THE EFFECTS OF COOPERATIVE LEARNING STRATEGIES ON MATHEMATICS ACHIEVEMENT AMONG MIDDLE-GRADES STUDENTS: A META-ANALYSIS

by

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(Under the Direction of Stacey Neuharth-Pritchett)

ABSTRACT

The purpose of this study was to examine the existing body of literature and through the use meta-analysis determine the effect of cooperative learning strategies on the mathematics achievement of middle-grades students, grades 4-8. A collection of 25 quantitative studies produced an effect size which indicated that cooperative learning strategies have a positive effect on the mathematics achievement of middle-grades students.

Through correlational analysis, the current study examined relationships between the duration of the studies and effect size of the studies. Also examined was the duration of the studies and grade 4 and grade 8 NAEP mathematics proficiency scores for 2003. Correlation Tables as well as scatter plots for each correlation were provided for visual examination. Also examined were the location of the studies; the particular method of data analysis that each study used; and the dependent outcome measure of each of the studies. Conclusions and recommendations for further research were provided.

INDEX WORDS: Cooperative learning strategies, Mathematics achievement, Middle-grades students

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CHAPTER 1

THE PROBLEM

A major crisis exists in the mathematics education of young adolescents in the middle-grades. For the past three decades, an alarmingly large percentage of middle-grades students have failed to reach proficiency levels in mathematics. In fact, the most recent National Assessment of Educational Progress (NAEP) data show that middle-grades mathematics students are not performing at the benchmark proficiency levels in which they should. Some students are reaching, yet not exceeding mathematics proficiency levels; they continue to achieve below the mathematics proficiency level set by the NAEP. This evidence of the underachievement of young adolescents is caused by several factors which may include the improper preparation for teaching mathematics, teachers' lack of continued participation in professional development opportunities and, most importantly lack of implementation of effective instructional strategies in the mathematics classroom. While all of these factors are pertinent to the mathematical learning and achievement of all students and middle-grades students in particular, the implementation of effective instructional strategies remains at the forefront of mathematics reform (Grouws & Smith, 2000).

All of these factors coincide with the fact that entrance into the middle grades is considered one of the most turbulent transitions in the life an adolescent as students enter adolescence. This turbulence is present in rapid and irregular physical, emotional, and intellectual changes that mark this time period as crucial to the learning process (National Council of Teachers of Mathematics, 2000).

During this transitional period, adolescents solidify conceptions about themselves as learners of mathematics - about their competence, their attitude, their interest and, their motivation; these conceptions are believed to influence how students approach the study of mathematics (NCTM, 1995). According to the National Council of Teacher of Mathematics (NCTM, 2000), in the middle-grades mathematics classroom, adolescents should regularly engage in thoughtful activity tied to their emerging mathematics capabilities of finding and imposing structure, conjecturing and verifying, thinking hypothetically, comprehending cause and effect, and abstracting and generalizing. Middle-grades students are drawn to mathematics if they find both challenge and support in the mathematics classroom (NCTM, 1989; 1991; 1995; 2000).

The Council suggests that students acquire an appreciation for and develop an understanding of mathematical ideas if they have frequent encounters with interesting, challenging problems. The Council notes that ultimately, middle-grades students should see mathematics as an exciting, useful, and creative field of study.

In their published reports [*Curriculum and Evaluation Standards for School Mathematics, 1989; Professional Standards for Teaching Mathematics,* 1991; *Assessment Standards for School Mathematics, 1995; Principles and Standards for School Mathematics; 2000]*, NCTM while striving for mathematics reform, have continuously advocated the use of a variety of instructional strategies in the middle-grades mathematics classroom. Through its standards, the NCTM recommends some of the following teaching strategies: the use of manipulative material, cooperative learning groups, writing about mathematics, and the use of calculators and computers.

These strategies have been identified as some of the most effective strategies in improving the mathematics achievement of all students, especially middle-grades students. Although there is evidence that these strategies have produced academic achievement across all grade levels and subject areas; cooperative learning approaches to mathematics learning in particular, appear to directly correspond to the learning styles of middle-grades students. Middle grade students especially benefit from cooperative learning strategies because of their personal and social learning orientations (Slavin, 1999). The students' success is related to their preference for experimentation, improvisation, and harmonious interaction with others in their learning environments.

Teachers can no longer depend solely on direct instruction as a primary method of instruction, the expectation that young adolescents thrive in a teacher-focused, textbook-centered classroom hour-after hour and day after day is at the very least naive; this traditional approach to instruction is highly inconsistent with adolescent development (Stevenson, 2002). Instead, mathematics teachers of adolescents need to incorporate a variety of teaching strategies into their lessons - strategies that cater to adolescent's developmental needs and that cultivate their mathematical learning.

Statement of the Problem

This study identified the research that has been indexed in ERIC, Dissertations Abstracts International, and professional journals concerning the effects of the use cooperative learning strategies on mathematics achievement in middle-grades, grades 4-8. The findings of the available research were investigated to determine the magnitude of the effect of cooperative learning on the mathematics achievement of middle-grades students.

Justification for the Study

The improvement of students' mathematics achievement in American schools is dependent on knowledgeable teachers who conduct high-quality lessons focused on important mathematics under conditions that support students' opportunity to learn (Grouws & Smith, 2000). This is why it is essential that teachers of mathematics implement instructional strategies that help improve students' learning, students' content knowledge, and student achievement in mathematics. There has been a wealth of research conducted on the effects of various teaching strategies on mathematics achievement, both qualitative and quantitative.

Researchers who have examined teachers who use instructional strategies and who incorporate the use of cooperative learning approaches in their mathematics classrooms, have seen substantial gains in students' overall mathematics achievement. The National Council of Teachers of Mathematics (NCTM, 2000) notes that effective teaching in mathematics requires: (1) knowing and understanding mathematics, students as learners, and pedagogical strategies, (2) a challenging and supportive classroom learning environment, and (3) teachers who continuously seek improvement through professional development opportunities. Intertwined within these three assertions is the importance of utilizing effective instructional strategies in the mathematics classroom.

With results from reports such as the National Assessment of Educational Progress (NAEP) and other studies that examine the mathematics achievement of middle-grades students in the United States, it is evident that our nation is in need of mathematics reform. This reform needs to include the re-assessment of what students are being taught and more importantly how they are being taught.

A meta-analysis appears to be an appropriate method for quantitatively integrating findings of the studies examining the effects of cooperative learning on the mathematics achievement of students in middle-grades. In this way, integration of the studies will provide a summary of the findings by yielding one numerical statement of the overall size of the effect produced by cooperative learning strategies in the middle-grades mathematics classroom.

Meta-analysis

Meta-analysis is described as the analysis of analyses; the statistical analysis of a large collection of analysis results from individual studies for the purposes of integrating the findings (Glass, 1976). Glass first used the term "meta-analysis" in 1976 to refer to a philosophy, not a statistical technique. Glass argued that a literature review should be as systematic as primary research and should interpret results of individual studies in the context of distributions of findings, partially determined by study characteristics and partially random. Since that time, meta-analysis has become a widely accepted tool, encompassing a family of procedures used in a variety of disciplines. In 1991, Bangert-Drowns and Rudner did a search of the ERIC database and found over 800 articles written after 1980 that used or discussed meta-analysis; since then, meta-analysis has grown from an unheard of preoccupation of a very small group of statisticians working on problems of research integration in education and psychotherapy, to a minor academic industry as well as commercial endeavor (Glass, 2000).

To synthesis the research, this study utilized *Comprehensive Meta-Analysis*, a statistical analysis computer software program. The program was developed by Michael Borenstein, in collaboration with Hannah Rothstein, Larry Hedges, and Jesse Berlin in 1999. The program performed a statistical analysis of 25 studies regarding the effects of cooperative learning on the mathematics achievement of middle grades students.

Delimitations

1. Only studies comparing experimental groups and control groups on mathematics pretest and posttest scores were included in the analysis.
2. Those studies that did not have sufficient data to calculate effect size were not included in the analysis (e.g. reported means, standard deviations, t-values, etc.)
3. Only those studies that included findings of mathematics achievement and cooperative learning strategies in grades 4-8 were included in the analysis.

Definition of Terms

Cooperative Learning – an approach or strategy to instruction that involves small, heterogenous teams that work together towards a common group task.

Jigsaw – Students are assigned to six member teams to work on academic material that has been broken down into sections; each team member then reads his or her section. Next, members of different teams who have studied the same sections meet in “expert groups” to discuss their sections. Then the students return to their teams and take turns teaching their teammates about their sections. They are motivated to support and show interest in one another’s work since the only way they can learn the different sections other than their own is by listening to their teammates.

Mathematics Achievement – students’ measured performance on mathematics pretests and posttests.

Middle Grades Students – young adolescent students (ages 10-14) who are enrolled in fourth grade, fifth grade, sixth grade, seventh grade, or eighth grade.

Student Teams Achievement Division (STAD) – a cooperative learning technique usually comprised of four member learning teams that are mixed in performance level, sex, and ethnicity. The teacher presents the lesson, the students work in their teams to make sure that students have mastered the lesson. All students then take individual quizzes on lessons. Student quiz scores are compared with their own past averages and points are awarded based on which students met or exceeded their own earlier performance. These points are summed to form team scores, and teams that meet certain criteria may earn certificates or other recognition.

Team-Assisted Instruction (TAI) – TAI is a comprehensive approach to cooperative learning in mathematics. In TAI students are assigned to heterogeneous teams in which they help one another learn. The teacher presents lessons that emphasize concepts, real life problems, and manipulatives to teaching groups composed of students from different teams. Students then return to their teams and work on individual materials that follow the teacher's lessons.

Teams-Games-Tournament (TGT) – TGT uses the same teacher presentation as STAD except it replaces the weekly quizzes with weekly tournaments in which students compete with members of other teams to contribute points to their team scores. Students compete at three-person “tournament tables” against others with similar past records in mathematics. A “bumping” procedure keeps the competition fair. The winner at each tournament table brings the same number of points to his or her team, regardless of which table it is; this means that low achievers and high achievers have equal opportunity for success. As in STAD, high-performing teams earn certificates or other forms of team recognition.

