to social cognitive researchers, the successful implementation of self-regulation strategies can influence performance and participants’ self-efficacy beliefs. Successful implementation of self-regulation suggests that motivation and continuance of actions build on successful implementation of effective strategies. Bandura (1997) proposes, “Individuals’ efficacy expectations are the major determinant of goal setting, activity choice, willingness to expend effort, and persistence” (p. 86). AES students defined self-efficacy with positive and negative word choices including: “fun, good, math comes easy, I want it over with, hard, not good, I don’t get it,” and needing “help from others.” A majority of participants believed they were good math students, supporting the claim that self-efficacy beliefs were positive. Reaction to the question of self-efficacy resulted in responses that implied a positive reaction to their mathematical performance. Student responses included:

I think I am a really good math student and like it’s really easy for me that that’s it; I think I’m a good math student because I really know how to multiply, divide, subtract and add; I think I’m pretty good at multiplying, subtracting, and dividing so I think I’m pretty good at that but I’m, not very good at problem solving; I think I’m a good math student like I’m not the best but I’m not the worst. I’m kind of like in the middle more towards the best but I’m kind of like in the middle; I think I’m a pretty good math student but I make it too hard for myself; I think I’m a good math student but with all like the stuff we are doing it came really easy to me and for second and third grade but now that I’m in fourth grade it gets a lot harder; I think I’m in the middle because on some multiplication facts I’m not that good and I don’t think I’m really good at division at all…; and I think I’m a pretty good math student but sometimes I don’t get some stuff in math very well and I need a little help.

The majority of student responses appeared to draw from past experiences and demonstrated self-reflection. Analysis of responses indicated that AES students assessed their performance in
a procedurally based concrete manner with variation noted in the degrees of performance and self-efficacy. It appeared that students were able to acknowledge that learning was a process and that mastery can be a difficult. Dweck (2006) asserts, “When people drop the good-bad, strong-weak thinking that grows out of the fixed mindset, they’re better able to learn useful strategies that help with self-control” (p. 242). Moreover, Bandura (2002) cautions, “Without a robust sense of self, people are easily overwhelmed by adversities…” (p.277).

Table 2 represents the consolidation of student responses and thematic analysis supporting Zimmerman’s Three Sequential Phases: Self-Regulation Model, (1998), prior to the implementation of the self-assessment tool. The coding and data analysis indicated the performance phase was referenced most frequently (123), suggesting that students were aware of their individualized results and described this in relation to their own work. Self-reported elements of forethought (78) and self-reflection (79) were not as frequently stated suggesting that self-regulation and factors that attributed to learning were not as overt for some students. Gardner (1983) explains,

Over the course of development, one proceeds from objects to statements, from actions to the relations among actions, from the realm of the sensori-motor to the realm of pure abstraction—ultimately, to the heights of logic and science. The chain is long and complex, but it need not be a mystery (p.129).

Moreover, self-regulation implementation may not be easily discernable to some students within this age range. The information gathered at the initial interview suggested that some students did express the implementation self-regulation strategies, and some students did express the belief that these factors influence math performance.
Table 2: AES Implementation of Self-Regulation prior to self-assessment tool.

**Mid-Point Student Interview:** At the midpoint of the study, the group implementing the self-assessment tool (n=23) underwent the second semi-structured interview to probe implementation of self-regulation strategies, perceptions of improvement, and change as it applied to mathematical performance. The group used the intervention for four weeks, Appendix A, recording both baseline and progress data. Students shared information about implementing the self-assessment tool and the impact on their performance. Self-described student responses to the semi-structured interview enabled this researcher to gather qualitative data from the student perspective at this critical phase of the study.

**Self-Assessment Tool:** This study and the use of the self-assessment tool provided a means for students to keep track of their mathematical performance, make adjustments, and control the outcome. The majority of students validated the claim that using the self-assessment tool did provide an added dimension to their mathematical learning. Only two students indicated that it did not change or provide a positive aspect to their learning, “I really don’t think it
changed my math because I really just stayed with what I was doing before; it didn’t change anything because I didn’t do anything different.” A few participants suggested that the self-assessment tool produced a change in their behavior. Student answers to the question of impact implied a change that resulted in self-correction:

It [self-assessment tool] changed my feelings about math because I got very low grades after I made my goal then I told myself I had to make my goals and I got to pass my goal; I think it [self-assessment tool] does change my thoughts and feelings because when I looked at my graph, I had really low grades too and I think it makes some kids challenge themselves to make their grades a bit higher or a lot; I think it [self-assessment tool] did help because when I wrote that down, I started working harder to that goal; I think the graph [self-assessment tool] did help because it showed me how I was doing in math. I think it [self-assessment tool] did help because I thought I was doing pretty well but I was actually doing worse than I thought; I think it [self-assessment tool] did change my goal because it helped me get better grades.

The majority of students noted a link between the self-assessment tool and the outcome. Zimmerman (1989) validates, “With self-regulated learners, strategic planning guides efforts to control learning and is affected reciprocally by enactive feedback from these efforts” (p.332). This suggested a teaching and learning dynamic within the AES classroom that was student-centered and offered the opportunity for self-directed student feedback. The self-assessment tool appeared to increase a few participants desire for change although slight, Table 3. This claim of change was perceived and suggested by students as positive to their learning:

I think it [self-assessment tool] does help me and I think it [tool] does change my thinking because it makes me feel good to look at my grades on paper; It [self-assessment tool] did change my thoughts and feelings because if I got a low grade I would work even harder to get higher; When I realized how low my grades were, I started paying a lot better attention in math; I think what is helping me most about the graphing chart [self-assessment too] is the chart itself because when I see how well I’m doing or how bad I’m doing, it makes me really want to achieve and makes me want to get better grades because this chart really matters.

Perception of improvement by the AES students appeared to indicate awareness that the self-assessment tool had an impact on math performance. This supported the claim that self-
regulatory processes were evident, Figure 1, and successful patterns of behavior appeared to influence learning and self-efficacy beliefs. Students voiced their perception of improvement and link to the self-assessment tool:

I noticed that I’m getting a lot better at math since I set my first math goal because I feel like it is really pushing me to do better; it’s been helping me a lot because I like to see how I’m doing in math; I’ve noticed that it helps me feel like I have to go down the right path if I want to get the right job and I want to do or what I want to become; it helps me a lot because I can look at it and I can see how I am doing.”

A similar response was expressed by another student who described a growth mindset by indicating that improvement can be made, and that this was malleable, “When I’m not doing good, I can improve.”

A link to the social environment and personal control was also identified by a student: “I think what’s been most helpful is my graph, my teacher, my family, and my friends because they have really been helping me with my multiplication facts, my subtraction, addition and division and longitude and latitude.” Other students commented on the impact of the self-assessment and the connection to a desired outcome. A student’s reflection revealed,

I think what’s helped me most about the graph is the chart itself because when I see how well I’m doing or how bad I’m doing, it makes me really want to achieve and get better because the chart really matters.

The interplay between student beliefs and self-regulatory processes suggested further evidence of self-awareness and students’ desire to engage in forethought with the anticipatory prospects of a positive outcome. Simply put, the data suggested that students see themselves as having control and the ability to successfully alter behavior as affirmed by a majority of student responses:

I think it did change my goal because it helped me get better grades; I think the graph did help because it showed how I was doing in math; and I think
it [self-assessment tool] did help because I thought I was doing pretty well but I was actually doing worse…

This strengthens the claim that shifting the locus of control from teacher-directed to student-centered learning provides a self-reported benefit in relation to performance. Moreover, it suggests that a student-centered approach with a self-monitoring aspect enables students to make adjustments and take control of their actions with the result of a desired change.

Table 3 provides a graphic display of student responses at the mid-point of the study and implied a link to the Three Sequential Phases: Self-Regulation Model (1998) with the application of each phase noted. Student references to goal setting and reflection further supported the claim that these factors were part of the mega-cognitive engagement in the problem solving strategies implemented. Additionally, the data analysis indicated a slight benefit of change and improvement.

The data and theme analysis indicates that student perception of performance and responses declined with the implementation of the self-assessment tool. The student reference to performance prior to the implementation of the self-assessment tool was (123) with a decline in responses to (45) when the tool was implemented. Forethought was noted more frequently prior to implementation of the tool (78) and less frequently (68) at the mid-point of the study. There appeared to be a notable decrease in frequency of student statements during implementation of the tool in each phase of self-regulation. The change noted from the original interview data and theme analysis, Table 2, when compared to the mid-point data, Table 3, provided further indication that the mathematical performance of students declined. During the self-assessment phase, when the perceived performance of students did not match the actual performance, there appeared to be a decrease in performance. Dweck (2006) shares, “What could put an end to exuberant learning? The fixed mindset. As soon as children become able to evaluate
themselves, some of them become afraid of challenges. They become afraid of not being smart” (p.16). Zimmerman and Schunk (1989) propose, “Self-observation can motivate one to embark on a program of change, although desire alone usually is insufficient. Sustained motivational effects also depend on people’s outcome and efficacy expectations” (p.88). Furthermore, forethought was more evident during the initial phase of the study, suggesting that students were thinking more about implementation of strategies and desired results. Moreover, it appeared that math results, when graphed using the self-assessment tool and supported by quantitative data, did not match student expectations and suggested that students were less inclined to discuss math performance and reference to such was less frequent. Frequency of student responses and description of forethought suggested an awareness of actions, control and planning. Following this further, Table 3 suggested mathematical improvement, as defined by AES student participants, was apparent but slight.

Table 3

<table>
<thead>
<tr>
<th>AES Student Implementation of Self-Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Table 3: AES Student Implementation of Self-Regulation during self-assessment tool administration.

**Mega-cognitive Engagement/Problem Solving:** Student participants were requested to solve a math problem at the midpoint of the study and asked to share what strategies they
implemented. Shared responses appeared to focus on the concrete application of operational procedures to solve the problem. Participants’ responses mirrored the first initial interview when expressing problem solving and mathematical operations. A majority of respondents expressed skill based mathematical operations that did not capture the language of self-regulation. Zimmerman (1989) cautions, “The most sophisticated levels of self-regulated learning cannot occur until the child enters Piaget’s highest period of formal operations in which personally created hypotheses can be tested systemically” (p.20). It appeared that some AES students were unable to move beyond the concrete level of problem solving into the realm of more abstract thinking. AES students shared,

I used addition and subtraction to help solve a couple of problems; I rounded most of the numbers to get the answers; I added, subtracted, rounded, and I think multiplied one; I also added, subtracted, rounded and I also wrote it on the paper next to the question; I used my adding, rounding, and estimating skills; I really just used a bunch of strategies and like combined them so I can’t really say but it’s a good method to use.

A majority of student responses expressed the belief that problem solving was concrete with a focus on specific mathematical operations. The participants identified behaviors when actually solving a math problem that did not appear to reach beyond a concrete, operational level of cognitive engagement to a more abstract level of thinking.

**Effort and Perseverance:** AES students’ self-described effort and perseverance as contributory factors to learning and performance were noted. Student responses indicated feelings of frustration as well as a willingness to keep trying to achieve the desired outcome. This information suggested the cyclical process, Figure 1, enabled an adjustment, offered control to build self-awareness, and facilitated a change in behaviors. Students in the study with varying degrees of achievement levels may have had varying success at employing the feedback loop to their learning. However, students were able to share some strategies that they implemented
when they encountered an obstacle demonstrating evidence of control to alter behavior. Several student responses identified executed actions:

You skip it or change the answer once you realize it’s wrong; I usually try to read the passage over and over until I get it; If it doesn’t turn out how I want it or if it doesn’t go with it, I also double check and I kind of do the problem all over again; If it doesn’t turn out to be the right answer, I usually get angry because I feel like I couldn’t figure it out and I get mad at myself; If it’s like the same subject on one page, and I don’t really know the answer to one question, usually I’ll just do the next questions because maybe they will help me with that question I’m still working on; I’ll usually just keep on trying until I get it; I will go over it a few times to see if it’s the same answer, it’s the answer I was thinking of; If I don’t understand it, I’ll read it a few times and then I’ll ask for help if I still don’t understand it; If I don’t understand it, I usually just try different methods.

AES student responses suggested a willingness to implement strategies that would enable them to find successful solutions to problem solving. Although the participants were novice in the language of self-regulation it appeared that they were able to identify attributes that could be beneficial to their learning.

**Self-Efficacy:** At the mid-point of the study, student responses appeared to support the claim of confidence in their mathematical goals. Zimmerman (2000) affirms, “Self-efficacy beliefs have also shown convergent validity influencing such key indices of academic motivation as choice of activities, level of effort, persistence, and emotional reaction” (p.86). When asked to describe how confident respondents were in meeting their math goals, positive responses were shared. A recurrent theme in the student responses included achievement and doing their best. Students shared the following:

I’m really confident when I set my math goals; I’m confident because I feel I can achieve them but I keep trying until I achieve them; I feel really confident because if I keep trying, I think that I’ll get my goal; I feel confident and I just try to do my best at every math problem and I feel very confident when I set my math goals because I set math goals that are realistic for me to achieve.

The lack of self-confidence in math was not expressed, suggesting that AES students were unsure and less willing to indicate weaknesses or to share this belief with their peers.
Zimmerman (2000) explains, “There is evidence that self-efficacious students participate more readily, work harder, persist longer, and have fewer adverse emotional reactions when they encounter difficulties than do those who doubt their capabilities” (p. 86).

Analysis at the mid-point of the study identified and offered this researcher several poignant points for consideration. First, the references to forethought, performance, and self-reflection declined from the initial interview, Table 3. Second, students may have demonstrated an implementation dip suggesting that they may have been unable to understand the potential link to self-regulation during this phase of the study. Next, respondents were unable to describe the full impact of the intervention tool as they assessed their own performance. Making a connection from graphing performance to verbally expressing the impact of the tool appeared to be difficult for students ranging in age from 9-10. Lastly, some student responses suggested that they were unable to effectively employ the feedback loop, Figure 1, to help assess their learning.

**Final Student Interview:** After implementation of the self-assessment tool, a final interview was conducted; student participants were asked to comment on self-regulation strategies, improvement, and change. Student responses to the semi-structured interview question, Appendix B, regarding the implementation of self-regulation strategies were vague. There was less frequency of responses and willingness by participants to share impressions suggesting to this researcher that implementation of self-regulation strategies may have been difficult to describe. It appeared that participants remained focused on the self-assessment tool results (outcome) rather than the implementation of self-regulation strategies (process). This appeared to support the claim that students at this age level had difficulty putting into descriptive language self-regulation and cognitive engagement. For this reason, the qualitative data
suggested that students at this age level had difficulty sharing strategies beyond operationally concrete mathematical thinking and problem solving.

Zimmerman (2002) cautions, “Self-regulation is not a mental ability or an academic performance skill; rather it is the self-directive process by which learners transform their mental abilities into academic skills” (p.65). Furthermore, it appeared that some student participants did not internalize the self-directive processes and were unable to make a connection beyond the concrete level of mathematical operation. Yet, it appeared that students were able to discern improvement in math performance as noted by an increase from 2 responses at the mid-point of the study to 12 responses at the final phase of the study, Table 4.

*Table 4*

![AES Student Implementation of Self-Regulation](image)

*Table 4: AES Student implementation of self-regulation post administration of self-assessment tool.*

Some AES students were able to outline strategies when confronting difficulty with math problem solving. Responses suggested a process that could be controlled which helped students to create a path for a positive outcome. Zimmerman (2002) offers, “Attributing a poor math
score to controllable processes such as the use of the wrong solution strategy, will sustain motivation because it implies that a different strategy may lead to success” (p.68). Perseverance and willingness to be challenged were attributes that appeared to motivate AES students’ effort. Student responses suggested the belief that adjustments to mathematical problem solving could be improved by perseverance. Various students shared as follows:

Well, when I don’t know the answer to a math problem, I’ll sit down, take a break, and I might drink some water or whatever I have and I might give my hand a rest; What I do is I usually skip that one and then I go back to it and if I still can’t figure it out, I guess; If I really can’t figure out a problem and I’m having a lot of trouble with it, I try all the methods I know to try and solve the problem. And, if I’m still not understanding it, I’ll do the rest of my packet or whatever I have and then I’ll go back to it and spend the rest of my time on it; I’ll really try to figure it out and if I can’t figure it out, then I’ll probably get help from someone; I’ll either ask or I’ll skip it if I can use the lattice if it was multiplication and if it’s division and I can’t figure out the problem, I’ll use multiplication reverse to figure it out; If I get stuck on a problem and I really can’t get it, I go ask for help; If I get stuck on a math problem, I usually just try to think of all the ways that I can solve it; If I get stuck on a math problem, I skip it and move on because maybe the next question has the answer I am looking for. I come back to it and if I still really don’t get it, I ask for a little help.

Students acknowledged the need to seek additional support, which suggested an understanding that learning can be influenced by social environmental factors. This contribution to the learning dynamic suggested the students understood that the support from others would increase the likelihood of a successful outcome. The connection between social environment and performance was a recurrent theme throughout the student interviews and subsequent data analysis.

Next, a description of self-efficacy after using the self-assessment tool did not mirror the level of confidence that was evident in the initial interview. The qualitative data suggested that an increased level of efficacy was noted prior to the implementation of the self-assessment tool. It appeared that a shift in student beliefs occurred indicating that benefit from the tool was not
evident to the users. This information appears to imply that students became more aware and exercised control, and that their perceptions were modified based on actual performance. Simply put, student responses suggested that they were more cautious when describing their ability after the implementation of the self-assessment tool and subsequent self-monitoring. A wavering between self-prescribed ability indicators was noted. Students appeared to be self-reflective and to carefully gauge responses as several students indicated:

I’m not sure if I’m good in math or if I’m bad in math; I’m kind of in the middle; It’s hard for me to do it but I do know how to do it; My mathematical ability I think is sort of in the middle because sometimes, it depends what subject I’m on in math; Some things I’m bad at, some thinks I’m sort of good at, some things I’m really, really good at, and some things I’m just terrible at; I’m like in the middle because I find when I pay attention to math, I do a lot better and I understand the subject; I don’t have a lot of weaknesses but I think I would like to improve a little more.

AES student responses appeared to denote a realistic assessment of abilities once the self-assessment tool was used. The information gathered through student interviews indicated that implementation of the self-regulation strategies coupled with the self-assessment tool appeared to help students form a more realistic picture of their math performance.

Looking through the social cognitive lens and application of self-regulation strategies offered students a process that could be self-directed with the potential to generalize to other academic areas. Analysis, therefore, supported the claim that students had the ability to adjust beliefs as new information was presented and observations, judgments, and reactions were formulated resulting in the perpetuating nature of the cyclical process, Figure 1. This process appeared to provide students with a better understanding of their learning outcomes, resulting in a student’s ability to make necessary changes and exercise control by way of self-regulation and actions. Although self-efficacy beliefs, as described by students, were not as strong at the final interview, Table 3, the student performance increased from 45 at the mid-point to 144 at the final
phase of the study suggesting improvement. For this reason, shifting the locus from teacher control to student management of learning suggested the potential by which to improve performance. It appeared that this shift would allow students to calibrate performance with a self-administered assessment tool and realistic self-evaluation.

**Change:** At the final phase of the study, students discussed change and improvement as an indicator of benefit. Implementation of the self-assessment tool had an influence on math performance, Table 4. Student performance was referenced by students more frequently post administration of the tool. However, in the post interview most students expressed the belief that the self-assessment tool did not have a notable benefit. This was a poignant difference from the mid-point interview and students’ expressed responses. This appeared to suggest that students described the tool as helping them to focus on math performance; however, self-knowledge and engagement did not appear to have a decisive benefit. The qualitative data analysis at the end of the 11 week period indicated that there may be a benefit in math performance as noted in the analysis, Table 4; however, the quantitative data results outlined in Table 5: Summary of Variables did not support the claim. Consequently, the triangulation of data and analysis did not provide a correlation between the tool and the students’ math performance. This was affirmed by students:

The thing that I usually do to get my answers is mental math. The [self-assessment tool] hasn’t done anything to change it at all; I use mental math, too. The tool [self-assessment] just shows your grade and it doesn’t make you want to use a different strategy; I pretty much kept the same strategy because sometimes it works and sometimes it doesn’t and I can’t really think of a better one; I think it [self-assessment tool] helped a little with seeing my grades and seeing how I could improve them; It [self-assessment tool] kind of did and it kind of didn’t because when I saw that I got the first one I got a two I was kind of disappointed.
Therefore, student responses suggested that the self-assessment tool had limited impact on implementation of self-regulated strategies, performance, and improvement and a claim of benefit could not be validated.

The predominant themes and key findings emerging from the qualitative data collection highlighted that students in the group that implemented the tool were able to suggest factors such as goal setting, long range planning, working with and support from others, learning strategies, efficacy beliefs, and perseverance to increase math performance, Figure 2. This data and identification of factors successfully answered the first researcher question under investigation: *To what factors do students from different mathematical achievement levels attribute their successes or failures?* Additionally, students were able to identify phases of self-regulation, Table 4, and noted change and improvement in math performance when using the self-assessment tool. Analysis of the quantitative data did not substantiate this claim, Table 5. Therefore, the implementation of a self-assessment tool and self-regulation strategies could not be directly linked to improved mathematical performance.

Finally, throughout the interview process, students did not indicate SES as a contributory factor that affected their learning or their performance. For this reason, the absence of comments and identification of SES status as a negative or positive attribute was viewed by this researcher as having no influence on the qualitative data. Students and parents did not voice a concern regarding the student’s SES status and potential influence on student performance. This further suggested to the researcher that the study participants demonstrated the belief that it had neither an effect on students’ mathematical performance nor impact on implementation of self-regulation strategies in this study. Although SES was not identified as a contributory factor, it was addressed in the quantitative data analysis and assigned an indicator variable. Bandura
(1999) cautions, “Economic conditions, socioeconomic status and family structure affect behavior through their impact on people’s aspirations, sense of efficacy and other self-regulatory factors rather than directly” (p. 24). This researcher did consider the SES data; however, not enough information was available to make a claim that SES did influence in a positive or negative manner AES participants’ math performance. Therefore, the factor of SES could not be effectively determined for this study.

**Parental Lens and Perspective:** An important dynamic for this study was the triadic interplay of student, parent, and teacher. Bandura (2002) avers, “At the elementary school level, maternal, paternal, teacher, and peer support all contribute to children’s perceived academic efficacy” (p.282). Examining the influence and perspective through the lens of the self-selected parents (n=15) and the master teacher provided an additional frame to gather valuable information. This exploration suggested a more comprehensive picture of mathematical learning, efficacy, improvement, and change coupled with the potential impact of the social environment on performance. The potential influence of parents as a significant factor in the child’s social environment provided a more in-depth analysis and understanding of students’ performance and efficacy. Schunk and Zimmerman (2007) assert, “The reciprocal interactions between personal influence, environmental features, and behaviors…can affect self-efficacy beliefs and influence choice, effort, and persistence” (p.8). The self-reported perceptions of their child’s mathematical ability and self-described experience offered an investigative pathway to illuminate areas of influence.

**Initial Parent Interview:** The interview conducted with the self-selected parent participants identified student efficacy, self-regulation strategies, and support offered to students prior to the implementation of the self-assessment tool. The parental responses provided
meaningful calibration with which to gauge student perception of self-efficacy, support provided, and evidence of change. Parental perspective and subsequent responses proffered qualitative data from the social environmental aspect pre/post administration of the self-assessment tool. Parents participated in a focus group format and willingly offered information and answered questions, Appendix B, during each 45-minute interview.

The self-selected parents were asked about their child’s experience in math. A majority of parent participants validated that their child had a positive experience. Conversely, a few parents shared that their child’s math experience was negative. Overall, parent responses were student-centered and indicated their perception of their child’s experience and feelings. One parent shared, “My son loves math always and feels like it’s a strength for him. He always likes to look at things in a different way and not really the traditional way…” Another parent noted the attribute of feeling less confident in the mastery of math concepts, “My daughter enjoys math generally…this year…there seems to be a lot of topics to cover…so she’s just mastering something and getting on to something quickly without necessarily feeling confident.” Parental responses supported the claim that within the same classroom students can exhibit a multitude of feelings and confidence levels.

Positively accepting challenges and a willingness to wrestle with more difficult math problems were expressed by a parent and suggested a growth mindset: “My daughter enjoys math and this year finds it more of a challenge and she does look forward to that.” Several responses noted recognition of challenge as a positive attribute as one parent explained:

My son is pretty confident in his abilities in math and he performs pretty well. I think some of the factors involved is that he has always wanted to be challenged, and we have fed into that and have always come up with other problems based on whatever, he was working on at school to try to extend what he was learning in class.
Another responded, “I know he likes the challenge like a lot of the parents said here, and I really feel he takes it on. He likes to do that so I think that’s a big plus.” Dweck (2006) notes, “People in a growth mindset don’t just seek challenge, they thrive on it (p.21). Another parent indicated a contrasting view indicating an emotional reaction as described by the feeling of frustration when understanding of the math concept and/or expected performance level was not apparent. The parent stated,

My son enjoys math probably because he does well in it. I did notice he was extremely frustrated when the MCAS [Massachusetts Comprehensive Assessment System] scores came in and he didn’t do as well as he thought he should have so that was a point of frustration for him.

Usher and Pajares (2008) caution, “Students who lack confidence in their capability to self-regulate their learning are less likely to implement adaptive strategies, and they will more quickly give up in the face of difficulty” (p. 460). Some parents suggested that their children demonstrated negative feelings when math did not come easily, and the struggle elicited negative feelings about learning math. This negativity appeared to imply that a student was not as opened to challenges, finding it stressful and less satisfying. Parents acknowledged,

My son really enjoys math but he’s the type of personality that needs to really understand it when there is so much going on in the class he gets frustrated with himself very quickly; My daughter claims she doesn’t like math but she is really, really good at it. So, she struggles with finishing it just because she claims she doesn’t care for it; My child hates math and it’s tough for her and it’s a fight to get her to sit down to try to apply herself; My child really hates math. She really thinks it’s stupid. She is very stubborn about it…; My child feels pretty confident in the area of math for the grade level and gets very frustrated when he doesn’t get them right.