Organization of the Study

The remaining four chapters of this study are organized as follows: Chapter 2 includes a review of relevant literature, Chapter 3 reflects a comprehensive review of the research studies included in the meta-analysis, Chapter 4 contains detailed results of the meta-analysis of the effects of cooperative learning on the mathematics achievement of students in middle grades as well as tables including statistical results, and Chapter 5 consists of conclusions and discussions of the study along with recommendations for further research.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

During the past three decades, educators have developed and refined mathematics instructional strategies that many believe will serve as a catalyst to improve the academic achievement of mathematics students. Some of the most prominent mathematics instructional strategies include the use of the following: manipulative material, cooperative group work, discussion of mathematics, questioning and making conjectures, writing about mathematics, specific problem-solving approaches, and the use of calculators and computers (Zemelman, Daniels, & Hyde, 1990). These strategies are particularly salient for educators and others concerned with enhancing the mathematics achievement of middle-grades students. More specifically, cooperative learning approaches to mathematics instruction have been identified by numerous researchers as one of most effective instructional strategies in improving the academic performance of middle- grades students overall (Joyce & Weil, 1986; Sharan & Sharan, 1992; 1994; Slavin 1995).

Research on cooperative learning is one of the great success stories in the history of educational innovation (Slavin, 1999) and research that has focused on the effects of cooperative learning among middle-grades students, particularly in mathematics, has found large effects. In the 21st Century it is imperative that teachers of mathematics use strategies such as cooperative learning in middle-grades classrooms. Cooperative learning strategies support the learning characteristics of young adolescents and when implemented effectively may produce academic success in the mathematics classroom.

This chapter provides a comprehensive review of middle-grades students' mathematics achievement. First, a brief discussion of the history of the mathematics achievement of middle-grades students is presented, that includes factors that effect the underachievement of middle-grades students. Next a recommended curriculum for middle-grades students is discussed and last an explanation of the effectiveness of cooperative learning strategies among middle-grades students is provided.

A Brief History of Middle Grades Students' Mathematics Achievement

The National Assessment of Educational Progress (NAEP) has brought major attention to the underperformance of middle-grades students in mathematics in the United States. NAEP is a congressionally mandated survey of educational achievement of American students and of changes in that achievement over time (Kenney, 2000). Since 1969, NAEP has been assessing what students know and what they can do in a variety of curriculum areas, including mathematics.

The National Assessment of Educational Progress (NAEP) focuses on the achievement of students in grades 4, 8, and 12 and to date has administered national mathematics assessments in the school years ending in 1973, 1978, 1982, 1986, 1990, 1992, 1996 and 2003. This survey stands as one of the most complex large-scale assessments ever designed and administered on a consistent basis.

The National Assessment of Educational Progress (NAEP) has evolved to include three components: the long term-trend NAEP, national NAEP. and state NAEP. Of these three components, the long term-trend NAEP in particular provides the most valuable information on whether students' fundamentals (i.e., paper-and-pencil computation skills, direct application of measurement formulas in geometric settings, and the use of mathematics daily-living skills involving time and money) have changed as the emphases in the curriculum has changed overtime (Dossey, 2000). Overall, results from all NEAP assessments provide classroom teachers and teacher educators with valuable information about students' strengths in mathematics and about areas in mathematics learning that need additional attention.

In order to assess and analyze students' performance in mathematics at various grade levels, The National Assessment Governing Board (NAGB) established three achievement levels – *Basic, Proficient, and Advanced,* which include scale scores ranging from 0-500. For eighth grade the levels are as follows: *Basic* (262-298), *Proficient* (299- 332) and *Advanced* (333-above) and fourth grade levels are: *Basic* (214-248) *Proficient* (249—281) and *Advanced* (282-above).

At the *Basic* level students demonstrate partial mastery of prerequisite mathematics skills that are fundamental to the specific grade level; at the *Proficient* level students should be able to demonstrate competency of challenging subject matter and be knowledgeable of applications pertaining to real-world situations. Reaching the *Advanced* level signifies superior mathematics performance. The NAGB also established benchmark scale scores to assess concepts, procedures, and processes associated with performance at each level; 350 is the benchmark scale score considered to be at the *Proficient* achievement level.

From 1973-2003, the National Assessment of Educational Progress' long-term data show that there has been a significant increase in average scale scores of students in fourth and eighth grades, with scores meeting or exceeding the *Basic* achievement level. In fact, 1973, fourth grade students had an average scale score of 219 while eighth grade students scored 266, both groups scored slightly above the *Basic* achievement level. In 1986, both fourth grade and eighth grade students made slight gains with average scores of 222 and 269 respectively.

Ten years later, in 1996 fourth grade students had an average scale score of 231, while eighth grade students scored 274. NAEP data from 1996 also reveals that while 64% of fourth grade students and 62% of eighth grade students reach the *Basic* level of mathematics achievement, only 21% of fourth grade students and 24% of eighth grade students reached the *Proficient* mathematics level that year. Now in the 21st Century, trends show a pattern with scale scores still remaining at the *Basic* achievement level. In 2003, fourth grade students had an average scale score of 235 while eighth grade students had an average scale score of 278. NAEP Data from 2003 also shows that while 77% of fourth grade students and 68% of eighth grade students reached the *Basic* level of mathematics achievement, only 32% of fourth grade students and 29% of eighth grade students reached the *Proficient* mathematics achievement level.

Despite the fact that data from the National Assessment of Educational Progress (NAEP) reveal that both fourth and eighth grade groups made some gains in achievement over three decades, the question still remains – "why does such a large percentage of middle-grades students continue to perform below the *Proficient* level in mathematics achievement?" Several hypotheses have been offered as reasons for the underachievement of middle-grades students and the National Assessment of Educational Progress has identified the most persistent of these assertions; these assertions include the use of ineffective instructional materials and strategies in the mathematics classroom, the lack of preparedness for mathematics among teachers, and the lack of professional development opportunities for teachers of middle-grades students.

Specific Factors Contributing to the Underachievement of Middle Grades Students in Mathematics

According to Grouws and Smith (2000), "Adequate instructional time is an important condition for students' high achievement, but how that time is used is equally important. In fact, the quality of mathematics instruction may be the single most important nondemographic factor in how much mathematics students learn" (p. 128). Variations in the ways students gain access to mathematical ideas along with the tools they use to solve problems are potential sources of difference in the use of instructional practices and materials that affect student performance (Strutchens & Silver, 2000). For instance, 1996 NAEP data show that both fourth and eighth grade mathematics students appear to spend a significant portion of time doing textbook problems and worksheets. NAEP data reveal that 61% of fourth grade students reported that they do mathematics problems from their textbook daily while an increasing 72% of eighth grade students reported daily use of textbooks. At the same time that textbook usage increased, the presence of worksheets decreased to 47% among fourth grade students and 30% among eighth grade students (Grouws & Smith, 2000).

NAEP data also indicated notable variations in instructional practices through the use of calculators and computers. Data from the 1996 NAEP revealed that 55% of students in grade eight had teachers who reported that students used calculators in mathematics class on a daily basis, whereas only 5% of fourth grade students had teachers who reported similar use. In addition, a large percentage of students in grade eight reported that they did not use graphing calculators for their mathematics work. In terms of computer usage, in 1996, 69% of eighth grade students had teachers who reported that they never use a computer as part of mathematics instruction while 22% of fourth grade students did not.

Being that the National Council of Teachers of Mathematics (NCTM, 1989; 1991; 1995; 2000) advocate the use of various instructional practices in the mathematics classroom such as increased involvement of students, more cooperative group work, and a greater focus on communication in mathematics to name a few, it is very interesting that some teachers of mathematics simply do not adhere to these NCTM *Standards.* For instance, NAEP data show that more than two-thirds of students in grade 4 and 8 have teachers who at least once or twice a week ask them to solve problems in a group or with a partner, ask them to talk to the class about their work, discuss problems to solutions with other students, and solve problems that reflect real-life situations; 30% of fourth and eighth grade students have teachers who never, or hardly ever require them to write about mathematics (Grouws & Smith, 2000). These results are surprising given that the National Council of Teachers of Mathematics are strong proponents of these types of strategy usage in the mathematics classroom.

Lack of preparedness for teaching among mathematics teachers contributes to the underperformance of middle- grades students and is directly correlated with the ineffectiveness of instructional strategies used by teachers of mathematics. NAEP data from 1996 report on the degree of preparation for teaching mathematics concepts and procedures among fourth and eighth grade mathematics teachers; questionnaire results indicated that more than three-fourths of the students in grade 4 and nine-tenths of students in grade 8 have teachers who report being very well prepared to teach both mathematical concepts and procedures. In addition, recent NAEP data show a connection between a teacher's sense of preparedness for teaching and students' performance at grade 8. Students with teachers who indicated that they were not very well prepared to teach mathematical concepts and mathematical procedures had an average

NAEP scale score of 238, while students whose teachers indicated that they were either very or moderately well prepared had an average score between 270-275.

> "This suggests that teachers who do not feel prepared to teach mathematics may have good reason to question their competence. This could result from the fact that some teachers of eighth-grade mathematics have limited preparation in mathematics and may not have elected to teach in this content area" (Grouws & Smith, 2000, p. 123).