Interwoven in the self-selected parent interview was the acknowledgement that effectiveness of the teacher and parental influence were important components in the process of learning. It was suggested that this influence could make a difference for children and their mathematical learning as one parent affirmed:
I think the teacher, having a good teacher definitely makes a difference. I also think because we have always done schoolwork with them, we have always done Mommy homework as well to teach a little different you know currency, we talk about EUROS you know that kind of thing. I’ve always tried to influence a different way of thinking and I think that’s his frustration at times because I know he can do it but something he lacks that little bit of confidence because he has that tunnel vision that sometimes he’s afraid to ask a question in class. I know he can get it but I think it’s that confidence thing.

One parent shared that a secondary factor that influenced learning and achievement was the interplay of peers in the form of competition: “I think motivation of almost competing with other kids to try to get to the next step has motivated him.” This aspect of the social environmental influences was important to note and reaches beyond the investigation and scope of this study. Simply put, this suggested that AES students’ were influenced by parents and teachers and also by their peers.

Looking through the lens of parental experience of learning math further suggested an awareness of the social environmental influence and the potential effect on student perception of mathematical learning. Self-selected parental responses suggested that there were a variety of experiences ranging from positive to negative. Parents shared an understanding of their child’s learning, potential link to self-efficacy, and performance. A parent shared a story of a past experience that enlightened perspective and demonstrated that negative experiences can influence self-efficacy:

I loved math right up until seventh grade and then I got Miss Richard and that was suppose to be a good thing because if you got Mrs. Richard’s you were good in math. By the end of that class, seriously, I thought I had a nervous breakdown…I didn’t touch math [in college] to be honest with you. Then I went on to run a 52 million dollar business. It was all about profit and loss statements and balancing the budgets. Go figure and I actually did very well.

Another parent shared how experiences of a daughter and achievement levels were different:

Math always came easy for me. My father was a navigator in the Air Force and he was a math wiz and I don’t know if I got it from my father, but then it skipped a generation with
my daughter because she just, I sit there and try to explain things and try to give her confidence that I think she needs to get that, you know, over the hump type. She just freezes right up and she gets so stubborn and that’s it. It’s so hard to get her excited about it but I have to admit the teacher has been the first teacher to actually get her excited and spark her interest a little bit more because some of the teachers in the past haven’t been a strong point, you know what I mean, their math hasn’t been a focus like her [master] teacher and I think that has been the difference this year for her to try to get her to appreciate it a little bit more than she has.

Both of these parents implied a strong connection between effective teaching and the influence on student learning. The ability of the teacher to structure the learning environment and instructional practices is a dynamic indicator for student learning. Bruner, 1960, Gardner, 1993, Bandura, 1997/2002, Wiggins and McTighe, 1998, Tomlinson, 2003 and Zimmerman, 2000 affirm that pedagogical practices can be a deciding factor for student learning and achievement. Lessons designed to enhance learning styles and opportunities to focus attention on the elements of self-regulation, including self-observation, self-judgment and self-reaction, can impact a student’s effective construction of learning. For this reason, the teacher has a strong contributory role and influence on how students perceive themselves as learners.

Teacher and parent encouragement and feedback have the strong potential to motivate a student’s willingness to wrestle with content resulting in a better understanding of mathematical process and progress. As suggested by AES parental responses, teachers who create a learning environment that focuses on a student’s level of understanding and extends this through a variety of pedagogical approaches demonstrate a critical component of the social environmental influences. The teacher’s ability to address the different mathematical achievement levels within the classroom can influence students’ motivational levels and understanding of mathematical concepts and ultimately build successful experiences.

**Final Parent Interview:** The post interview was conducted with self-selected parents after the implementation of the self-assessment tool. Parental responses to the semi-structured
interview questions, Appendix B, reflected positive and negative feeling regarding their child’s math performance, self-assessment tool impact, confidence level, and improvement. It was noted that the AES students’ math experience was varied, as was the parental experience. The adult perception of their child’s experience ranged from very successful to lacking skills and confidence. It was suggested by the self-selected parents that this academic year for their child was focused on math, and it helped to motivate the majority of student’s in the AES classroom. Therefore, students who might have struggled in other teaching environments seemed to respond positively to the pedagogical approach that the teacher was using to teach mathematical concepts. A parent shared a personal story of influence and the ability of the master teacher to demonstrate and foster a growth mindset. The student was affected in a positive and a reflective manner in which expression of self-regulation strategies were evident. The parent explained,

My daughter is a good math student and it kind of caught the teacher off guard [when she did not score well on a test]. I guess in this open response [test] you have to quickly answer the questions and my daughter was deliberating over this one question and she didn’t finish the test and she got like a 1 out of 4 or whatever it was. Her reaction was she started to cry and the teacher was so great because she spoke to her not only about the math piece of it but also, this is life and you’re not perfect. There were so many life lessons brought into this circumstance. The teacher called home…which talks about the quality…she was basically calling to see how my daughter was doing. My daughter’s reaction to that was ‘I’m, just going to do the best I can and my teacher explained to me I just need to move a little quicker’.

This exchange between the teacher, child, and parent demonstrated how a dynamic interaction can have an impact on learning. This child’s acquisition of self-knowledge and self-reflection was an example of the implementation and cyclical phase of self-regulated learning, Figure 1. This information implied that the social environment does play a key role in helping to shape and influence a child’s learning and response to difficult situations.

Self-Assessment Tool: Parents were asked to share their perception of their child’s experience using the self-assessment tool and impact on math performance. Answers from the
parents were also brief and not precise as to the impact. Parental response and information aligned with the responses shared by students at the conclusion of the study. A parent noted her daughter’s experience and the lack of a descriptor and response that was also noted in the final student interview:

My daughter shared where she was and where she wanted to be. She didn’t share a lot. She doesn’t share a lot with me anyway so for her to say anything you know…I think her understanding of where she is and where she wants to be definitely made a difference.

Another parent commented on the notion of limited influence and indicated a similar experience:

My son hasn’t said that much about meeting with you…I think the goal is they get the right answer and if they get the right answer the traditional way we all learned how to do multiplication versus the new way which I guess is Everyday Math, I don’t think that’s the big deal. I think it’s if they get there so I think if it can be incorporated that they can do either way it might be better off for the majority of kids.

This suggested that a few students in the AES classroom and a few self-selected parents might be struggling with problem solving techniques and teaching approaches that were not traditional. The core program [Everyday Math] offers a variety of methods to differentiate instruction. The differentiation of instructional approaches helps students with different learning styles solve math problems in a variety of ways. These approaches can create an environment of openness and thinking beyond traditional methods that can spark math performance. Fluidity in thought and the willingness to stretch beyond a fixed mindset through effort as suggested by Dweck (2006) can lead to greater success (p.44).

Parents and students suggested that the social environment interplay and direct help from others influenced math performance. The self-selected parents appeared to be involved offering assistance in finding strategies that would benefit problem solving. The availability of different mathematical methods and learning strategies allowed for choice and control. Various parents shared their views as follows:
My son is very confident…sometimes he gets a little bit confused. His concern would be there is so much going on sometimes in the classroom to get the individual answer. The reason I think he is doing well is because I do the basic stuff as well as the new math. I’ve always taught him the old-fashioned way of doing things and because he feels confident tackling that, he’ll do it his way.

As far as the new math and the old math, yes I agree maybe because I’m not used to the new stuff obviously, but it can be confusing. That’s is why I chuckled at the columns if they’re not neat doing it, it could be an issue for them.

I think with the help of the teacher and her friends [was important]. I think they all help each other and I think that the teacher…is always helping students individually, but she also tries to empower them to say, ‘You figure it out and I’m right here for you’ she is the safety net but she’s not going to do it for them.

My son doesn’t really say much with the Everyday Math, he is more frustrated with it than what he has learned in the past. So again, I think whatever way they can do it and get the right answers, is the way they should do it. So I tell him that you can do it whatever way he’s good at doing it.

Although a few parents struggled with the Everyday Math program and the recommended methods of problem solving, it appeared that there was an openness to understand that non-traditional learning strategies could be of benefit. This suggested that parents believed the ability of their children to exercise control and discover a learning approach that was beneficial for their understanding of math was important.

Furthermore, parents shared what they considered to be the important factors that contributed to a student’s success in math, Figure 4: patience, confidence, effort, time, critical thinking, and working with and support from others.
AES parent’s perceptions and describers suggested students could implement self-regulation strategies and coach themselves through problem solving with internal speech patterns. Additionally, the combination of mega-cognitive engagement, effort, willingness to challenge, failure, and ultimately application of prior learning to build on mathematical success was identified. A parent offered,

The ability to reason it out in your own head, problem solving, maybe knowing I’m going to try this I may not come up with the right answer but I’m going to guide myself through with everything I have learned and do the best that I can.

Success was described as “knowing the basics will give them the confidence to even ask a question if they don’t understand. That’s a big thing.” Another parent added, “It’s just setting the expectations to do, show up for it, do your very best, take it seriously and give it your best shot.” A similar response suggested that it was a simple combination that would offer success in math, “confidence and understanding the concepts.”
A recurrent theme interwoven throughout the interviews and described as crucial for success were confidence and effort, variables that were internalized and demonstrated as a child became successful. Therefore, AES students’ ability to exercise control and the application of self-regulated strategies suggested a positive cyclical process, Figure 1, in which to build successful experiences.

When parents were asked to share expectations in math, they suggested that self-efficacy was critical. A majority of parents suggested that students who felt confident and were willing to struggle with mathematical problem solving were more likely to have a successful outcome. A parent affirmed, 

I just want him to be confident. I just want him to know that if he doesn’t get it right on the first time, he can always go back and try again on the second time. He doesn’t always have to be perfect…

Another parent interjected, “Know that maybe it’s not your favorite subject but not to hate it and not to be so shaken by it that you just put up the barriers and just not be able to get through.”

Moreover, a parent noted concern:

We have had to work on the whole perfectionist thing, which can wreak havoc on somebody. I try to send that message sometimes you don’t have to be a perfectionist; you don’t have to get a 100. Just do the best you can.

Additionally, another parent expressed concern:

I don’t want him to give up easily. He will just give up on a problem because he gets frustrated with himself because he doesn’t understand it. I always tell him to have the confidence to ask questions.

Finally, parents were asked to describe how their child reacted when unable to solve a math problem. Frustration and perseverance were two prominent indicators. A parent stated, “The majority of the time my daughter tries and she tries to figure it out. I think she is asking questions.” Another parent interjected, “Sometimes he will have a complete meltdown and there
are tears.” A similar response was, “I can see frustration, meltdowns, everything when he gets to that frustration level where he can’t do it and he needs help.” This suggested that students did have emotional reactions to difficult encounters, and some students were able to adapt and implement strategies to help solve math problems. However, the majority of responses indicated a period of frustration was evident with most AES students that could overwhelm the learner. This information implied that students might be struggling with a fixed mindset and a novice approach to implementation of self-regulation strategies. Additionally, it was suggested that explicit teaching of self-regulation strategies might benefit students’ mathematical understanding. The levels of engagement and the processes needed to push through episodic periods of confusion and difficulty were suggested as needing to be student-centered. Ultimately, this offered a framework to guide responses when encountering difficult or confusing math material and situations. Zimmerman and Schunk (1989) explain:

When children reach an age when self-regulation learning processes should have emerged developmentally, their failure to use these processes are attributed usually to one or more of three factors:

1. Students may not believe that a known self-regulation process will work, is needed, or is preferable in a particular learning context.
2. Students may not believe that they can successfully execute an otherwise effective self-regulation response.
3. Students may not be sufficiently desirous of a particular learning goal or outcome to be motivated to self-regulate (p.5)

Parent interviews and data offered a unique and important lens from which to capture the social environmental influence on learning and self-efficacy. When considering the factors that affect learning and success for elementary students, it is important to explore the influence and potential impact of significant others. The triangulation of data and thematic analysis of the qualitative data provided a comprehensive lens in which to calibrate experiences, mathematical learning, and implementation of strategies. Analysis, therefore, was able to shed light on and
identify the factors that parents believe attributed to students’ mathematical learning and ultimate success.

**Teacher Initial Interview:** The teacher-student dynamic within a math classroom needs to be fluid and dynamic to shift the locus of control from the teacher to students as managers of their learning. This study examined the teacher’s perspective and the selected teaching approaches that were used to guide student learning and differentiation of tasks. Explicit instruction of self-regulation strategies prior to skill instruction was theorized as advantageous for mathematical progress. The study’s findings offered insight into the claim that if student management of learning was effective and implementation of self-regulation strategies produced higher math achievement, it would be a value-added strategy. The data from the student and parent interviews suggested that some students were aware of the self-regulation strategies and students reported that they used these variables to improve learning. Student responses demonstrated that they were able to coach themselves by employing self-regulatory skills. For this reason, the teacher was able to release control, and student learning was more self-directed.

Rienties, Brouwer, and Lygo-Baker (2013) assert, “It is believed that academics who have a more student-centered approach to teaching are more likely to achieve conceptual change amongst students” (p. 123).

The initial semi-structured interview with the teacher, Appendix B, prior to the implementation of the self-assessment tool provided this researcher with information about beliefs, math experience, and self-described perceptions of teaching and methodology. This information created a baseline for comparison after the implementation of the self-assessment tool. Additionally, the initial interview explored student efficacy, self-regulation strategies, and support provided to students. Probing into the teacher’s experience of teaching math and the
instructional approaches used within the AES classroom opened the door and provided a unique opportunity in which to investigate the learning experience shared by participants. The teacher shared the framework in which instruction was designed:

…The frameworks [Massachusetts Curriculum Frameworks- which are the educational standards used by all public school educators] are my backbone. But how do I deliver the content to children and have them master content? That is where I really look at different methods and ways to teach…

To gather information about the teacher as a learner, the researcher asked about the teacher’s perception of experiences and influence on teaching methodology. The master teacher offered,

Well, I learned math through rote…I basically just learned algorithms without a lot of emphasis on the why or the process. And I think that really hindered my learning and becoming a good math student…today I look at myself as a very good math teacher maybe it was good that I struggled with math. Because of that I can help struggling kids…

The teacher offered insight into a past experience when help from others influenced learning. This first hand experience appeared to help the teacher to better understand learning mathematics and how help from others influences learning. The teacher shared, “I have fond memories well not so fond memories of doing long division with my dad in the summer after 4th grade because I did not get it. Every night, I did long division with my dad.” This scenario suggested and affirmed the teacher’s belief that perseverance was indeed important, and assistance from others had an influence on behavior, additionally, suggesting through the lens of experience that not all students were able to achieve at the same pace. The triadic reciprocal interplay of the personal, behavioral, and social environmental factors that Bandura (1986) describes and Stronge (2002) affirms does impact performance.
The interplay of the social environment and influence on learning was evident through the role of helping students. The teacher offered information that explained the processes of instruction within the AES classroom and the ability to support students’ understanding of math. The teacher elaborated on the process, which was embedded in pedagogical practices, of helping students’ master mathematical concepts and skills:

I introduce skills and give them time to practice. Practice can be paper pencil. Practice can be through games working with a partner with manipulatives. It really depends on the skill and then at that point in time I usually know or I will say I do know who needs a little extra work. So I feel I do a good job with differentiation in math and where students who need help can get help with me or with tasks that are going to help them.

Her comments suggested that the teacher was aware of the different levels of mathematical achievement and was able to differentiate instruction to accommodate student's learning styles and student's needs. Tomlinson, 2001, Marzano, Pickering, and Pollack, 2001, Gardner, 1993, Meyer and Turner, 2002, Stronge, 2002, and Strong, Silver, and Perini, 2001 concur that acknowledgement of diverse skill levels and diverse learning styles is an important aspect of effective teaching and learning. The seminal works of these prominent researchers embody the belief that effective teachers have a strong influence on student achievement and will do whatever it takes to ensure success. In the same way, the teacher acknowledged, “I can also stretch and enrich horizontally with whatever skill I am on for children. Or [students] who have mastered the skill but, can have it reinforced at a bit [at a] higher level or probably more horizontally.”

The difficulty for AES students to achieve at levels comparable to the state MCAS results was evident and was a concern for this researcher. The 2011 math data indicated that 52% of students were below the proficiency level. AES students were not meeting the necessary benchmarks to make adequate process. However, the disparity in achievement levels among
groups had the potential to positively be influenced by students’ ability to direct their learning. Through the lens of SES, math learning and the effect on students were explored with the teacher. The teacher was asked if SES could have an effect on AES students learning in math. The teacher paused on this question, appearing to consider it very carefully prior to giving a response. This suggested to the researcher that it might not have been a question that was often considered. The teacher’s response suggested a belief that in terms of support, the social environment was more critical to achievement and learning than financial implications:

I don’t know if it really does. Some kids really I think if you have a good math mind or math brain I don’t know if socioeconomics would really affect you. I do think in some cases kids who are maybe gifted and talented. But, kids that are not gifted or talented I do feel it does hurt them because they don’t have the practice at home…I think sometimes those families are struggling to stay above water financially and don’t really have the time and energy to even look at schoolwork.

Furthermore, this suggested to the researcher that the teacher did not use the SES lens to filter success or failure for students in the classroom. The focus was on support, assistance, and the level of commitment to ensure mathematical learning. This appeared to imply that the limited numbers of lower SES students in the classroom might have influenced the response or non-response. This variable could not be substantiated or validated as having an effect on learning within the AES classroom. Based on the information that was shared, SES could not be suggested as an indicator of performance within the parameter of this study.

The teacher did suggest important factors that were believed to contribute to student mathematical achievement, Figure 5, and appeared to imply that these factors had more of an influence on AES student’s performance than SES.
Figure 5: Factors the master teacher described for success in math.

The cyclical nature of this learning dynamic, Figure 5, is fluid and represents a bellwether of indicators, as suggested by the teacher, by which achievement could be sustained. Building self-efficacy and sustaining student achievement would be perpetuated by successful experiences. The flow and application of this continuous, dynamic cycle implied that students would assess and evaluate performance. The master teacher’s beliefs acknowledged the professional responsibility to ensure that all students were provided with successful learning experiences. The positive experience would build a strong foundation for learning, a further indication that the teacher was aware of and believed in the importance of motivation and stimulating positive thinking to encourage students’ willingness to persevere. Quite boldly the teacher offered the following comments:

So, I champion success all day long especially in math. And have them [AES students] motivated. I have a lot of kids come in and they hate math and they are not good at math. But they really are. They have had some bad experiences. So I work on success. Positive thinking I can do this and usually it works.
They [the AES students] need to have success in order to be successful…It is my job to unlock that quagmire of fuzziness and why they don’t get it [math]. Or back up skills and figure out why they don’t get it [math].

The teacher’s math experience as a learner suggested the acknowledgement of and understanding for the need to create an instructional environment that supported students at different mathematical achievement levels and encouraged self-efficacy through perseverance and motivation.

The recurrent theme throughout the interview with the teacher and self-selected parents was student motivation. It was visual and was described as follows: “Motivation to do more; motivation to help others. Just that good ole warm fuzzy feeling that you get it [math] and you can use it in different situations.” This response implied and gave further evidence that motivation was an important variable for student learning and skill development. The teacher appeared to believe that motivation in the form of perseverance and the willingness to extend beyond their own learning to help others was a key indicator of success.

Additionally, the teacher expressed helping others as an indication of mastery and self-efficacy. The social environment was considered in the construct of learning, and the teacher felt that it demonstrated understanding and acquisition of math skills. The teacher also implied that modeling, breaking problems down, and the gradual release of support helped students to succeed. Shifting from the locus of control from teacher to students as managers of learning and moving into the realm of peer tutoring, the teacher shared that students could demonstrate mastery, performance, and successful learning. The teacher was quick to point this out:

I think the backbone really is…helping kids have success. Showing them strategies that are going to help them or breaking it down so that they understand. I think it is really the nuts and bolts and nitty gritty and that is why I need to get kids who are successful working on something.
This response implied that the internalization of mathematical understanding by the students and the implementation of self-regulation strategies, Figure 1, had an effect on achievement. This further supports the belief that the relationship between self-regulatory processes and student beliefs contribute to math achievement. The teacher goes on to describe that helping students to understand and correct work were important learning strategies. Unpacking the reasons why students were struggling was part of the AES classroom instructional process. The teacher believed it was essential to diagnosis math misunderstandings and to provide targeted instruction, as well as, breaking through emotional barriers:

…I work with them [AES students] when they are doing something wrong and I help them correct it…I teach them that [self-correction]…” When a student is struggling to solve a math problem the teacher indicated, “…I have to figure out why. Sometimes it is attitude and effort. They [student] don’t care and they [student] don’t want to do it…So, I breakdown skills, I guess I do a backward progression to see where it going wrong and I then fix that and bring them back up to speed…I am quite compassionate about doing that individually with kids. And if I have help…I have them [parents] monitor the class or help a kid with that [math problem]. I am careful how I choose my parents…some parents just give the answer. I am pretty selective on that kind of thing.”

The teacher suggested the dynamic and continuous exchange between adult and student was also important. This implied that students’ learning needs and their ability to work with the problem, develop strategies, and build self-efficacy were influenced by the supports that they received. It also suggested that creating an environment that fostered social processes, student engagement, Table 1, and successful outcomes could directly affect achievement and motivation. Moreover, the support by adults, as noted by the teacher, suggested that an environment that supported students’ willingness to wrestle with math concepts that were confusing and complex enabled the learners to build confidence and subsequently enhance achievement. Educational research supported and affirmed the triadic interplay of the social environment, personal variables, and behavior as influencing achievement as validated by Dweck, 2006, Marzano,
Teacher Final Interview: The final 45-minute interview was conducted with the teacher, Appendix B, after the implementation of the self-assessment tool. The master teacher shared the belief that self-regulation strategies were evident and the implementation of self-assessment strategies, change, and confidence were contributory factors of mathematical achievement. The teacher offered a unique perspective and insight into the AES students’ ability to control learning by exercising self-determined strategies. The shift to a student-centered approach was accomplished by a gradual release of assistance. The qualitative data collection and thematic analysis from the teacher interviews implied that student self-efficacy, defined as self-confidence, increased with the implementation of self-regulation strategies, and the need for help and support from others lessened. In contrast, the quantitative data, Table 5, did not support the claim of benefit of using the self-assessment tool to increase mathematical achievement.

The teacher was asked to share if there were any noted changes after the student used the self-assessment tool. The teacher affirmed that some positive attributes were observable:

I think the changes I have noticed have been when we talk about attitude and effort towards their [AES] student work. Several children will bring up setting goals. Their more conscientious of setting goals and it’s good that they are speaking about it. I think coming from them it helps others to think about setting goals, too.

The role of helping students and providing gradual release was an indication that students were able to manage their learning. It was described by the teacher that students in the AES classroom were achieving and mastering math at different levels of skill acquisition. The master teacher fostered student learning with a continuous process of analysis of math skills and application of effective pedagogical approaches to support student learning. The teacher
described the role of helping students during the 11-week study. The teacher explained that the focus on role and influence was apparent:

My role is major because I present information; we practice skills and hopefully master the skills. So, I pretty much take them through all the steps, work to help the kids who don’t get it the first time through and at the same time offer enrichment for those who do get it. So it is a juggling act but I do like that. I like the juggling act and I like having the mix of kids [different mathematical achievement levels] in my room.

The teacher demonstrated the belief that students can increase math performance by setting goals and using a self-assessment tool. However, the teacher response appeared to be calibrated according to the student’s level of motivation and desire. Pause and deliberation during the interview by the teacher indicated much thought went into word choice and information provided to this researcher, perhaps implying that the teacher was aware that not all of the AES students found math success implementing self-assessment or applying self-assessment strategies. A cautious response was shared:

I think overall yes for most students, for students who want to do well, have the desire to achieve. The children who don’t care and have a poor attitude towards their work, I don’t know if goal setting matters to them and I’m only speaking through experience.

The limited impact of the self-assessment tool was noted in the teacher response and appeared to suggest minimal influence to increase a student’s desire to share thinking. The teacher expressed that within the classroom structured time was allotted to enable students to share mathematical problem strategies:

Honestly, I think we already were doing it so I think it’s ongoing. We do that a lot [share problem solving strategies] or they do more sharing in small groups or with a partner, too. Again, I think that is more valuable more people understanding it than just have one person sharing.

A positive benefit of the study the teacher observed and noted was the frequency of students making positive statements about mathematical abilities. This was evident in students’
expressive language and their demonstrated willingness to struggle with math problems. This teacher believed that confidence was the cornerstone of students’ achievement. The teacher passionately affirmed that confidence needed to be nurtured and supported with positive statements that could be internalized:

I didn’t measure it but that’s kind of my whole mantra is being confident about your math because I had six, seven kids come in with very poor math confidence and I found it’s not because they have low aptitude for math they lacked the confidence. So positive statements are coming along mostly because I foster that. When I work with them. I can see that they understand math but some little thing is getting in the way. Their math aptitude isn’t low and I’ve taught students who are low. This gang isn’t and so I think I’ve been doing all along and it is getting better because I will be like ‘see you can do this or you have good math thinking’. So again it’s building confidence in them and they are starting to make positive statements because they are beginning to be able to do the math and have confidence with it.

The cyclical nature of building confidence through incremental steps of instruction, practice, and positive statements was evident in the teacher’s response. The teacher believed that confidence was an important building block of math achievement. The teacher validated the cyclical processes by affirming, “I say that started day one not so much with your project [study] but your project [study] reinforced that.”

It was affirmed that confidence helped students demonstrate an increased willingness to struggle with math problems and challenge themselves with more difficult problems after using the self-assessment tool. The teacher claimed students were more attentive and focused on understanding the math problems, demonstrating implementation of self-regulation strategies, Table 1. Personal variables appeared to have an impact on execution of self-regulation as validated by the teacher:

Definitely, I think instead of pushing the panic button that’s what we say, their kind of picking it apart and looking at it more. As far as challenging themselves with more difficult problem, there was a piece recently with Everyday Math where they had to make up their own problem. It was very interesting to see who really challenged themselves to do something that was at fourth grade level or higher and those who didn’t. So I really
think it depends on, I’ll use the ‘L’ word, if their a little bit lazy, their going to do the easy way out and not challenge themselves. So I think it’s really something that is within them. The confident ones [students] are some of the ones [students] who didn’t challenge themselves. They got the paper back and I wrote, ‘You need to challenge yourself’ Don’t pass that in!

The explicit teaching of self-regulation strategies, through the lens of social cognitive theory and self-assessment, was contemplated and considered as a pedagogical practice by the teacher. Investigating the potential whereby the increase of time in class for students to set math goals, discuss successful mathematical problem solving strategies, and graph performance was probed. The teacher shared,

I think I would like to I don’t know if I can fit that in. But definitely, I think the more we look at what we want to achieve and where we want to be is a life skill. Absolutely, I might think about doing it more after your study.