Teacher preparation and education programs have a huge impact on the efficacy of mathematics teachers in the classroom. More specifically, "effective programs of teacher preparation and professional development help teachers understand the mathematics they teach, how their students learn mathematics, and how to facilitate that learning" (National Research Council, 2001 p. 10). In recent years, there has been some debate over whether there is a relationship between teacher preparation, the type of degree that a mathematics teacher has obtained, and student performance in mathematics. Teachers' majors at the undergraduate and graduate level provide information regarding their preparation for teaching mathematics. To determine whether there is some correlation between teacher preparation and student performance, NAEP sorted teachers' majors into four mutually exclusive categories: *mathematics,* which includes teachers with an undergraduate or graduate major in mathematics; *mathematics education*, which includes teachers with an undergraduate or graduate major in mathematics but not in mathematics; *education*, which includes teachers with an undergraduate or graduate major in education at any level, but not mathematics education; and *other*, which includes teachers who had majors in areas other than those described by previous categories (Hawkins, Stancavage, & Dossey, 1998). Investigation of student performance within these categories does in fact indicate that preparation in mathematics appears to be related to student performance at grade 8 but not grade 4. For instance, 1996 NEAP data revealed that students' at grade 8 who were taught by teachers who have an education degree (not mathematics or mathematics education) had an average mathematics proficiency score of 269. Students who were taught by teachers who obtained a mathematics education degree (not mathematics) had an average mathematics proficiency score of 270, students who were being taught by teachers who had degrees in some other field had an average score of 267, and students who were being taught by teachers who have a mathematics degree had an average mathematics proficiency score of 278; this score is significantly higher than scores in the other three categories and suggests that preparation for mathematics teachers' of eighth grade students needs to focus primarily on teachers' mathematics content knowledge with some emphasis on pedagogy, since the mathematics curriculum at this level is much deeper than that of the mathematics curriculum at the elementary school level. This could explain why results from the 1996 NAEP at grade 4 were slightly different, students who were taught by teachers with a mathematics education degree (not mathematics) had significantly higher average achievement scores (235) than students who were taught by teachers with majors in mathematics, education (not mathematics or mathematics education), or some other field, with average scale scores of 220, 225 and 209 respectively. These findings suggest that preparation for mathematics teachers at the elementary level needs to focus not only on mathematics content knowledge but also the necessary pedagogical strategies that are useful and effective for these particular young adolescents.

Unfortunately, programs of teacher education have traditionally separated knowledge of mathematics from knowledge of pedagogy by offering separate courses in each (Swafford, 1995). A common practice in university-based teacher preparation programs has been for prospective teachers to take courses in mathematics from the mathematics department and courses in pedagogy from the college or department of education, although some recent programs have attempted to bring content and pedagogy together in both teacher preparation and professional development by considering the actual mathematical work of teaching (NRC, 2001). This combination of content and pedagogy is absolutely necessary, particularly in the mathematics teaching of middle-grades students.

Inadequate professional development for teachers of mathematics also contributes to the underachievement of middle-grades students in mathematics. The National Council of Teachers of Mathematics (NCTM) addresses professional development within *The Equity Principle*. They believe that the professional development of teachers is an important component of achieving equity. The NCTM recommends that professional development opportunities be in place so that through these opportunities, teachers can gain a better understanding of the strengths and needs of students who come from diverse linguistic and cultural backgrounds and who have specific disabilities or who have a special interest in mathematics. Also, through *The Teaching Principle*, the NCTM (2000) insists that effective teaching requires that teachers seek improvement through professional development opportunities. These efforts will allow teachers opportunities to learn about mathematics and pedagogy as well as reflect on and refine instructional practices. Furthermore, through *The Learning Principle,* the NCTM (2000) maintains that students learn mathematics with understanding when their teachers are grounded in the mathematics content and pedagogy needed to engage them in tasks and experiences that deepen and connect their mathematical knowledge. Mathematics teachers can definitely capitalize on the components of these *Principles* by simply incorporating them in their instructional strategies.

Through *The Professional Standards for Teaching Mathematics*, the NCTM (1991) also advocates the importance of professional development. They identify “knowing mathematics pedagogy” and “having knowledge of both the content and discourse of mathematics” as two essential components for the professional development of teachers of mathematics; mathematical pedagogy focuses on ways in which teachers help their students come to understand and be able to do and use mathematics (NCTM, 1991), while classroom discourse allows students to concentrate on sense making and reasoning, to reflect on students’ understanding and to stimulate mathematical thinking within the mathematics classroom (Martino & Maher, 1999). An important part of classroom instruction is to manage the discourse of the mathematical tasks in which teachers and students engage (NRC, 2001). White (2003) suggests that “productive classroom discourse requires that teachers engage *all* students in discourse by monitoring their participation in discussions and deciding when and how to encourage each student to participate” (p. 37). Both mathematical pedagogy and classroom discourse are essential to what students learn about mathematics and how students learn mathematics; these components are necessary in the teaching of mathematics and are crucial in contributing to the success of students in the mathematics classroom.

A 1996 NAEP questionnaire asked teachers to indicate how important their mathematics instruction is to four pedagogical techniques: (1) involving students in constructing and applying mathematical ideas; (2) using problem solving both as a goal of instruction and as a means of investigating important mathematical concepts; (3) using questions that promoted students’ interaction and discussion; and (4) using the results of classroom assessment to guide instructional decisions. Results from the questionnaire revealed that almost all fourth and eighth grade teachers reported that these techniques were either somewhat or very important to their mathematics instruction. These findings suggest that mathematics teachers of middle-grades students are beginning to realize that incorporating mathematical content knowledge and discourse together with pedagogical techniques is an absolute necessity for the mathematics achievement of young adolescents.

Ongoing professional experiences also provide practicing teachers with opportunities to continue to learn mathematics content and pedagogy. Data from NAEP (1996) show that the majority of students in fourth grade and eighth grade (more than 80% and 90%) have teachers who are receiving some ongoing support. Students at grade 4 however, were twice as likely as students at grade 8 to have a teacher with no such recent experience. In addition, nearly three-fourths of students at the fourth grade level and a little less than half of the students at the eighth grade level have teachers who have had less than 16 hours of professional development during the previous year.

Data from the National Survey of Science and Mathematics Education (NSSME) provide an even more alarming view of teacher professional development opportunities, with 60% of teachers in grade 5-8 and 70% of teachers in grades 1-4 reporting that they had 15 hours or less of in-service education in the last three years (National Science Foundation, 1996). The issue of inadequate professional development for mathematics teachers is a serious one. This inadequacy prevents practicing teachers from adopting the types of practices being advocated by mathematics educators, becoming proficient in new technologies, and learning mathematics in ways that enhance their teaching of a range of topics (Dossey, 2000).

Professional development beyond initial preparation is critical for helping mathematics teachers develop the content knowledge and pedagogical practices that they need in order to teach young adolescents. According to the National Research Council (NRC, 2001), such professional development requires the marshalling of substantial resources; one of the critical resources is time. “If teachers are going to engage in inquiry, they need repeated opportunities to try out ideas and approaches with their students and continuing opportunities to discuss their experiences with specialists in mathematics, staff developers, and other teachers” (NRC, 2001, p. 399). These opportunities are unfortunately limited to a period of a few weeks or months which is not nearly enough time for teachers to adapt what they have learned to their teaching practices. Professional development opportunities should instead be part of the ongoing culture of professional practice where teachers’ learning becomes generative and teachers have opportunities to continue to learn and grow as professionals.

A Developmentally Responsive Mathematics Curriculum for Middle Grades Students

Although the aforementioned issues remain persistent in mathematics education, there are still other important aspects pertaining to the mathematics achievement of middle-grades students which must be addressed, such as the curriculum that is being taught to this group of young adolescents.

In today’s society, young adolescents face adversity on a day to day basis and many of the transitions that these individuals undergo make growing up extremely difficult in an ever-changing world. Young adolescents are faced with things such as self-esteem and identity issues, peer pressure, eating disorders, drug and alcohol abuse, suicide and death, sexual issues, sibling rivalry, and competitiveness among their peer group (Stevenson, 2002). All of these physical, emotional, and moral developmental issues should be of major concern to educators who teach young adolescents and who have a vested interest in their learning. These particular issues must be considered in the guidelines for selecting curriculum content for middle- grades students.

The U.S. elementary and middle school mathematics curriculum has been characterized as superficial, underachieving and diffuse in content coverage (McKnight & Schmidt, 1998). This is the reason that many organizations have attempted some type of curriculum reform over the years. One such organization in particular is the National Middle School Association (NMSA), who recommends a developmentally responsive curriculum for all middle-grades students; a curriculum that is relevant, challenging, integrative and exploratory (NMSA, 2003). The curriculum recommendations from the National Middle School Association are directly aligned with the National Council of Teachers of Mathematics (NCTM) recommendations through *The Curriculum Principle* (NCTM, 2000).

The NMSA advocates a curriculum that is relevant in that it “allows students to pursue answers to questions they have about themselves, content, and the world” (NMSA, 2003, p. 20). Similarly the NCTM recommends that mathematics curricula of middle-grades students focus on mathematics content that is worth the time and attention of students and most importantly has relevance and utility in our technological society. Also recommended by the NMSA is a curriculum that is challenging. Such a challenging curriculum is purposed to engage young adolescents, marshalling their sustained interests and efforts. Likewise, the NCTM notes that a “well articulated curriculum challenges students to learn increasingly more sophisticated mathematical ideas as they continue their studies” (NCTM, 2000, p. 15).

Additionally, the NMSA suggests an integrative curriculum that focuses on helping students make sense of their lives and the world around them as well as make meaningful decisions about their learning. Equally, The NCTM agrees that mathematics curricula should be coherent, effectively organizing and integrating important ideas so that students may see how the ideas build on and connect with other ideas, thus enabling them to develop new understanding and skills. The NMSA recommends that middle-grade students experience a curriculum that is exploratory where students have opportunities to ascertain their special interests and aptitude and engage in activities that broaden their views of the world and themselves. In the same way, the NCTM proposes a curriculum that offers experiences that allow students to see that mathematics has powerful uses in modeling and predicting real-world phenomena.