The teacher investigated pulling each component apart for consideration and application. When asked if the information shared suggested that allowance of time for students to set math goals was possible within the master teacher’s classroom, the teacher responded with a simple and emphatic, “Yes!” Additionally, when asked if instruction in mathematical problem solving strategies aligned with self-regulation strategies, another firm positive response was given. On the other hand, having the students take time in class to graph learning as was done with the KTML, Appendix A, was not considered as a viable option. The teacher expressed doubt by stating, “I don’t know that’s kind of hard, that would be time-consuming. It would really have to [weight the] have merits, [there would need to be] really great merits for me to do it. I don’t know. I’m being honest.”

Finally, the hypothesized merit of the self-assessment tool and teacher beliefs during the 11-week study was further explored. The teacher carefully weighed if a positive or negative impact was evident in student’s math achievement at the final phase of the study. The teacher
made an interesting claim as to the benefit of the study and influence of the researcher on student behavior:

I think it was really positive just that the principal, you being the principal coming in and doing it, just who you are doing the project and I think they enjoyed the interviews. I think it was really good for them to think about what their doing and where they want to be with it referencing the goal setting. I think it [study] was very valuable.

The focus on the self-assessment tool may have influenced students’ responses. Moreover, the spotlight may have affected student responses on implementation of self-regulation strategies and beliefs as they shared the potential influence on math performance, an indication that for this study there was the probability for a “Hawthorne effect” which might have influenced participant’s responses. The Hawthorne effect (Parsons, 1975) “shows how variables can be unwittingly confounded in an experiment because of some aspect of the experiment itself” (p.33). The familiarity of the researcher and the spotlight on mathematical learning during the 11-week study may have influenced the study results. Any claims of benefit needed to be considered in light of this phenomenon.

**Discussion of Findings**

In summary, the social cognitive theory using a self-regulation lens guided the key findings derived from the qualitative data collection, coding, thematic analysis, and evidence provided during the 11-week study. First, students from different mathematical achievement levels were able to indicate the factors that attributed to their successes or failures and provided evidence to answer the first research question under investigation; *To what factors do students from different mathematical achievement levels attribute their successes or failures?* The factors described by students aligned and overlapped with factors that the self-selected parents and master teacher attributed to math success. Additionally, factors were identified, Figure 6, to
denote each category of the participants’ beliefs as attributing to student success or failure. Recurrent themes of motivation, perseverance, confidence, and working with and getting support from others suggested that these factors were prominent, frequently noted, and fostered student achievement. Highlighted were the factors students, parents, and the master teacher indicated as strong attributes for mathematical success.

![Diagram showing factors attributed to math success](image)

*Figure 6: Factors AES students, parents, and master teacher describe as attributing to math success.*

Second, the teacher and the parent interviews offered a unique perspective into the complex environment of mathematical learning. The triadic reciprocal relationship and social environment as expressed by participants appeared to imply a strong connection to student learning. Participants in the study suggested the belief that factors identified, Table 6, worked within a framework of learning. The fluid mechanism of the framework and confidence in the implementation were suggested as influencing math learning. Following this further, it was
suggested the result of successful implementation of some of the self-regulation strategies would benefit student performance. The implementation of the strategies would have a positive influence on some of the student’s self-efficacy and desire to improve performance. Moreover, thematic analysis suggested that explicit and implicit messages given to students were important contributions to students’ perceptions as learners.

Third, the expressive voice of students and actual experience in real time had an impact on math understanding as described in the narratives of students. The self-assessment tool enabled learners to process math learning through the Three Sequential Phases of the Self-Regulation Model, Table 1. Forethought, performance, and self-reflection were described by students and evident in student responses. The data analysis supported that a few students indicated that they found merit from using the tool. Additionally, neither a positive nor a negative connection to SES was indicated by students or self-selected parents, and the teacher claimed that the lack of support from others was a stronger indicator of math performance than SES.

Finally, to capture a comprehensive picture of math learning and to determine if claim of benefit of using the self-assessment tool could be validated with quantitative data, the second research question was investigated: What effect would a self-assessment tool have on student performance? A holistic picture of student learning and performance with a well-validated and substantiated investigation explored more deeply the claim of benefit of the self-assessment tool.

**Quantitative Data Collection Procedures and Key Findings**

To achieve well-validated and substantiated findings, a mixed method design with the employment of a concurrent triangulation strategy was used. This quasi-experimental study, with a pretest-posttest nonequivalent groups design application and multiple regression analysis
addressed the second research question: *What effect would a self-assessment tool have on student performance?* This design was employed to measure the relationship between the self-assessment tool (independent variable) and pretest-posttest (dependent variable) results. Descriptive and inferential statistics meaningfully described the data and ascertained if results based on the experimental group implementation of the self-assessment tool were statistically significant as compared to the group not implementing the tool. A simple chart, Chart 2, outlined the procedures and the analysis that guided this research offering greater clarity and structure.

**Chart 2: Quantitative Data Collection**

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Instrument</th>
<th>Participants</th>
<th>Timeline</th>
<th>Data Collection</th>
<th>Description of Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>What effect would a self-assessment tool “Keeping Track of My Learning” have on AES 4th grade student performance?</em></td>
<td>STAR Math fall/winter performance</td>
<td>Students (n=23) implementing the self-assessment tool</td>
<td>Week 1: collect data from Star Math fall results</td>
<td>STAR Math fall data (n=47)</td>
<td>Reviewed results on the fall STAR Math assessment and record</td>
</tr>
<tr>
<td></td>
<td>Marzano (2009) KTML /Self-Assessment Tool</td>
<td>AES student scores from comparison group (n=24) not implementing the self-assessment tool</td>
<td>Week 2 Introduce self-assessment tool</td>
<td>STAR Math winter data (n=47)</td>
<td>Reviewed data of student implementation of self-assessment tool to ensure accuracy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Weeks 3-10: students (n=23) in self-evaluation conditions assessing math performance with KTML</td>
<td></td>
<td>Multiple regression test to identify if a statistically significant positive relationship was indicated Table 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Star Math winter data collection</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For the purpose of this study, the quantitative data collection comprised the student scores from the STAR Math test administered in September and in February. STAR Math was administered as part of the annual testing protocol at the elementary school. The experimental
group and the comparison group (n=47) were given the pretest and posttest concurrently within the parameters of this study. The experimental group (n=23) was placed in self-evaluation conditions using the self-assessment tool after taking the September STAR Math test and prior to the February STAR Math test administration. Results of the AES student fall and winter scores for the experimental group were recorded and participants were assigned a number to ensure confidentiality. Additionally, the STAR Math scores for each individual participant who implemented the self-assessment tool (n=23) were documented and placed in a Summary of Scores, Appendix D. The increase and/or decrease from September performance to February performance on STAR Math provided additional information in which to ascertain if a positive or negative result was indicated by the posttest results.

The comparison group (n=24) did not implement the self-assessment tool. Concurrently, the comparison group scores were recorded, and each student assigned a number to ensure confidentiality. The individual achievement levels of each student in the comparison group (n=24) and performance result from the fall to winter scores were identified and documented in Appendix E. A descriptive statistical display of scores was outlined consecutively, Figure 7 & 8, to illustrate both experimental and comparison group performance on the STAR Math test for each test administration. In addition, the score differential for students in both groups was
A scatterplot, Figure 7, was designed to represent each student’s (n=47) September performance data. Each number on the horizontal x-axis was associated with each participant in the study. Identification of the experimental group 1-23 and the comparison group 24-47 were noted in consecutive order. The range of STAR Math scores were noted on the vertical y-axis.

The September STAR Math data indicated that the experimental and comparison group scores ranged from 516 to 866 a further indication that different achievement levels as was hypothesized by the first research question under investigation was evident. The pretest mean for the September STAR Math experimental group and comparison group was calculated and noted in Appendix F. Furthermore, the analysis of the experimental group pretest distribution indicated a higher mean [m=692] result compared to the comparison group [m=676] on the September STAR Math test. The average score in the experimental group distribution was higher prior to the implementation of the self-assessment tool compared to the comparison group that did not implement, Appendix F. Additionally, the data indicated that the majority of AES
scores were clustered within 150 points, and only a few participants, 7 out of the 40, scored outside of the cluster.

The next phase of the study was the implementation of the self-assessment tool by students in the experimental group. The self-assessment phase of the study was conducted during weeks 3-10 with students (n=23) using the self-assessment tool. The experimental group completed the self-assessment phase prior to the winter test. The comparison group did not implement the tool. All AES students were administered the STAR Math test in February. The February results were recorded and noted in Figure 8. Each score was documented and placed in a scatterplot providing a visual representation of the data. Consistent with the September scatterplot, Figure 7, the x-axis in Figure 8 designated individuals in both the experimental (1-23) and the comparison groups (24-47), and the y-axis indicated the STAR Math scores.

The posttest analysis noted a mean score for the experimental group [$m=742$] and a mean score for students in the comparison group [$m=722$]. The experimental group increased the mean score from pretest [$m=692$] to posttest [$m=742$] resulting in a 50 point difference. The mean score increase for the comparison group on the pretest [$m=676$] to posttest [$m=722$] indicated a 46 point difference. The higher mean gain outcome although slight may indicate an internal validity threat such as subject characteristics differential based on the teaching methodology and presentation difference. Although there appeared to be a positive gain for the students using the self-assessment tool with a coefficient of 9.805, it was not statistically significant as noted in the large p-value of .55, Table 5.

Furthermore, the posttest result on the STAR Math identified that 26 out of 47 students were within the interval of 600 to 750, indicating a decrease of 14 students from the pretest. More AES students scored between 750 to 950 on the February test, evidenced by 18 out of 47
students in comparison to 3 out of 47 in September STAR Math, a further indication that performance levels for most students improved from September to February. Only 2 students scored below 600 on the posttest, and only one student scored consistently below on both tests. Visual analysis of February results indicated that all students in the experimental group (n=23) scored above 600, and 22 students in the comparison group (n=24) did as well.

![Figure 8: STAR Math performance data for both experimental and comparison group.](image)

The AES students’ change of scores from the pretest to the posttest were calculated and displayed in Figure 9. The scatterplot identified the data points and score differential from the September performance to the February performance with the majority of score distribution falling between the intervals of 0-100 points. The data indicated that the majority of students, 29 out of 47, increased scores between 0-100 points from the September performance to the February performance results. There were 10 out of 47 students who scored above 100 points; 8 out of 47 students scored 0 or below. Analysis, therefore, was that majority of student’s
improved math scores from pretest to posttest as demonstrated by the positive gains, Figure 9.

![Figure 9: Individual participant's data in both experimental and comparison group.](image)

**Discussion of Findings**

Examination and analysis of the quantitative results obtained on the STAR Math pretest and posttest did not provide the necessary evidence to support the claim that using the self-assessment tool and implementing self-regulation strategies had a statistically significant and positive effect on student performance. Furthermore, self-regulation and self-management of learning could not be decisively linked to student performance. Although students provided qualitative evidence, as noted in Table 4, by indicating change and improvement, the results were quite small. The fourth grade student performance data did indicate a p-value of <.001, as noted in Table 5, which demonstrated that a student’s fall grade was a statistically significant component of the winter STAR Math grade. However, a significant relationship between the self-assessment tool and academic performance could not be determined. The coefficient was positive when using the self-assessment tool (KTML) at 9.805 but not statistically significant
because the p-value was .55. What was apparent from the data was that students who did well in the fall performed even better in the winter. This could be attributed to test familiarity; evidence from the quantitative data and subsequent large p-value could not support the claim that it had a correlation to the self-assessment or implementation of self-regulation strategies. The null hypothesis could not be rejected; further indication that the study could not show statistically significant evidence that self-assessment did affect test scores.

The impact of being low SES was investigated. This study captured a very small sample of 4 out of 43 AES students in the SES category. The data indicated that if a student was not low SES, then a 6.658 coefficient was evident, which indicated a positive effect, but not a statistically significant one. It could not be determined if the impact of SES could be mitigated by using the self-assessment tool. Moreover, students who were coded as SES, based on the federal government eligibility guidelines with an approved documented application, similarly demonstrated different achievement levels. Appendix C indicated the qualifying income levels based on US government guidelines. The initial entry point for eligibility, based on the guidelines for free meals, was $19,123, and the Massachusetts median income as reported by the U.S. Census during the time period of this study was $63,313, Appendix C.

The students identified as low SES were highlighted, Appendices D & E. The low SES students’ STAR Math scores and improvement in the experimental group ranged from 114, which was at the upper level of achievement, to 0, indicating no change in performance. Additionally, achievement comparisons of low SES students using the self-assessment tool were made relative to the non-low SES students. The low SES student in the comparison group score fell at the lower range of achievement with only a 15-point increase from pretest to posttest. The regression analysis was also used to examine if a correlation between the SES and academic
performance was evident. An indicator variable was used to categorize students as either low SES or non-low SES, as noted in Table 5. Analysis, therefore, indicated that identified SES students performance did not offer enough evidence that could be attributed to influencing math achievement. Simply put, the small sample did not offer evidence to support the claim of influence.