This recommended developmentally responsive curriculum is also supported by the four guiding principles of the *No Child Left Behind Act* (NCLB), signed into legislation by George Bush in January 2002. These guiding principles are: (1) *stronger accountability for results*, which means that states, the federal government, are responsible for setting academic standards for what every child should know and learn in reading, math and science, and for regularly assessing student achievement against those standards at the elementary, middle, and high school level; (2) *increased flexibility and local control*, which gives school leaders a stronger voice in determining how to use the federal grants they receive to support student achievement; (3) *more information and options for parents*, which enables parents to obtain more test-derived information about how their children and their local schools are performing and (4)*emphasis on proven education methods*, which requires that programs implemented with federal education dollars be supported by scientifically based research and proven to help students learn (George, 2002). Within these principles, the NCLB advances the notion that all students can achieve and identifies effective instructional strategies that include hands-on activities and integrative approaches to instruction; it is the belief that the implementation of these principles can provide support for the many practices that are the hallmark of middle level education.

In addition, with this recommended developmentally responsive curriculum for young adolescents, teachers must work together to design learning activities that will ensure appropriate challenges for all types of learners; this calls for the implementation of various instructional strategies within the classroom. Much emphasis in the middle-grades is placed on collaboration and cooperation through varying forms of group work. Middle-grades students are often placed in clusters at random, by ability, by interest, or by other criteria with the goal of increasing student engagement and learning (NMSA, 2003). This type of cooperative learning approach is consistent with the distinctive developmental and learning characteristics of young adolescents and furthermore has proven to be highly effective among middle-grades students (Johnson, Johnson, & Holubec, 1986; Kagan, 1989; Sharan & Shachar, 1988; Slavin, 1986).

Why Cooperative Learning for Middle Grades Mathematics Students?

As mentioned earlier in the body of this literature review, there are several factors effecting the mathematics achievement of middle-grades students and one of most important of these factors is the ineffectiveness of instructional strategies that some mathematics teachers are using in their classrooms. No longer can mathematics teachers rely on direct-instruction as the primary method of instruction for middle-grades students; instead they must choose teaching approaches that enhance and accommodate the diverse skills, abilities, and prior knowledge of young adolescents, that cultivate multiple intelligences, and draw upon students' individual learning styles (NMSA, 2003).

According to the NMSA (2003), because young adolescents learn best through engagement and interaction, learning strategies should involve students in dialogue with teachers and with one another; these two learning characteristics are consistent with the structure of cooperative learning approaches that emphasizes interaction with peers through communication and collaboration.

Cooperative learning is the name given to a method of instruction that includes over 80 different strategies, in which students work together in small teams toward a common goal (Nattiv, 1994). In these usually heterogeneous groups, students work together to help one another master academic content. “Almost unknown in the 1970’s, cooperative learning strategies are now so commonplace that they are often seen as a standard part of educational practice, not as an innovation” (Slavin, 1999, p. 74). In fact, a national survey found that 79% of third grade teachers and 62% of seventh grade teachers reported making regular, sustained use of cooperative learning strategies (Puma, Jones, Rock, & Fernandez, 1993). Similar results from a 1998 study by Antil, Jenkins, Wayne, and Vadasy, revealed that 93% of the teachers in six Pacific Northwest elementary schools reported using cooperative learning, 81% said they used it daily. Despite the development and widespread use of cooperative learning approaches, unfortunately some teachers are still reluctant to implement this strategy in their methods of instruction, unaware of the potential positive effects that it has on student achievement.

For several years the benefits of cooperative learning strategies for students’ achievement have been clearly demonstrated and since, effects of a variety of cooperative learning strategies on a range of student outcomes have been investigated (Nattiv, 1994). Researchers have consistently reported positive effects for cooperative learning on a variety of academic, personal, and social student outcomes. Johnson & Johnson (1984) reported gains among young adolescents in academic achievement, increases in critical thinking, improved collaborative competencies, and improvements in psychological health when team learning was employed. Their findings indicated gains in socialization and increases in liking for subjects, classmates, teachers, and administrators when cooperative strategies were used. Students working in cooperative learning environments became more tolerant and improved in their ratings self-esteem.

Slavin (1980) reported positive effects for cooperative learning on achievement, self-esteem, social skills, and liking for school subjects among young adolescents as well. He found that friendships with students of other ethnic groups and mainstreamed students with special needs increased when cooperative learning was used.

There is a definite relationship between the basic elements inherent in cooperative learning approaches and the learning interaction preferences of middle-grades students. In fact, various studies over the years, particularly in the 1980's and 1990's have shown that cooperative learning strategies significantly improve middle-grades students' performance across various subject areas including mathematics (Brush, 1996; Webb & Farivar, 1994; Slavin 1989; Bryant, 1981).

Fennema and Peterson, in 1985 found that cooperative learning groups were used in mathematics classrooms across the country and there were several studies that focus on its effectiveness among middle-grades students. For instance a 1985 study involving 345 students in 15 fourth, fifth, and sixth grade classes, conducted by Slavin and Karweit, compared the use of The Missouri Mathematics Program (MMP), Ability Grouped Active Teaching (AGAT), and Team-Assisted Instruction (TAI), to determine which strategy yields the largest impact on mathematics achievement. Results from the study indicated no significant difference between TAI and AGAT. There was however, a significant statistical difference between both TAI and AGAT, with TAI and AGAT scoring significantly higher than MMP on computations.

A 1998 study conducted by Ginsburg and Fantuzzo, compared the effects of two instructional methods, problem solving and peer collaboration, on mathematics achievement.

The study involved two experimental groups and a control group. The sample consisted of 104 third and fourth graders with students in the problem solving condition, seated in small groups of 3-4 students who completed their work individually. Students in the peer collaboration condition solved problems in collaborative dyads. Students in the control condition received neither a problem solving approach to practicing computation, nor did they work in dyads. Results from the study indicated that students who participated in peer collaboration scored higher on measures of computation and word problems than did students who did not participate in peer collaboration.

These studies provide some evidence that cooperative learning is an effective strategy for middle-grades students and that cooperative learning has the potential to increase mathematics achievement. These studies are part of a collection of 25 other studies included in this meta-analysis that examine the effects of cooperative learning strategies on the mathematics achievement of middle grades students. In the next chapter, descriptions of additional studies will be presented and effect sizes will be calculated to determine the magnitude and overall effect of cooperative learning strategies on the mathematics achievement of middle-grades students.

CHAPTER 3

META-ANALYSIS

This chapter provides a description of the studies in the meta-analysis and includes computed effect sizes. A computer search of the electronic databases was conducted using the following descriptors: middle grades students, fourth grade students, fifth grade students, sixth grade students, seventh grade students, eighth grade students, cooperative learning groups, cooperative learning strategies, mathematics and mathematics achievement. In addition, references cited in journal articles identified through the computer search were examined to locate any possible research not included in the computer search.

The *Comprehensive Meta-analysis* computer software program developed by Michael Borenstein was used in order to synthesis data from 25 studies, all of which pertain to the effects of cooperative learning on the mathematics achievement of middle grades students. The computer program itself includes a wide array of computational options, however the primary use of this software program was to compute effect size. Using this program, effect sizes were computed by entering data such as sample size, means and standard deviations, F-values or t-values, according to the statistical information that was given in each study. Once the statistical information was entered, the software program computed effect sizes utilizing several of the following methods.

Method 1

This method was used when group means and pooled standard deviation were reported; the effect size was calculated through the following equation:

$$ES = \frac{\bar{X}_{G1} - \bar{X}_{G2}}{S_p}$$

Method 2

When n_{G1} and n_{G2} , the size of each group and the Fisher's F were reported, the following formula was used to calculate the effect size:

$$ES = \sqrt{F\left(\frac{1}{n_{G1}} + \frac{1}{n_{G2}}\right)}$$

Method 3

The following formula was used when the significance level of the difference in means and the sample sizes of both groups were reported; the effect size was calculated through the following formula:

$$ES = t\sqrt{\frac{1}{n_{G1}} + \frac{1}{n_{G2}}}$$

Interpretation of Effect Size

Some confusion exists about the interpretation of effect size, so the following frame of reference should be kept in mind when interpreting the results of studies included in the meta-analysis as well as for the current study. Cohen (1977, 1988) reported his general observation that over a wide range of behavioral science research, standardized mean difference effect sizes fell into the following ranges:

Small	Medium	Large
ES $\leq$ .20	ES = .50	ES $\geq$ .80

So, for the 22 effect sizes of the meta-analysis and for the mean effect size of the current study, the above range should be referred to for interpretation of the magnitude of the effect of cooperative learning on mathematics achievement among middle-grades students.

Review of Studies

Studies included in the meta-analysis are reviewed in alphabetical order and include a brief description of the research project. Each review also includes a description of the sample, measurement variables, and computed effect size values.

Study No. 1

Brush, T. A. (1996). The effectiveness of cooperative learning for low-and high achieving students using an integrated learning system. *Proceedings of selected research and development presentations at the 1996 National Convention of the Association for Educational Communications and Technology*, Indianapolis, IN.

Description. The purpose of this year long study was to determine whether integrating cooperative learning strategies with Integrated Learning Systems (ILS) delivered instruction, in mathematics produced academic and attitudinal gains in students. Results of the study revealed that students using ILS for mathematics instruction performed better on standardized tests when they completed the computer activities in cooperative groups.

Sample. The sample consisted of 65 fifth grade students in an elementary school located in a small city in the upper Midwest. Approximately 43% of the students served by this school are eligible for free or reduced lunch. The Ethnic distribution of the students was 60% White, 30% African-American and 10% from other ethnic groups.

Variables. The California Achievement Test, Fifth Edition (CAT/5) was used as both the pre- and posttest instrument for mathematics achievement.

Effect Size. An effect size of .270 was computed by averaging the means and standard deviation provided.

Study No. 2

Bryant, R. R. (1981). Effects of team-assisted individualization on the attitude and achievement of third, forth, and fifth grade students of mathematics. (Doctoral dissertation, University of Maryland, 1981). *Dissertation Abstracts International, 43,* 70A.

Description. The purpose of this eight-week study was to compare two cooperative learning methods the Team-Assisted-Individualization (TAI) and Rapid Progress Mathematics (RPM) to a control group and determine if the cooperative learning methods produced higher achievement in mathematics than the control group. Results from the study revealed that both the TAI and RPM groups achieved more than did the control groups, however there was no statically significant difference between the TAI and RPM groups in mathematics achievement.