Table 5

Summary of Variables

<table>
<thead>
<tr>
<th>Sept STAR Math Grade</th>
<th>Coefficient</th>
<th>p-value</th>
<th>Mean</th>
<th>SE</th>
<th>Min</th>
<th>Max</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.638</td>
<td>&lt; .001</td>
<td>684</td>
<td>.124</td>
<td>516</td>
<td>866</td>
<td>350</td>
</tr>
<tr>
<td>SES</td>
<td>6.658</td>
<td>.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Assessment Tool (KTML)</td>
<td>9.805</td>
<td>.55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Summary of Key Findings

The predominant themes and key findings emerging from the qualitative data collection highlighted that students in the experimental group were able to suggest factors such as goal setting, long range planning, working with and getting support from others, learning strategies, efficacy beliefs, and perseverance to increase math performance, Figure 2. The social cognitive lens of Zimmerman’s Self Regulation Model (1998), Table 1, illuminated student’s self-reported elements in relation to their mathematical learning. Moreover, students from different mathematical achievement levels were able to indicate the factors that attributed to their success or failures and provided evidence to answer the first research question. The suggested factors aligned and overlapped with the factors that the self-selected parents and master teacher attributed to math success, Figure 6. Recurrent themes of motivation, perseverance, confidence,
and working with and getting support from others suggested that these factors were prominent, frequently noted, and fostered student achievement.

The triadic reciprocal relationship and social environment, as expressed by participants, appeared to imply a strong connection to learning. A majority of AES students in the experimental group shared that working with others was part of a successful repertoire of strategies that were implemented to increase math understanding and achievement. Additionally, the social environment and familiar role models were recognized as contributing factors to strengthen feelings of confidence.

The three phases of self-regulation, forethought, performance, and self-reflection, were cited with varying expressions of implementation noted by students in the experimental group. The majority of students expressed the intention of goal setting and cited the ability to make a connection between forethought and positive math performance. Students demonstrated awareness and understanding that the goals they employed would help them achieve. The social-cognitive model of self-regulation learning (Schunk and Zimmerman, 1989), Figure 1, bi-directional exchange was evident in the student’s responses and self-reported observation of math performance. Long range planning and goal setting by AES students were defined by the importance of math as this related to future success and described by the master teacher as evident, expressed more frequently, and aligned with action steps. Student discussions during each interview showed evidence of self-regulation and connection to math performance, a further illustration that self-reflection was apparent and used to shape future actions. An important finding evident in this study indicated that student’s description of self-efficacy after using the self-assessment tool did not mirror the level of confidence that was evident in the initial interview. Self-assessment coupled with quantitative data may provide feedback that is less than
anticipated by students and can also calibrate results that are not positive. Further examination of math performance results with clarification of weaknesses with descriptive feedback might help students to use the quantitative data to improve performance. The potential of this exchange would be powerful offering guidance and assistance to help student’s self-assess without loss of confidence and the loss of motivation to work through difficult tasks. The connection to the implementation of self-regulation strategies and achievement should still be conducted before concluding there is no impact on these results.

Overall, student responses suggested that Zimmerman’s Self-Regulation Model (1998) was indeed a cyclical process with one component working to drive the next, and the experience of success fostered self-efficacy and motivation to continue the process. Students acknowledged that the learning experience shaped reactions and provided valuable feedback to adjust and make changes that were likely to increase performance. Additionally, AES students expressed beliefs that the self-regulatory process can be implemented, filtered through a social cognitive lens, and the resulting self-reflection would allow for adjustments and control. Shifting the locus from teacher-centered to student as managers of their learning provided valuable qualitative feedback for this study and insight into the learning processes of AES students. The findings suggest that before concluding there is limited causal connection to achievement it would be worthy of further study.

The qualitative data and identification of factors, Figure 2, successfully answered the first researcher question under investigation: **To what factors do students from different mathematical achievement levels attribute their successes or failures?** In summary, the factors as determined by AES students were as follows: working with and getting support from others, setting goals, multiple strategies, confidence, perseverance, and long range planning for future success. Lastly,
students were able to identify phases of self-regulation, Table 4, and noted a slight change and improvement in math performance when using the self-assessment tool.

Quantitative data strengthened the analysis and provided statistical information to calibrate the claim of benefit of using the self-assessment tool. The quantitative analysis and findings did provide further evidence to answer the second research question: *What effect would a self-assessment tool have on student performance?* Findings derived from the numerical representation and multiple regression analysis did not substantiate this claim of benefit of the self-assessment tool to provide a strong correlation with math performance. The implementation of a self-assessment tool and self-regulation strategies by AES students could not be directly linked to improved mathematical performance. Moreover, the STAR Math pretest and posttest did not provide the evidence to support the claim that using the self-assessment tool and implementing self-regulation strategies had a statistically significant and positive effect on student performance. The fourth grade student performance data did indicate a p-value of <.001, which demonstrated that a student’s fall grade was a statistically significant component of the winter STAR Math grade. Analysis, therefore, did not indicate a correlation to the self-assessment tool, and influence on academic performance could not be determined. The coefficient was positive, when using the self-assessment tool, at 9.805, but not statistically significant as evident with the large p-value .55.

The study captured a very small sample of low SES students. The data indicated that if a student was not low SES, then a 6.658 coefficient was evident, which indicated a positive effect size. It was not a statistically significant one. It could not be determined that the impact of SES could be mitigated by using the self-assessment tool.
Furthermore, as expressed by the master teacher, the experimental group attitudes could have been influenced by the researcher’s spotlight on the implementation of the self-assessment tool and student achievement. This focus may have influenced the students’ responses and benefit of change and improvement that was indicated. The Hawthorne effect (Parsons, 1975) may have provided a threat to the internal validity of the study due to the introduction of the intervention and potential positive effect on student responses and performance. Additionally, as students in the experimental class knew that their classroom experience was part of a study, it was hypothesized that scores would improve by using the self-assessment tool. Additionally, as students in the experimental class knew that their classroom experience was part of a study, it was hypothesized that scores would improve by using the self-assessment tool. Furthermore, internal validity threat due to differential subject characteristics related to the teachers and their teaching methodology and credentials may have occurred despite the similarity of experimental group and comparison group. This appeared to imply a weakness of this study.

Finally, the mixed method design of this study and the triangulation of the data provided a comprehensive investigation of students’ mathematical performance. A convergence of data was ascertained at the performance level. AES students expressed perceptions and implementation of self-regulation strategies as it related to math performance, and STAR Math data indicated performance. The researched questions under investigation were addressed and answered. The key findings from the data collection indicated that AES student participants did offer robust information to describe the factors that influence math performance learning and offered insight through the lens of self-regulation. A strong, recurrent theme was the influence of the social environment on student performance for participants of this age level. Not only did the triadic exchange influence performance, it also affected self-efficacy and motivation. The
qualitative and quantitative findings could not decisively ascertain whether the changes in test scores were attributed to teacher instructional approaches, test familiarity, and/or Hawthorne effect (Parsons, 1975). Furthermore, the quantitative data analysis indicated that the coefficient was positive when using the self-assessment tool at 9.805 but not statistically significant because of the p-value of .55. Therefore, the implementation of a self-assessment tool and self-regulation strategies could not be directly linked to improved mathematical performance. In summary, the triangulation of data strengthened this study. Well-validated and substantiated findings enabled a comprehensive picture of participant’s mathematical performance to be investigated through the convergence of qualitative and quantitative data.
Chapter 5

Discussion of Research Findings

This research study addressed the need to go beyond traditionally defined student categories to explore other intra-relational factors that contribute to improved student performance. This study enabled an extension beyond high school and college into the elementary grades to probe the implementation of self-regulation strategies and the influence on performance. Findings of this study offered marginal evidence of how students’, parents’, and a master teacher’s self-reported variables would influence mathematical performance and would narrow the achievement gap.

This research is of educational significance primarily because of the potential negative repercussions that low achievement gains have on a child’s future educational success. Shifting the locus of control from teacher to students as managers of their learning provided the opportunity for the identification of factors that contributed to mathematical performance. As was hypothesized, the qualitative data suggested that student implementation of self-regulation strategies was a lens into math performance, an exploration of efficacy beliefs, and the link to achievement. The first research question suggested that when students self-assessed their performance, a claim of benefit with the implementation of self-regulated strategies was self-reported by some AES students. Extensive review of the literature indicated that no single factor or label would adequately offer insight into the achievement gap. Therefore, the social cognitive theoretical framework provided an investigative opportunity to explore self-regulation and the impact on student performance.

The achievement results captured during the study affirmed that AES students continued to demonstrate a performance fluctuation and a discrepancy scatter. The quantitative data
analysis indicated that some students were not consistently progressing to increase scores from one test administration to the next test administration. The fluctuation in AES student performance confirmed that a mixed-methods design was a major implication for this research and addressed the research questions in a comprehensive manner. Moreover, the focus on students’ mega-cognitive analysis coupled with the identification of attributes that contributed to performance outcomes was a touchstone that provided solid qualitative evidence. The quantitative data captured real time acquisition of performance levels, which allowed for pretest-posttest analysis. Extension of the research to investigate fluctuation in performance and narratives from fourth grade students in relation to other elementary schools would provide additional information and generalization. Further research of the type being recommended here; would provide a more intensive exploration of intra-relational factors in relation to actual performance. This would enable researchers to investigate further before concluding there was no connection between self-regulation and math results.

**Implications of Findings**

Research indicated that it is problematic when teachers do not actively involve students as partners in the educational process and acknowledge students’ learning styles, “Education must begin with the solution of the teacher-student contradiction, by reconciling the poles of the contradiction so that both are simultaneously teachers and students” (Freire, 2002, p. 57). Social cognitive theorists argued that without the fluidity of instructional roles, a severe chasm would exist that would influence the construction of learning. There was, in fact, rich evidence presented by social cognitive theorists and progressive thinkers that suggested that a child must actively participate in the teaching and learning dynamic in order to succeed. Therefore, extending this research and conducting further study to probe more deeply into the classroom
dynamics and performance levels of elementary students would offer keener insight into the achievement gap. Further research would provide a better understanding of abilities, influence of a growth mindset, and efficacy beliefs that strengthen effort and achievement.

AES students’ verbal and written expression of math thinking, problem solving strategies, self-efficacy, and misunderstanding of mathematical concepts provided a window into learning needs, self-described factors, and a link to performance. Examination of factors within the teaching and learning dynamic with AES students’ self-prescribed attributes presented critical information for analysis. The students’ self-assessment and critical analysis of performance clarified perceptions of learning and offered insight into the application of self-regulation strategies.

Further research and examination of professional development for teachers based on this study results would offer an understanding of Zimmerman’s Three Phases of Self-Regulation (1998) and the bi-directional exchange of Schunk and Zimmerman’s (1989) Social-Cognitive Model of Self-Regulation Learning, application would strengthen pedagogical practices. For this reason, probing more deeply into the effective teaching approaches that master teachers’ employed and the influence of effective teachers on student performance would be a worthy extension of this study. Qualitative analysis for this study did support the claim that some participants’ perception of increased mathematical performance was evident, and the influence of the social environment was an identified contributory attribute. While the self-assessment tool did not show quantitative evidence of a link to performance, it did provide a framework for dialogue and narrative descriptions of strategies and self-efficacy.

An additional implication of this study was the benefit of a mixed methods methodology, robust collection of data, and triangulation of data to explore the hypothesis that if students
became the managers of their mathematical learning (using the vehicle of self-regulation, analysis of meta-cognitive reflection, and self-assessment), then a measurable positive gain in mathematical achievement would result. Although the quantitative results did not indicate a statistically significant benefit by using the self-assessment tool, there was evidence to support extension of this research. AES fourth grade student performance data did indicate a p-value of <.001, which demonstrated that a student’s fall grade was a statistically significant component of the winter STAR Math grade. Further research on the effect of SES and performance would be needed to support a claim of benefit using the AES student’s identified factors and examining beyond this initial study the potential for a positive gain in performance.

Another implication of this study was the vibrant opportunity to explore what happens when students and teachers strategically work together to establish students as managers of their own learning. The paradigm shift from a teacher-centered focus to a student-centered focus had the potential to open the door to a deeper understanding of the achievement gap beyond test results. A focus on external factors, such as poverty levels and subgroup identification, did not offer enough information to conclude that academic achievement gaps exist primarily due to aspects beyond students’ control. Extending the research beyond the initial study to a larger sample would generate more data on SES and not SES students. This extension of the study would enable a deeper analysis of student performance and further exploration beyond the limitation and interpretation of a predominant socioeconomic and subgroup frame. Future research would extend insight into the academic gap by assessing growth potential and self-regulation factors that influence student math performance.
Limitations of Study

A limitation of this study was looking through the social cognitive lens and narrowing the beam for this research. Cobb (2007) explains that this type of research, “provides only limited guidance because the classroom processes on which design focuses are emergent phenomena rather than already established practices into which students are inducted” (p. 24). For this reason, it is important to note that a connection to an individual’s self-assessed mathematical performance can be mediated and influenced by the social dynamic within each classroom environment. Therefore, additional research beyond this initial study would be needed to determine benefit of this social cognitive focus as it pertains to mathematical achievement for elementary students. Qualitative data for this study did provide narrative descriptions from some students that supported a claim of benefit and self-reported belief of achievement gains. Further examination of the link between self-regulatory processes and student beliefs would need to be conducted before concluding that there was no impact on the combined qualitative and quantitative results. A further examination of the influence on self-efficacy beliefs and bi-directional exchange, as expressed by Schunk and Zimmerman (1989), Figure 1, would offer additional data for a more in-depth analysis of student achievement to extend beyond this initial research.