Sample. The sample consisted of 361 third, fourth, and fifth grade students who attended six elementary schools in Howard County, Maryland. All six schools were located in and served primarily middle and upper-middle socioeconomic status communities. The sample comprised of Asian-American, White, and African-American Students.

Variables. The dependent variable of interest was mathematics achievement as measured by the Comprehensive Test of Basic Skills (CTBS), used as both a pretest and posttest in the study.

Effect size. Given means and standard deviations, an effect size of .117 was computed.

Study No. 3

De Ligny, R. (1996).How will the use of the jigsaw technique of cooperative learning affect mathematics achievement of sixth graders? *Dissertation Abstracts International*, *42*(01), 35. (UMI No.1415620)

Description. The purpose of this four-week study was to examine the effectiveness of using the Jigsaw method technique of cooperative learning on students in a mathematics class. The study compared the mathematics achievement of students in a class which used the Jigsaw method (N=20), to achievement in a class receiving traditional teacher-centered instruction (N=21). Results from the study revealed a no significance difference in mathematics achievement among the two groups.

Sample. The participants were 41 sixth grade students attending a middle school in Essex County, NJ, predominantly from middle class, two parent homes.

Variable. A teacher-made pre and post test consisting of logic-word problems was used to measure mathematics achievement.

Effect size. An effect size of .074 was computed by averaging the means and standard deviation provided.

Study No. 4

Dubois, D. J. (1990). The relationship between selected student team learning strategies and student achievement and attitude in middle school mathematics. *Dissertation Abstracts International*, *52*(02), 408. (UMI No.9118120)

Description. The purpose of this 18 week study was to investigate the extent to which involvement in cooperative learning is related to student achievement and attitudes in mathematics. Students were compared in three groups: in a class where students whose mathematics teachers were trained in and used cooperative learning, in a class where students' mathematics teachers were trained in cooperative learning, but did not use it, and in a class where students' mathematics teachers were neither trained nor used cooperative learning in mathematics instruction. Results indicated that there was a statistically significant difference between students who were involved and students who were not involved in cooperative learning strategies in the development of computational skills and the formation of mathematical concepts.

Sample. The study consisted of 2175 middle school students in grades 6-8 (86 mathematics classes and eleven middle schools) in a south central Louisiana school district.

Variable. The mathematics computation section of Iowa Test of Basic Skills (ITBS) was used as both a pretest and posttest to measure mathematics achievement.

Effect size. Given means and standard deviation, an effect size of .015 was computed.

Study No. 5

Edwards, K. J., Devries, D. L., & Snyder, J. P. (1972). Games and teams: A winning combination. *Simulation Games, 3*, 247-269.

Description. This study compared two sets of seventh grade math classes over a six-week period. Two math classes were assigned to the TGT condition and two math classes were assigned to the individualistic condition. Both conditions studied operations on fractions, decimals, and percents. Both conditions listened to lectures, did math drill and practice in class, and took three quizzes. The TGT group participated in games and tournaments twice a week. The results of the study revealed that the TGT group performed significantly better than the individualistic group.

Sample. The sample consisted of 96 seventh grade students in a large urban junior high school. The study took place in four math classes with each class containing 24 students.

Variables. The computation subset of the Stanford Achievement Test in Mathematics, 25 topic specific questions from the Stanford Achievement Test, and a divergent solution test developed by experimenters were the instruments used to measure mathematics achievement.

Effect size. An effect size of .466 was calculated, given a reported t-value of 2.30.

Study No. 6

Farivar, S. (1993, April). *Prosocial attitudes and achievement in middle school mathematics.* Paper presented at the annual meeting of the American Educational Research Association, Atlanta, GA.

Description. This study analyzed the relationships between students regard for one another and their mathematics achievement in cooperative groups. This 18 week study consisted of four phases, which focused on learning how to work with others, communication and cooperation skills and teambuilding versus traditional instruction. Results from the study revealed that overall, students increased their regard for teammates but there was no significant increase in mathematics achievement and no correlation between regard and mathematical achievement.

Sample. The sample consisted of 40 students enrolled in two general seventh grade pre-algebra mathematics classes in a city in Los Angeles, California. The sample included 14% African- American, 55% Hispanic, 27% White and 3% Asian-American.

Effect size. An effect size of .635 was calculated for the study using the t-value of 2.41.

Study No. 7

Fuchs, L. S., Fuchs, D., Karns, K., Hamlett, C. Katzaroff, M. & Dutka, S. (1998). Comparisons among individuals and cooperative performance assessment and other measures of mathematics competence. *The Elementary School Journal, 99,* 24-20.

Description. The purposes of this 22-week study were to examine how well 3 measures, representing 3 points on a traditional-alternative mathematics assessment continuum, interrelated and discriminated students achieving above, at, and below grade level and to explore effects of cooperative testing for the most innovative measure (performance assessment). Results showed that among individually administered measures, intercorrelations were moderate and significant; correlations were stronger for performance assessments that were individually rather than cooperatively completed. Exploratory analysis suggested that cooperative performance assessment scores corresponded better with other measures for above-grade level students than for below-grade level students.

Sample. The participants were 72 students in six fourth grade general education classrooms. The sample consisted of 25% African-American, 70% White, and 4% Asian-American. In addition, 66% were eligible for free or reduced lunch.

Variables. The Comprehensive Test of Basic Skills (CTBS) Mathematics Total Battery, a curriculum based measurement and performance assessment was used to measure mathematics achievement.

Effect size. An effect size of .317 was calculated for this study given means and standard deviation.

Study No. 8

Gordon, A. B. (1985). Cooperative learning: A comparative study of attitude and achievement of two groups of grade seven mathematics classes. (Doctoral dissertation, Brigham Young University, 1985). *Dissertation Abstracts International, 47*, 772A.

Description. The study was conducted over an eight week period using two groups. An experimental group exposed to cooperative learning methods and a control group exposed to traditional individualistic methods. Results from the study revealed that there were no statistical differences in mathematics achievement between the two groups.

Sample. The sample consisted of 55 seventh grade students in a school located in British Columbia, Canada. The participants comprised of 29 boys and 26 girls.

Variables. Form A of the British Columbia Mathematics Assessment was used as both a pretest and posttest to measure mathematics achievement.

Effect size. An effect size of .191 was computed from a reported t-value of 0.71.

Study No. 9

Ginsburg-Block, M.D., & Fantuzzo, J. W. (1998). An evaluation of relative effectiveness of NCTM standards-based interventions for low-achieving urban elementary students. *Journal of Educational Psychology, 90*(3), 560-569.

Description. The purpose of this study was to evaluate the independent and interactive effects of two instructional methods for enhancing mathematics achievement, academic motivation and self-concept of low-achieving urban students. The two independent intervention methods - problem solving (PS) and peer collaboration (PC) were based on the NCTM standards for mathematics. Results from the study revealed that students who participated in peer collaboration scored higher on measures of computation and word problems and reported higher levels of academic motivation and social competence than did students who did not participate in peer collaboration. Both groups scored higher than the control group on all measures.

Sample. The sample consisted of 104 third and fifth grade low achieving students, 51 girls and 53 boys. Sixty-Seven percent of students qualified for the federally subsidized lunch program and 41% scored below basic levels of performance in mathematics at the beginning of the school year in which this study was conducted. Sixty-eight percent of the 104 participants were African-American, 11% White, 18% Asian-American and 3% Hispanic.

Variables. The fourth edition of the Stanford Diagnostics Mathematics Test (SDMT), was used a pretest and posttest to measure mathematics achievement.

Effect size. Three separate effect sizes were calculated for each condition using means and standard deviations: Control Versus Problem Solving: ES = 0.389; Control Versus Peer collaboration: ES = 0.385; Problem Solving Versus Peer Collaboration: ES = 0.059

Study No. 10

Hernandez-Garduno, E. L. (1997). Effects of problem solving through cooperative learning methods on student mathematics achievement, attitudes toward mathematics, mathematics self-efficacy, and metacognition. *Dissertation Abstracts International*, *58*(08), 3053. (UMI No.9806174)

Description. The purpose of this study was to assess students' metacognition, self-efficacy, attitudes toward mathematics and achievement in a summer enrichment program. The study compared students in two experimental groups who were taught through cooperative learning methods to students in a control group who were taught using whole-group instruction in which competition and individual work was stressed. Results from the study revealed that there were no statistical differences in achievement among the groups.

Sample. The sample consisted of 48 high-ability seventh and eighth grade students attending a six week, university based summer enrichment program in a southern state; 6.3% of students were African-American, 12.5% Asian-American, and 81.2% were Caucasian.

Variable. Mathematics achievement was measured by the *Probability and Statistics Achievement Pretest and Posttest*, developed by the researcher.

Effect size. Using t-value of 1.76, an effect size of .267 was computed.

Study No. 11

Johnson, D. W., Johnson, R. T., & Scott, L. (1978). The effects of cooperative learning and individualized instruction on student attitudes and achievement. *The Journal of Social Psychology, 104*, 207-216.

Description. This study compared two groups of students, who were placed in either a cooperative learning condition or an individualistic effort condition. The students studied advanced set theory, advanced number theory, and geometry for 6 weeks. Cooperative students were given all mathematics tests individually and then again in groups while individual effort students were given tests individually. Results from the study revealed that the individualized effort groups performed slightly higher on set theory problems. Individual effort groups also performed significantly better on retention tests than did cooperative students.

Sample. The sample consisted of 30 fifth and sixth grade math students. There were 12 male participants and 18 female participants; all participants were white.

Variables. To measure mathematics achievement, the study used a 37-item multiple-choice teacher-made test for both the pretest and posttest.

Effect size. A t-value of 3.79 was reported and an effect size of .694 was computed.