A second limitation of this study was that the small study sample size could not support the claim that using a self-assessment tool would increase mathematical performance for students identified as SES. The quantitative data for this study indicated that if a student was not low SES, then a 6.658 coefficient was evident, which indicated a positive effect size. However, it was not a statistically significant one, and it could not be determined that the impact of SES could be mitigated by using the self-assessment tool. The limitation of sample size was a
weakness that did not enable a robust collection of SES data for interruption, which limited the opportunity to make a claim of benefit. The extension of this study with a larger SES study sample would provide more data to determine statistically significant results. Further exploration and the result of this investigation could lead to a deeper understanding of not only what students are thinking, but also how they strategically shape academic achievement for themselves. Ramirez and Carpenter (2005) aver, “The practice of lumping together data from all students of color—even data from divisions within a single group—is a mistake that is bound to produce poor policy choices and poor educational practices” (p. 602). Further examination and research that extends beyond socioeconomic conditions would offer more data to determine whether the achievement gap would be effectively narrowed through the implementation of self-regulation strategies, self-prescribed factors, and performance gains.

A third limitation was the selection of students from just one master teacher’s classroom to implement the self-assessment tool. A larger sample size would provide more data beyond the initial study to ascertain if shifting the locus from teacher-control to students as managers of their own learning would strengthen performance and offer a value added dynamic to narrow the achievement gap. Further investigation with additional participation from other master teachers would provide additional data to further understand the social environmental influences on performance and the pedagogical approaches used by effective teachers to ensure achievement gains.

Additionally, extension of this research into other classrooms would enable further insight into students’ self-prescribed variables and employment of learning strategies to capture a student-centered picture of performance, efficacy, and change. Also an investigative probe beyond this study with a larger sample size and additional classroom sites would determine if a
statistically significant relationship was evident with employment of the self-assessment tool. This quasi-experimental study using pretest-posttest nonequivalent groups design captured only one experimental and one comparison group, which provided limited data and made the study vulnerable to the internal threat of differential subject characteristics.

The focus on the self-assessment tool may have influenced students’ responses and limited this study. Directing a spotlight on the experimental group may have affected student responses on implementation of self-regulation strategies, description of beliefs, and the effect on math performance. For this study there was an indication of the “Hawthorne effect” which might have influenced participants’ responses. The Hawthorne effect (Parsons, 1975) “shows how variables can be unwittingly confounded in an experiment because of some aspect of the experiment itself” (p.33). The familiarity of the researcher and the focus on mathematical learning during the 11-week study may have influenced the study results. Consideration for future study would center on the claim of benefit of the tool and self-described achievement in light of the potential for this internal threat.

Although these findings amongst AES fourth grade students are important steps toward validating and refining the link between math performance and Zimmerman’s Model of Self-Regulation (1998), more research would be recommended at the elementary school level. The limitations of this study confirmed that further research would be required to more extensively address self-regulation, elementary students’ performance levels, factors that influence performance, and effective pedagogical practices to narrow the achievement gap. Although there were some positive indications of performance results as described by some students, it was not evident in the quantitative data. Simply put, some students expressed a link between implementation of self-regulatory strategies and performance. Performance for some students
did increase from the pretest to the posttest; however, the link to self-regulatory processes and math results were not statistically significant.

Further investigation would be needed to go beyond high stakes testing and teacher-directed assessment protocols to explore the additional possibilities that would alter the mathematical decline. Shifting the locus of teacher-control to students as managers of their learning and implementing self-assessments as part of the unit of study have the potential to deepen the understanding of why fourth grade students succeed or fail to grasp math content. Findings indicated that AES students at this age level had difficulty putting into descriptive language self-regulation and cognitive engagement. Determination as to why AES students at this age level had difficulty sharing strategies beyond operationally concrete mathematical thinking and problem solving would be a worthy continuation of this study to allow for greater insight into student performance and learning gaps.

Finally, this mixed methods study did provide a robust investigation of the research questions. The triangulation of data, analysis, and results of the study, however, did not support the hypothesis that the self-assessment tool impacted mathematical performance and narrowed the achievement gap. Therefore, self-regulation and student management of learning could not be decisively linked to student performance. As stated, it would be a worthy pursuit to undergo a broader and longer study beyond this initial study. The investigation would capture a larger sample size before determining that there was no impact on achievement on the combined qualitative and quantitative results.

**Recommendations for Future Research**

Interpretation of the key findings guided these recommendations to support an extension beyond this study to develop a deeper understanding of the academic achievement gap. The SES
subgroup category in this study provided limited data to make a strong prediction of whether self-regulation strategies would narrow the mathematical achievement gap. Extension of this research would be needed and beneficial to examine what successful SES students were doing to increase math performance and the potential for generalization.

The first recommendation for extension of this research would be investigation with a larger statistically powerful sample of SES students. This examination would provide additional data that would ascertain if a statistically significant result would be identified in the qualitative analysis and qualitative narratives of students with this indicator. The acquisition of income levels of all participants would enable a drill down to different levels of SES distribution and strengthen the claim of benefit that SES and not low SES can achieve at high levels. The participants’ perceptions of SES and influence on performance would be required and would need to be addressed specifically. This focused narrative discussion, data, and analysis would have clarified student thinking and provided more information to further understand the complex variables that contributed to students’ performance.

A second recommendation would be extension of this research to examine professional training programs for teachers. This information would address the underlying premise that shifting the locus of control from teacher to students as managers of their learning would have an impact on mathematical learning and performance. Future research would enable teachers to determine if self-regulation strategies embedded into pedagogical practices would result in narrowing the achievement gap. Additionally, the data would determine if explicit teaching of self-regulation with a more self-reflective component for knowledge acquisition would benefit students and increase achievement. Explicit teaching methods that supported students’ ability to construct knowledge, employ problem-solving strategies, and self-assess performance to increase
understanding would be an area for further study. This pedagogical research would enable an educator to move beyond traditionally defined subcategory analysis that perpetuates a deficient mindset. Research that examines the employment of explicit instruction embedded into pedagogical practices would help educators and students better understand the phases of self-regulation, application, and results of implementation in order to potentially facilitate a greater gain in performance. In this way, students would self-monitor learning and make adjustments as needed to improve performance. Duckworth, et al. (1990) offer, “The teacher acts neither as a dispenser of knowledge nor as a ‘guide’ on a journey of knowledge, but as an interlocutor who encourages children to construct their own knowledge” (p. 186). Modifying the role of teacher from being the sole instructor to teacher and students as partners within the classroom would be an important educational advancement worthy of further examination.

The third recommendation and extension to the study would be the exploration of the pedagogical practices that effective teachers implemented to support all learners. An investigative lens that would illuminate the impact of Dweck’s (2006) growth mindset, Gardner’s (1993) Multiple Intelligences Theory, Zimmerman’s (1998) Self-Regulation Model, and the influence on achievement of not low SES students and SES students would be important. Extending research and examining more deeply beyond this initial study, the influence of Zimmerman’s (2000) and Bandura’s (1997) work by with the inclusion of self-regulation of learning and determination of how effective teachers foster students’ self-observation, self-judgment, and self-reaction to narrow the achievement gap would be highly recommended.

Additionally, expansion of this initial study with a full year of data capturing student implementation of self-regulation strategies and impact on mathematical performance would be recommended. Further consideration and research into the influence of significant others on
student learning and self-efficacy beliefs would be beneficial. Examination of this variable and determination if a decreased amount of help from significant others would be an indicator of increased self-confidence and improved math performance would be a worthy investigation. The expansion beyond the initial study would offer further insight to determine if the hypothesis of shifting the locus of control from teacher to students as managers of their learning would be an indicator for narrowing the achievement gap. For this reason, additional interviews with master teachers and parents would add a unique perspective into the complex environment in which self-efficacy beliefs were embedded into students’ attitudes.

Engagement in further study and determination if self-regulation strategies embedded within the instructional practices of teachers and help from parents would increase a student’s ability to understand the process of knowledge acquisition would be recommended. Further investigation of a shift from teacher-centered to student-centered learning and subsequent impact on math performance would be needed before concluding that no demonstrated connection between the implementation of self-regulation strategies and math achievement was evident. However, as Cobb (2007) implied, there would be limitations and a relevant weakness, in this type of investigation since a student-centered approach can be less structured than a teacher-directed approach in which learning experiences were guided by the curriculum and textbook.

As indicated, a comprehensive examination with a large sample size would extend this research and provide additional data before concluding that there was no impact on performance. Examination of the triadic reciprocal interplay with the student at the center would offer additional insight into what might answer the question as to why some students succeed and others fail in the same learning environment. Lastly, the subcategory listing and examination of student performance, as determined by high stakes testing results and reporting out, provided
limited information from which to plan effective teaching, understand the variables that affect student performance, investigate performance successes and failures, and make policy decisions to address the achievement gap. A robust opportunity would be available for researchers to partner with the educational community and expand research both inside and outside the classroom to move beyond traditionally defined analysis and assessment that has limited thinking and unduly categorized students.

**Conclusion**

This study was a formidable attempt by this researcher to offer a comprehensive understanding of AES fourth grade students’ insight into the mathematics learning dynamic. This mixed methods study did successfully answer the research questions under investigation. What was evident from the literature review and these initial results was that the extension of the study offered policy makers, teachers, and administrators keener insight beyond the traditionally held beliefs that subcategory analysis alone effectively described the learning and performance of students without consideration of intra-relational factors.

The educational community and national trends solidly indicated that an academic gap in mathematics between student aggregate performance and subgroup performance was evident. This gap was indicated in statistical data generated by standardized testing results both across the nation and in local school districts. The concern remained as to how to narrow the mathematical performance gap to enable all students to achieve at high levels. At the local level, this study investigated this problem by using a social cognitive lens and looking at mathematical performance using a mixed methods study. This study did offer results that defined the factors that students described as influencing learning and math performance however, it did not show evidence to conclude that there was a linked to self-regulation. The data presented some
alternative conclusions by the experimental group that highlighted the lack of self-efficacy, lack of mathematical foundational skills, not setting a goal or focus for mathematical learning, and the lack of concise problem solving steps to complete the mathematical computation process. The quantitative data did not conclusively offer information as to why this might be happening for some AES students therefore, concluding that no impact was evident would require further study. A focus on external factors, such as poverty level and subgroup identification, did not offer enough information to conclude that academic achievement gaps exist primarily due to aspects beyond students’ control. The focus on self-regulation and math achievement was worthy of investigation; however, the results of this study did not support a conclusive indication of impact.

The achievement gap remains of educationally significant primarily because of the potential negative repercussions that low achievement gains has on a child’s future educational success. It was proposed that low math performance levels adversely affect students’ educational achievement, self-esteem, motivation, and ability to grasp more complex content. Massachusetts high stakes testing still remains the bellwether of accountability and achievement. Student mathematical performance of this measure is regarded by Massachusetts Department of Education as predicting future performance. Some AES students indicated that they continue to struggle to meet their math goals which hinders their ability to successfully achieve at the proficiency levels needed to master complex mathematical concepts and problem solving. The lack of math proficiency by some AES students has been described as having a negative influence on self-efficacy.

Literacy researchers offered additional insight into student learning outcomes. Literacy findings have resulted in an attempt to document what good readers do to become fluent and
master the comprehension of texts. Likewise, the qualitative data of this study offered self-described factors that indicted variables that some AES student’s used to improve mathematical performance. Some students described a benefit from the implementation of self-regulated strategies and increased performance. The AES student’s perspective offered information as to what good math students do in order to achieve math fluency and master problem solving.

Ultimately, the goal of this study was to explore how fourth grade students from different mathematical achievement levels utilized self-assessment intervention, described success and failure, and demonstrated achievement. The qualitative results of this study indicated that students, parents, and the teacher were able to describe valuables and offered insight into the mathematical learning and mega-cognitive engagement of AES students. The qualitative data suggested that there was some evidence that student’s self-described variables would have a potential link to achievement.

The influence of a master teacher and precision of instructional strategies and assessment would be powerful indicators to help educators, administrators, and policy makers move beyond socioeconomic and subgroup analysis to define achievement results. The dynamic and the fluid interplay between teacher and students and the potential impact on achievement would serve to provide additional data beyond this initial study. This investigation and would further examine the impact and the influence on elementary school students’ mathematical performance and self-regulation. A weakness of this study was that there was limited concluding information from the combined data to fully ascertain the full measure of influence that the triadic reciprocal interplay has on math performance.

This study does not establish a statistically significant relationship to support the claim of benefit of the self-assessment tool on student performance. The quantitative data indicated that
the self-assessment was not effective as a tool to increase math performance. However, this researcher recommends that further insight into the drivers that would improve performance be investigated to move beyond limited socioeconomic and subgroup categorization and analysis of achievement results. The AES students’ achievement growth from 3rd grade to 4th grade administration of high stakes testing results would allow researchers to investigate a claim of benefit to determine ways that would improve mathematical performance. Additionally, the focus on students’ quantitative performance results from the initial study and self-reported learning profiles would offer a bridge to answer the question as to why some fourth grade students succeed and others do not.