Study No. 12

Johnson, L.C. (1985). The effects of groups of four cooperative learning models on student problem-solving achievement in mathematics (Doctoral dissertation, University of Houston, 1985). *Dissertation Abstracts International, 47*, 403-A.

Description. The study compared fourth and fifth graders in two groups, a cooperative group and an individualistic group; the length of the study was one year. Results from the study indicated that there were statistically significant differences in the mean achievement scores between conditions with the cooperative group showing the greater gains.

Sample. Participants in the study consisted of 859 fourth grade students from 10 elementary schools in a suburban school district in the Houston, Texas area. The school district serves primarily middle to upper class students.

Variables. The Romberg and Wearne Problem Solving Test was used as both a pretest and posttest to measure mathematics achievement.

Effect size. An effect size of .134 was computed given a reported t-value of 1.91.

Study No. 13

Mevarech, Z. R. (1985). The effects of cooperative mastery learning on mathematics achievement. *Journal of Educational Research, 78*, 372-377.

Description. This 15 week study used two groups to compare two cooperative methods (STAD and JIGSAW) to a control condition, to determine if cooperative learning methods produced higher mathematics achievement among students. Results from the study revealed that there was no significant difference between the cooperative learning groups and the control groups in computation and comprehension in mathematics. However, when compared with the control group both the STAD and JIGSAW groups scored significantly higher in computation and comprehension.

Sample. The study consisted of 134 fifth grade students who attended one school in Israel. The school served predominately middle class students from Israel; forty percent of the participants were male.

Variables. To measure mathematics achievement, an objective mathematics test measuring computation achievement and comprehension achievement was used as a pretest, while a 20-item mathematics test created by the researcher was used as the posttest.

Effect size. An effect size of .560 was computed given means and standard deviation.

Study No. 14

Mevarech, Z. R., & Susak, Z. (1993).Effects of learning with cooperative-mastery method on elementary students. *Journal of Educational Research, 86*(4), 197-205.

Description. The purpose of this three month long study was to examine the effects of the cooperative-mastery method on each of its components on children's questioning behavior, creativity, and achievement. Participants were randomly assigned to one of four conditions, cooperative learning (CL), mastery learning (ML), cooperative mastery learning (CML)or ac control group. Results indicated that the CML and ML groups scored higher on measures of higher order questioning skills and originality that did the CL group, who in turn scored higher than the control group.

Sample. The participants were 271 third and fourth grade Israeli students.

Variables. A 20-item, teacher-made multiple choice test consisting of the curriculum unit content, was used as both a pre- and posttest to measure mathematics achievement.

Effect size. Means and standard deviation was used to compute and effect size of .030 was computed.

Study No. 15

Moskowitz, J. M., Malvin, S. H., Schaeffer, G. A. & Schapps, E. (1983). Evaluation of a cooperative learning strategy. *American Educational Research Journal, 20,* 687-696.

Description. The study compared an experimental group to a control group. The experimental group comprised of four schools in which the cooperative learning method - the JIGSAW method was the primary method of instruction. The control group also consisted of four schools that utilized a more traditional and individualistic method of teaching. The purpose of the study was to determine if cooperative leaning strategies produced higher standardized tests scores in the subject areas mathematics and reading; the length of the study was one year. Results from the study revealed that there were no significant differences in either reading or mathematics achievement between cooperative and individualistic groups.

Sample. The sample consisted of 264 fifth and 147 sixth grade students. The cooperative group comprised of 71 fifth graders and 76 sixth graders. The individualistic group consisted of 77 fifth graders and 40 sixth grade students.

Variables. The Stanford Achievement Test was used as both a pretest and posttest to measure mathematics achievement.

Effect size. The reported t-value was 1.21. The effect size was computed as .149.

Study No. 16

Nederhood, B. (1986). The effects of student team learning on academic achievement, attitudes toward self and school, and expansion of friendship bonds among middle school students.

(Doctoral dissertation, University of Washington, 1986). *Dissertation Abstracts International, 47*, 1175A.

Description. This 15 week study compared groups of students taught using STAD, JIGSAW, and TGT to students taught using traditional methods in mathematics, language arts, and social studies classes. The purpose of the study was to determine if cooperative learning teaching strategies produced higher standardized test scores among students than students taught traditional teaching methods. Results from the study revealed no significant differences for academic achievement measures between experimental and control groups.

Sample. The sample consisted of 1145 seventh grade students in five middle schools located in the Seattle, Washington Area. There were 114 seventh grade classes in all.

Variables. The California Achievement Test (CAT), Mathematics Subsets and Total Battery, were used as both the pretest and posttest to measure mathematics achievement.

Effect size. An effect size of .030 was computed given means and standard deviation.

Study No. 17

Peterson, P. L., Janicki, T. C., & Swing, S. R. (1981). Ability *x* treatment interaction effects on children's learning in large-group and small group approaches. *American Education Research Journal, 18*, 453-473.

Description. The study compared four math classes over a four week period. Two classes were assigned to cooperative learning groups and two groups were assigned to individualized instruction. The purpose of the study was to determine if cooperative learning approaches produced higher achievement among mathematics students versus students who were taught using a more individualized method of teaching.

Sample. The sample consisted of 93 fourth and fifth grade students in an elementary school in one school in rural Wisconsin.

Variables. Mathematics achievement was measured by a geometry posttest developed by researcher of the study.

Effect size. Effect size of .000 was computed using a t-value of 0.

Study No. 18

Pratt, S. J., & Moesner, C. (1990). *A comparative study of traditional and cooperative learning on student achievement.* Indianapolis, IN: Elementary and Early Childhood Education. (ERIC Document Reproduction Service No. ED 325258)

Description. The primary purpose of this four week study was to determine whether cooperative learning would produce higher achievement test scores among elementary school students than the traditional mode of instruction. Results indicated that students in the cooperative learning class scored higher than students in the traditional class. In addition, there were statistically significant differences in favor of the cooperative learning class on mathematics total battery scores.

Sample. The study consisted of 38 fifth grade students who attended an elementary school in Chrisney, Indiana. Most students originated from lower to middle income families.

Variables. Mathematics achievement was measured by the California Achievement Test (CAT), used as both the pretest and posttest.

Effect size. An effect size of .816 was computed from reported means and standard deviation.

Study No. 19

Reid, J. (1992). *The effects of cooperative learning with intergroup competition on the mathematics achievement of seventh grade students*. Chicago, IL: Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 355106)

Description. The purpose of this study was to determine the effects of cooperative learning strategies on mathematics achievement of students in grade seven; the length of the study was one year. Results from the study revealed that seventh grade students taught mathematics using cooperative learning strategies did not obtain significantly higher mathematics achievement scores on the ITBS than those using whole group (individualized/competitive) strategies.

Sample. The study consisted of 50 seventh grade students who attended Coleman Elementary School, which is located in a low socioeconomic neighborhood in Chicago’s grand crossing area. Twenty-five students participated in the cooperative learning strategies group and 25 students received individualized or competitive instruction; all children were minority students.

Variables. The 1991 Iowa Test of Basic Skills (ITBS) was used as a pre-test measurement and the ITBS 1992 was used as a post-test for mathematics achievement.

Effect size. An effect size of .654 was computed from means and standard deviation.

Study No. 20

Shupe, A. (2003). Cooperative learning versus direct instruction: Which type of instruction produces greater understanding of fractions with fourth graders? *Dissertation Abstracts International, 42*(01), 27. (UMI No. 1415034).

Description. The purpose of this study was to determine which method of instruction, cooperative learning or direct instruction, would produce greater understanding of fractions with fourth graders; the length of the study was four weeks. The results showed noticeable differences in the improvement of the test scores between the two groups. Students taught with the direct instruction method demonstrated greater understanding of fractions and higher frequency of mastery than those taught with the cooperative learning method.

Sample. The sample consisted of 50 fourth grade students at an elementary school in a rural county in central West Virginia, where the majority of the area's population is middle class. In addition, the classrooms contained children who were students of the gifted program, participants in Title I Math, and individuals with behavior disorders, as well as learning disabilities.

Variable. Mathematics achievement was measured by a teachers made test devised using the West Virginia instructional goals and objectives for 4thgrade and the text *Math Grade 4*, published by Scott Foresman-Addison Wesley, copyrighted in 1999; this was used for both the pre-and posttest.

Effect size. Means and standard deviations were used to compute an effect size of .100.

Study No. 21

Slavin, R. E. (1984). Team-assisted individualization; cooperative learning and individualized instruction in the mainstreamed classroom. *Remedial and Special Education, 5*, 33-42.

Description. The purpose of this study was to compare the use of the Team-Assisted-Instruction (TAI) cooperative strategy to traditional instruction in mathematics classes and determine which method produces higher achievement among third, fourth, and fifth grade students. Results indicated that the TAI group had higher gains than the control group.

Sample. The sample consisted of 504 third, fourth, and fifth graders in 18 classes in six elementary schools. The schools were located in a middle-class suburban Maryland school district. Fifteen-percent of the students in the sample were African-American.

Variable. Mathematics achievement was measured by the Computation subscale of the Comprehensive Test of Basic Skills, used as both a pre-and posttest in the study.

Effect size. Using a t-value of 2.32, an effect size of 0.275 was calculated for this study.

Study No. 22

Slavin, R. E. & Karweit, N. L. (1985). Effects of whole class, ability grouped, and individualized instruction on mathematics achievement. *American Education Research Journal*, *22*, 351-367.

Description. The purpose of the study was to compare the use of The Missouri Mathematics Program (MMP), Ability Grouped Active Teaching (AGAT), and Team-Assisted Instruction (TAI), and determine which strategy yields the largest impact on mathematics achievement; the length of the study was 18 weeks. Results from the study indicated no significant difference between TAI and AGAT. There was however, a significant statistical difference between both TAI and AGAT, with TAI and AGAT scoring significantly higher than MMP on computations.

Sample. The sample consisted of 345 students in 15 fourth, fifth, and sixth grade classes. All students in the study attended urban schools in one Wilmington, Delaware school district. Approximately 71% of the students were White, 26% African-American, and 3% were Asian-American.

Variable. To measure mathematics achievement the California Achievement Test (CAT) and the Comprehensive Test of Basic Skills (CTBS) were used as the pretest and posttest, respectively.

Effect size. Given means and standard deviation, an effect size of .385 was computed.

Study No. 23

Slavin, R. E., Leavey, M., & Madden, N. A. (1982). *Combing learning and individualized instruction: Effect on student mathematics achievement, attitude, and behaviors* (Tech. Rep. No. 326). Baltimore, MD: The John Hopkins University.

Description. The purpose of the this study was to compare a TAI group to a control group to determine which group made higher gains in mathematics achievement; the study was conducted over an eight week period. Results from the study indicated that The TAI group scored significantly higher than the control group, controlling for pretest and grade.

S*ample*. The sample consisted of 286 students in grades four, five, and six. Fifty-five percent of the students were White, 43% African-American, and 2% Asian-American; the study took place in an elementary school located in a suburban Maryland school district.

Variable. To measure mathematics achievement, the Mathematics Computations subscale of the Comprehensive Test of Basic Skills (CTBS) was used as both a pre-and posttest.

Effect size. Given means and standard deviation, an effect size of .222 was computed.

Study No. 24

Webb, N. & Farivar, S. (1994). Promoting helping behavior in cooperative small groups in middle school mathematics. *American Educational Journal, 31*(2), 369-395.

Description. This six week study compared the effects on mathematics achievement and verbal interaction of two instructional programs designed to teach students how to work effectively in small groups; (1) cooperative learning with instruction and practice in basic communication skills and academic helping skills (experimental condition) and (2)cooperative learning with instruction and practice in basic communications skills only (comparison condition). Results of the study revealed no significant differences between conditions, in verbal interaction or achievement.

Sample. The sample consisted of 166 students in six seventh grade general mathematics classes at an urban middle school. The classes were comparable on entering student achievement level and had similar mixes of student gender and ethnic background; 15% of the participants were African-American, 55% Latino, 26% White, 2% Asian-American, and 1% Middle Eastern.

Variable. To measure mathematics achievement, a researcher-made mathematics test consisting of 11 items on computation of fractions was given. A post-test consisting of 32 items on reducing fractions was also given.

Effect size. Given a t-value of 0.47, an effect size of .468 was computed.

Study No. 25

Zaidi, H. A. (1994). Comparing cooperative learning variations and traditional instruction in seventh-grade mathematics: Effects on achievement and self-regulation strategies. *Dissertation Abstracts International, 55*(04), 858. (UMI No. 9424546)

Description. The purpose of this eight week study was to examine the effects of two cooperative learning treatments on the mathematics achievement of students. Students were randomly assigned to one of three modes of instruction: traditional instruction, student Team learning and enhanced cooperative learning. Three criterion referenced based tests were administered. The first two tests consisted of both basic skills and word problems; the third consisted entirely of word problems requiring higher order thinking skills. The study tested the hypotheses that cooperative learning is superior to traditional instruction and that the enhanced cooperative learning method is superior to the students learning method. Results revealed no significant differences between teachers or methods on the first test, but a strong teacher effect on the second and third tests. The hypothesis that cooperative learning was superior to traditional teaching methods was supported on the third test.

Sample. The sample consisted of 122 seventh grade students from six intact classes in a suburban public school in New Jersey; 35% of the students were African-American, 55% White, 10% Asian-American.

Variable. The Metropolitan Achievement Test (MAT) was used as both a pretest and posttest to measure mathematics achievement.

Effect size. Given means and standard deviation, an effect size of .457 was computed.

CHAPTER 4

ANALYSIS OF DATA

This chapter provides an analysis of the studies reviewed in Chapter 3. The studies were reviewed using a format that included a brief description of the study, the sample size, and variables. In addition, the computations of effect size for all 25 studies were also presented in Chapter 3.

Meta-Analysis

Twenty-five studies were collected and sorted. Of the 25 studies, 22 studies were identified in chapter 3 as having met the entire selection criteria:(1) only studies comparing experimental groups and control groups on mathematics pretest and posttest scores were included in the analysis, (2) those studies that did not have sufficient data to calculate effect size were not included in the study, and (3) only those studies that included findings of mathematics achievement and cooperative learning in grades 4-8 were included in the analysis.

Effect sizes were computed for only 22 studies; study numbers 9, 14, and 21 did meet selection criteria and effect sizes were calculated for these studies, however because these studies included statistical results of third grade students in the findings, effect sizes from these three studies could not be included in computing the mean effect size for the current study. Twenty-Two effect sizes were computed from the 25 collected studies, as shown in Table 1. Table 1 shows the individual sample sizes per study, computed individual effect sizes for each study and the average effect size for the current study. The Duration of each study and 2003 average NAEP mathematics proficiency scores per study for grade 4 and grade 8 were also included in Table 1;

only those studies that specified the location of the study include grade 4 and grade 8 2003 average NAEP mathematics proficiency scores.

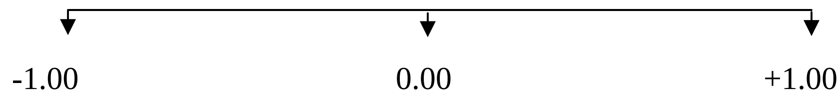
Table 1 indicates that the overall sample size for the treatment groups (cooperative groups) was 3,334 and the overall sample size for the control groups (individual groups) was 3,121. Effect sizes for each study were computed and a mean effect size of .135 was determined for the major research question of the magnitude of the effect that cooperative learning has on the mathematics achievement of middle-grades students; according to Cohen (1977, 1988) this indicates that the magnitude of the effect of cooperative learning on mathematics achievement among middle-grades students is moderately small.

Duration of Studies and Effect Sizes

The length of the studies ranged from 4 weeks to 1 year (52 weeks) and because this is such a large range, the data was analyzed to determine if there was a relationship between the duration of the studies and the effect size of each study. For the current study, duration of study is defined as the entire length of time that the study was conducted; this data is shown in Table 1.

Using the statistical Package for the Social Sciences (SPSS) computer software program, a Pearson-product moment correlation was performed to determine if a relationship existed between the duration of the studies and the effect sizes of the studies; an alpha level of .05 was used for all correlational analyses. Data entry included the duration and effect sizes of all 22 studies and both duration and effect sizes were entered as bivariate variables. Data analysis revealed that the correlation between the duration of each study and the effect size for each study was not significant, $r(20) = -.031$, $p = .892$.

To interpret correlation coefficients, the following correlational continuum should be considered:



any r that falls on the right side of the continuum represents a positive correlation and any r that ends up on the left hand side of the continuum represents a negative correlation, therefore since r = -.031 falls on the left hand side of the continuum, the relationship between the duration of the studies and effect size of the studies represents a negative and weak relationship. Strength and direction characterize a correlation and to get a better feel for the strength of the relationship between the duration of the studies and effect sizes of the studies, the coefficient of determination was calculated resulting in a value of $r^2 = .0009$, which means that only 0.09% of the variance in the duration of studies can be explained by the variance in the effect size of the studies.

A scatter plot is one of the most appropriate methods of visually showing the relationship between two variables. A strong relationship is shown if the points seem to form a linear pattern, in other words, the more closely the points appear to fall around a straight line, the stronger the relationship. Visual investigation of the scatter plot in Figure 3 indicates that there is a nonlinear, weak, and negative relationship between the duration of the studies and effect size of the studies. Furthermore, it appears that the majority of studies with relatively medium to large effect sizes lasted between 4 to 18 weeks. More specifically, study no.18 which was conducted over a four week period had the largest effect size (.854) of all 22 studies, study no. 19 had the second largest effect size (.654) however its length of time was 1 year or 52 weeks. These findings suggest that the duration of the study is not relative to the effect of cooperative learning strategies on the mathematics achievement of middle-grades students and that cooperative learning strategies do not necessarily have to be implemented for specific lengths of time in order to be effective with middle-grades students in mathematics.

Duration of Study and 2003 Average NAEP Mathematics Proficiency Scores for Grade 4 and Grade 8

A Pearson-product moment correlation was also conducted to determine whether there is some correlation between the duration of the studies and the 2003 average NAEP mathematics proficiency scores for students in grades 4 and 8. Fourth and eighth grade students have been identified as target groups for the current study since NAEP data report on these specific grade levels in each of its assessments. Correlations for each grade level were computed separately. To compute the correlations, data entry included the bivariate variables - duration of studies and grade 4 and grade 8 2003 NAEP mathematics proficiency scores for each study. NAEP scores could only be assigned to studies that reported the specific State in which the study was conducted. Of the 22 studies, 13 studies reported the specific location and therefore only 13 studies were included in the correlations for each grade level.

Data analysis revealed that the correlation between the duration of the study and 2003 NAEP average mathematics proficiency scores for grade 4 was negative and nonsignificant, r(11)= -.215, p = .481. The coefficient of determination was calculated as r^2 =.046, which indicates a weak relationship between the duration of studies and NAEP mathematics achievement scores and shows that only 4.6% of the variance in the duration of the studies can be explained by the variance in NAEP mathematics achievement scores for grade 4.

The scatter plot in Figure 2 also indicates a negative and weak relationship between duration of studies and NAEP mathematics proficiency scores for grade 4. Closer examination of the scatter plot also shows a trend that studies conducted between 4 to 18 weeks have some of the highest NAEP mathematics achievement scores.

The National Assessment of Educational Progress (NAEP) reports on fourth and eighth grade students' average mathematics proficiency scores by state and region of the United States. In Table 2, the locations of each study (if applicable), as well as grade 4 and grade 8 2003 NAEP average mathematics achievement scores are provided. Interestingly enough, most of the studies which lasted 4 to 18 weeks were conducted in the Northeast and Midwest portion of the United States and these same studies have some of the highest NAEP mathematics achievement scores of the studies included in the correlational analysis, with NAEP mathematics proficiency scores ranging from 233-239.