It would be highly recommended that all students have the opportunity to narrate the variables that would improve performance and assess in real time actual results of high stakes testing. Finally, this study provided meaningful data to drill down into the classroom to discover effective pedagogical practices that shifted the locus of control from teacher directed to students as managers of their own learning.
References


Ed.Gov., U.S. Department of Education


Bloomington, IN: Solution Tree.


*Journal of Educational Psychology, 81*(3), 329-339.


*Educational Psychologist, 25*(1), 3-17.


Appendix A

Student Progress Chart
Keeping Track of My Learning

Name: ________________________
Learning Goal: _______________________________________________________

My score at the beginning: ______. My goal is to be at score ______ by ______.
Specific things I am going to do to improve: ________________________________

Learning Goal: _______________________________________________________

<table>
<thead>
<tr>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>b</td>
<td>c</td>
<td>d</td>
<td>e</td>
</tr>
<tr>
<td>f</td>
<td>g</td>
<td>h</td>
<td>i</td>
<td>j</td>
</tr>
</tbody>
</table>

a. _____ f. _____
b. _____ g. _____
c. _____ h. _____
d. _____ i. _____
e. _____ j. _____
INTerview QUESTIONS

Student
First interview
1. Feelings/Perceptions: How do you feel when you are in math class? Do you share how you feel about math with anyone? If so who? What do you say? If not why not?
2. Strategies: What have you found helpful when you are asked to solve a math problem?
3. Performance: Would you explain how you would solve this math problem?
4. Perseverance: Tell me what you do if you get stuck when you are solving a math problem. Do you check your answers when you have finished solving a problem? If you do check your answers what do you look for? Tell me how you feel if your answer is not what you expected?
5. Efficacy: How would you describe yourself as a math student?
6. Achievement: Why do you think it is important for you to learn math?
7. Goals: Do you set math goals? If so what goals have you set for yourself? Have you ever graphed your math progress? If so describe what you did.

Mid-point interview
1. Feeling/Perceptions: How do you feel about math class since you started using the “Keeping Track of My Learning” (KTML) graph to track your learning?
2. Strategies: Tell me about the different strategies you use when solving a math problem.
3. Performance: How would you solve this math problem?
4. Perseverance: Tell me what happens when you are unable to solve a math problem. How do you feel if your answer to the math problem is not what you expected?
5. **Efficacy:** Describe how confident you are in reaching your math goal.

6. **Achievement:** Describe any changes that you have noticed in your mathematical abilities since using the KTML graph to track your learning.

7. **Goals/Self-Assessment:** What do you feel has been most helpful about assessing your math progress?

**Final Interview**

1. **Feelings/Perceptions:** Have your feelings about math changed since using the KTML graph?

2. **Strategies:** What strategies do you most often use when solving a math problem? Have these changed since using the KTML graph?

3. **Performance:** Tell me how you would solve this math problem.

4. **Perseverance:** Describe what happens when you are not able to solve a math problem.

5. **Efficacy:** Describe your mathematical abilities.

6. **Achievement:** Tell me how self-assessing your learning influenced your math performance.

7. **Goals/Self-Assessment:** Tell me what you feel has been most helpful about assessing your math progress. Are you planning on setting math goals in the future?

**Parent/Guardian**

1. Describe your child’s experience in math.
2. Describe how your child feels about math and his/her mathematical abilities? Tell me about any factors that have influenced your child’s math performance.

3. Share your experiences learning math.

4. Name the factors that you feel are important for a student to be successful in math.

5. Describe your role in helping your child learn math.

6. What expectations do you have of your child in math?

7. Describe what your child does when unable to solve a math problem.

Post Interview

1. Tell me about your child’s math experience during these eight weeks.

2. What factors have had an effect on your child’s performance or feeling about math? Why do you think your child performs or feels this way?

3. Name the factors that you feel are important for a student to be successful in math.

4. Describe your role in helping your child learn math.

5. Tell me if your child shares his/her mathematical thinking when solving a math problem.

6. What expectations do you have of your child in math?

7. Describe what your child does when unable to solve a math problem.

Teacher

1. How would you describe your experience teaching math?
2. Share your experiences as a student learning math and how that has influenced how you teach mathematics.

3. Describe your role in helping your students learn math.

4. How does a student’s background (socioeconomic factors) affect their learning in math?

5. Do you feel that a student can increase their math performance by setting goals and using a self-assessment tool?

6. Name the factors that you feel are important for a student to be successful in math.

7. Tell me what you do when a student is unable to solve a math problem?

Post Interview

1. Tell me about your student’s math experience during these eight weeks. Have you noticed any changes? If so please describe any changes you have noticed.

2. Describe your role in helping your students learn math.

3. Do you feel that a student can increase his/her math performance by setting goals and using a self-assessment tool?

4. During these eight weeks have your students increased their willingness to share their mathematical problem solving strategies in class?

5. During the eight weeks what specific math problem solving strategies have most frequently been shared?
6. Did you observe any changes in the frequency of your students making positive statements about their mathematical abilities? During the eleven weeks have any of your students demonstrated an increased willingness to struggle with a math problem and try to challenge themselves with more difficult problems?

7. Would you explicitly teach self-assessment strategies as part of a lesson planning? If so would you increase the time in class for students to set math goals, discuss successful mathematical problem solving strategies, and graph their learning.
Appendix C

Income Eligibility Guidelines
July 1, 2011 to June 30, 2012

<table>
<thead>
<tr>
<th>Household Size</th>
<th>Federal Poverty Guidelines</th>
<th>Free Meals</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>14,710</td>
<td>19,123</td>
</tr>
<tr>
<td>3</td>
<td>18,530</td>
<td>24,089</td>
</tr>
<tr>
<td>4</td>
<td>22,350</td>
<td>29,055</td>
</tr>
<tr>
<td>5</td>
<td>26,170</td>
<td>34,021</td>
</tr>
<tr>
<td>6</td>
<td>29,990</td>
<td>38,987</td>
</tr>
<tr>
<td>7</td>
<td>33,810</td>
<td>43,953</td>
</tr>
<tr>
<td>8</td>
<td>37,630</td>
<td>48,919</td>
</tr>
<tr>
<td>For each add’l family member, add</td>
<td>3,820</td>
<td>4,966</td>
</tr>
</tbody>
</table>

Massachusetts Median Household Income 2011  

| Massachusetts Median Household Income 2011 | 63,313 | Standard Error 3,226 |

Department of Agriculture Food and Nutrition Service  
Child Nutrition Programs – Income Eligibility Guidelines  
Federal Register/Vol.76, No. 58 March 25, 2011 pg. 16725,  

Massachusetts Median Household Income by State  
US Department of Commerce United States Census Bureau Single-Year Estimates  
http://www.census.gov/hhes/www/income/data/statmedian/  
Retrieved 08/10/13.
Summary of Scores for the Experimental Group

<table>
<thead>
<tr>
<th>Experimental Group (n=23)</th>
<th>Pretest – Star Math September Prior to implementation of the self-assessment tool</th>
<th>Posttest-Star Math February After the implementation of the self-assessment tool</th>
<th>Increase or decrease score results from Pretest to Posttest (after implementation of self-assessment tool)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>543</td>
<td>605</td>
<td>62</td>
</tr>
<tr>
<td>2</td>
<td>675</td>
<td>805</td>
<td>130</td>
</tr>
<tr>
<td>3</td>
<td>625</td>
<td>688</td>
<td>63</td>
</tr>
<tr>
<td>4</td>
<td>696</td>
<td>803</td>
<td>107</td>
</tr>
<tr>
<td>5</td>
<td>703</td>
<td>682</td>
<td>- 21</td>
</tr>
<tr>
<td>6</td>
<td>866</td>
<td>903</td>
<td>37</td>
</tr>
<tr>
<td>7</td>
<td>664</td>
<td>725</td>
<td>61</td>
</tr>
<tr>
<td>8</td>
<td>713</td>
<td>790</td>
<td>77</td>
</tr>
<tr>
<td>9</td>
<td>643</td>
<td>659</td>
<td>16</td>
</tr>
<tr>
<td>10</td>
<td>738</td>
<td>738</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>623</td>
<td>687</td>
<td>64</td>
</tr>
<tr>
<td>12</td>
<td>674</td>
<td>695</td>
<td>21</td>
</tr>
<tr>
<td>13</td>
<td>728</td>
<td>757</td>
<td>29</td>
</tr>
<tr>
<td>14</td>
<td>684</td>
<td>753</td>
<td>69</td>
</tr>
<tr>
<td>15</td>
<td>675</td>
<td>792</td>
<td>117</td>
</tr>
<tr>
<td>16</td>
<td>771</td>
<td>832</td>
<td>61</td>
</tr>
<tr>
<td>17</td>
<td>709</td>
<td>715</td>
<td>6</td>
</tr>
<tr>
<td>18</td>
<td>696</td>
<td>772</td>
<td>76</td>
</tr>
<tr>
<td>19</td>
<td>729</td>
<td>738</td>
<td>- 9</td>
</tr>
<tr>
<td>20</td>
<td>651</td>
<td>651</td>
<td>0</td>
</tr>
<tr>
<td>21</td>
<td>627</td>
<td>695</td>
<td>68</td>
</tr>
<tr>
<td>22</td>
<td>677</td>
<td>791</td>
<td>114</td>
</tr>
<tr>
<td>23</td>
<td>809</td>
<td>797</td>
<td>-12</td>
</tr>
</tbody>
</table>
### Appendix E

Summary of Scores for the Comparison group

<table>
<thead>
<tr>
<th>Control Group (n=24)</th>
<th>Pretest–STAR Math September</th>
<th>Posttest–STAR Math February</th>
<th>Increase or decrease score from Pretest to Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>516</td>
<td>665</td>
<td>149</td>
</tr>
<tr>
<td>2</td>
<td>737</td>
<td>558</td>
<td>-121</td>
</tr>
<tr>
<td>3</td>
<td>665</td>
<td>734</td>
<td>69</td>
</tr>
<tr>
<td>4</td>
<td>634</td>
<td>693</td>
<td>59</td>
</tr>
<tr>
<td>5</td>
<td>668</td>
<td>724</td>
<td>56</td>
</tr>
<tr>
<td>6</td>
<td>548</td>
<td>694</td>
<td>146</td>
</tr>
<tr>
<td>7</td>
<td>735</td>
<td>773</td>
<td>38</td>
</tr>
<tr>
<td>8</td>
<td>643</td>
<td>723</td>
<td>80</td>
</tr>
<tr>
<td>9</td>
<td>674</td>
<td>672</td>
<td>-2</td>
</tr>
<tr>
<td>10</td>
<td>734</td>
<td>780</td>
<td>48</td>
</tr>
<tr>
<td>11</td>
<td>742</td>
<td>696</td>
<td>-46</td>
</tr>
<tr>
<td>12</td>
<td>696</td>
<td>807</td>
<td>111</td>
</tr>
<tr>
<td>13</td>
<td>704</td>
<td>733</td>
<td>29</td>
</tr>
<tr>
<td>14</td>
<td>739</td>
<td>717</td>
<td>22</td>
</tr>
<tr>
<td>15</td>
<td>520</td>
<td>551</td>
<td>31</td>
</tr>
<tr>
<td>16</td>
<td>708</td>
<td>739</td>
<td>31</td>
</tr>
<tr>
<td>17</td>
<td>712</td>
<td>778</td>
<td>66</td>
</tr>
<tr>
<td>18</td>
<td>703</td>
<td>807</td>
<td>104</td>
</tr>
<tr>
<td>19</td>
<td>659</td>
<td>684</td>
<td>129</td>
</tr>
<tr>
<td>20</td>
<td>693</td>
<td>818</td>
<td>125</td>
</tr>
<tr>
<td>21</td>
<td>707</td>
<td>723</td>
<td>16</td>
</tr>
<tr>
<td>22</td>
<td>670</td>
<td>797</td>
<td>127</td>
</tr>
<tr>
<td>23</td>
<td>708</td>
<td>755</td>
<td>47</td>
</tr>
<tr>
<td>24</td>
<td><strong>715</strong></td>
<td><strong>730</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>
Appendix F

Descriptive Statistical Data of AES Experimental Group and Comparison group

<table>
<thead>
<tr>
<th></th>
<th>Pretest Experimental Group</th>
<th>Posttest Experimental Group</th>
<th>Pretest Control Group</th>
<th>Posttest Control Group</th>
<th>September STAR Math Grade Combined</th>
<th>Self-Assessment Tool (KTLM)</th>
<th>SES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Valid</strong></td>
<td>23</td>
<td>23</td>
<td>24</td>
<td>24</td>
<td>47</td>
<td>23</td>
<td>43</td>
</tr>
<tr>
<td><strong>Missing</strong></td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>692</td>
<td>742</td>
<td>676</td>
<td>722</td>
<td>684</td>
<td>23</td>
<td>1</td>
</tr>
<tr>
<td><strong>Std. Error of Mean</strong></td>
<td>0.124</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Median</strong></td>
<td>684</td>
<td>738</td>
<td>699</td>
<td>727</td>
<td>708</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>266</td>
<td>227</td>
<td>226</td>
<td>267</td>
<td>350</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Minimum</strong></td>
<td>543</td>
<td>605</td>
<td>516</td>
<td>551</td>
<td>516</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum</strong></td>
<td>866</td>
<td>903</td>
<td>742</td>
<td>818</td>
<td>866</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>