Even more interesting is the fact that of the four regions – Northeast, Midwest, South, and West, both Northeast and Midwest regions have the highest average NAEP mathematics achievement scores (238) at grade 4; the Southern and Western regions of the United States have average NAEP mathematics achievement scores of 234 and 231 respectively for grade 4. It has been established that most of these studies were conducted mainly in the Northeast and Midwest regions of the United States and it is within these regions that some of the most prominent Research I Universities are located. Research I Universities have the necessary funding and available resources needed to conduct research such as this on an ongoing basis and therefore it is probably by no coincidence that most of the studies in the meta-analysis were conducted in these particular portions of the United States.

Although there exist some variation in effect sizes within the current study, further investigation of Table 2 reveals that most of the studies conducted in Northeast and Midwest regions of the United States have medium to large effect sizes. For instance, an effect size of

.385 was computed for study no.22, which was conducted in Delaware, study no.19 which was conducted in Illinois yielded an effect size of .654 and study no. 25, conducted in New Jersey had an effect size of .457.

Results from the Pearson correlation between duration of study and 2003 NEAP mathematics proficiency scores for grade 8 were similar to that of the results from the Pearson correlation for grade 4. Data analysis for grade 8 shows that there exists a negative, nonsignificant relationship between the two bivariate variables, with r(11)= -.169, p = .580.The value of the coefficient of determination (r^2 =.028) indicates that only 2.8% of the variance in the duration of studies can be explained by the variance in NAEP mathematics proficiency scores.

The scatter plot in Figure 3 reveals a weak and negative relationship and shows a pattern of data plots that is similar to the scatter plot in figure 4, with the majority of higher NAEP achievement scores falling in the duration range of 4 to 18 weeks. The correlational analysis for grade 8 also shows that most of the studies conducted within Northeast and Midwest regions of the United States have higher NEAP mathematics proficiency scores, as well as larger effect sizes within the current study.

Although results from these correlational analyses revealed weak, negative and nonsignificant relationships between duration of study and 2003 NAEP mathematics achievement scores for grades 4 and grade 8, some of the additional findings have profound implications for the mathematics education of middle-grade students. The fact that most of the studies with medium to large effect sizes also had high mathematics proficiency scores and were conducted in Northeast and Midwest portions of the United States has much to say about the mathematics curriculum being taught in these particular regions. These findings suggest that teachers of mathematics in the Northeast and Midwest regions of the U.S. may be utilizing effective mathematics instructional strategies, such as cooperative learning, to produce higher levels of mathematics achievement among middle-grades students and therefore mathematics students in these particular regions of the U.S. on average are outperforming mathematics students in other regions of the United States.

Study Data Analysis and Effect Size

Results from these analyses allow for even further investigation into the fact that meta-analyses studies conducted in Northeast and Midwest portions of the United States also have high average NAEP mathematics achievement scores. These findings are not the only commonality that these particular studies share, all of these studies also produced medium to large effect sizes for the current study. This being the case, the particular analysis of data used within each individual study was examined to determine if there is some relationship between the type of analysis used in each study and the particular effect size that the study produced.

In Table 3, study effect sizes along with the type of data analysis that each study used were presented. Visual analysis of Table 3 reveals that in most cases where studies produced large effect sizes, a t-test was used as a method of analyzing the data. More specifically, study no. 6, 11, 18, and 19 produced effect sizes ranging from .635 to .816 and all used a t-test for analyzing the data. In most cases where a study produced a small to medium effect size, other methods such as Analysis of Variance (ANOVA), Analysis of Covariance (ANCOVA) and regression analysis were used in analyzing the data. For instance, study no. 2, 5, 10, and 25 all produced small to medium effect sizes ranging from .117 to .457.

In some instances, there were studies that utilized the same method of analyzing data, yet yielded effect size values that varied. Evidence of this is shown when comparing the computed effect size of study no. 3 to that of study no. 22, both of which used ANOVA in analyzing data, but produced effect sizes of .074 and .385 respectively. When comparing two additional studies (study no. 4 to study no. 24) that used ANOVA for data analysis, there is also evidence of variation in computed effect sizes, where study no. 4 produced an effect size of .015 and study no. 24 produced an effect size of .468. These results are give cause for looking at other reasons for variation in effect size, such as the particular design that was used within the study.

Although both study no. 3 and study no. 22 used ANOVA in analyzing the data within the study, they used different evaluation designs. In study no. 3, a nonequivalent posttest only quasi-experimental design was employed, where participants were not randomly assigned to treatment and control groups. Study no. 22 employed a pretest-posttest experimental design where participants were assigned to both groups randomly. This difference in evaluation methodologies may be some justification for the differences in the computed effect sizes of both studies. For instance, in study no. 3, a comparison was made between mathematics students taught using the cooperative learning strategy the JIGSAW method (experimental group) and students being taught traditional teaching methods (control group), to determine which group exhibited higher mathematics achievement scores; results indicated no significant difference in mathematics achievement of the two groups. The problem with using a posttest only quasi-experimental design is that the two groups being compared may not necessarily be the same before instruction takes place and may differ in important ways that may influence their mathematics achievement. This could have some bearing on the statistical results of the overall study, therefore influencing the produced effect size of .015 for the current study.

On the other hand, experimental designs such as the one used in study no.22 are generally considered the most robust of the evaluation methodologies. Study no. 22 compared students being taught with the use of TAI (treatment group), a cooperative learning strategy to students being taught using MMP (control group), a mathematics program used by a Delaware school district; results indicated that the TAI group scored higher on computation than did the MMP group. Although experimental designs can be problematic as well, there are some advantages to using this evaluation method. By randomly allocating the intervention among eligible beneficiaries, the assignment process itself creates comparable treatment and control groups that are statically equivalent to one another (Gribbons & Herman, 1997). Randomization helps to assure that the two groups are comparable or equivalent in terms of characteristics which could affect any observed differences in posttest scores. The fact that participants were randomly selected for treatment and control groups in study no. 22 may have some impact on the overall results of the study itself and the produced effect size of .468 for the current study, which is larger than that of study no. 4, where participants were not randomly assigned to treatment and control groups.

When looking at the differentiation in effect sizes of study no. 4 and study no. 24, the idea that different designs were used within each study can also help to explain the variation in effect size value for each of these studies. Study no. 4 used a quasi-experimental type design, while study no. 24 used an experimental type design. This is not to imply that one design is superior to another, yet it suggests that one design may help to positively influence the results of a study more so than the other.

In order to further explain variation in the effect sizes of the meta-analyses studies, individual outcome measures for each study were examined to determine whether the type of dependent measure that each study used may have had some influence on the produced effect size of the individual study. In chapter 3, a brief description of each study was given including the type of dependent measure that each study utilized.

Studies no. 5, 11, 13, 18, 19, 24 and 25 all produced medium to large effect sizes ranging from .457 to .816 and these particular studies used either teacher/researcher made mathematics achievement tests or the mathematics sections of a particular standardized test, as dependent outcome measures. Study no. 5, 18, 19 and 25 all used some type of standardized test as a means of measuring mathematics achievement. In the case of the current study, standardized tests are considered less specific to cooperative learning instruction since they are unvarying in the way that they are designed; standardized tests usually consist of multiple choice questions that are created on the basis of specific objectives of a given curriculum and because of this standardized tests usually cannot be modified to a particular type of instruction.

For example study no. 5,18,19 and 25 all used the mathematics portion of the Stanford Achievement Test (SAT), the California Achievement Test (CAT), the Iowa Test of Basic Skills (ITBS), and the Metropolitan Achievement Test (MAT) respectively. Many schools systems in the United States use these types of standardized tests to assess what students knows and understand in a particular subject area, the tests are not developed to assess how effective a particular instructional strategy is being implemented in classroom. Furthermore, these types of tests are less tailored to instructional strategies such as to cooperative learning and therefore no conclusions can be made regarding how these outcome measures possibly influenced the effect sizes of the individual studies.

In contrast, study no. 11, 13, and 24 used posttests that were developed by the researcher and/or the teacher who conducted the study. In this case, some conclusions can be made about the possible influence of these types of outcome measures on the effect sizes of the individual studies because with these types of tests researchers and teachers are able to adapt the tests specifically to the type of instruction given. For example, study no. 11 compared a group of 30 fifth and sixth grade students who were placed in either a cooperative learning condition or an individualistic effort condition. Both groups, taught by the same teacher studied advanced set theory, advanced number theory, and geometry. Cooperative students were given mathematics tests individually and then again in groups while individual effort students were given mathematics tests individually. The outcome measure for this study was a 37-item multiple choice teacher-made test consisting of the types of problems that students studied individually and in cooperative groups. The fact that the teacher in the study was able to tailor the tests so that students could complete mathematics tests in groups may have had some influence on the results of the individual study as well as had some influence on the medium effect size of .694 for the current study.

Study no. 13 which produced a medium effect size of .560 for the current study compared fifth grade students in cooperative conditions to students in an individual instruction type of condition; the two groups were taught by the same teacher and an objective mathematics posttest measuring computation achievement and comprehension achievement was used as a dependent outcome measure for the study. Results from the study indicated that cooperative groups outscored the individualistic group in computation and comprehension. The fact that the teacher of the study was able to adapt the test to the instruction given to the cooperative groups shows that the teacher had complete control over the types of questions given on the test. This in turn could have had some influence the results of the individual study and the effect size that the study produced for the current study.

Study no. 24 also used a teacher-made posttest as a means of measuring mathematics achievement. This 32-item posttest was divided into for composites according to the topic. The 13-item numerical exercise composite included addition and subtraction of fractions, determining equivalent fractions, reducing fractions, and converting between improper fractions and mixed numbers. Eight items required students to compare sizes of fractions, four word problems dealt with addition or subtraction of fractions and seven items required students to estimate fractional areas of diagrams. The fact that the outcome measure was specifically tailored to cooperative learning instruction may also explain the computed medium effect size of .468. These analyses are not to show favoritism of one particular outcome measure over another, yet these analyses are merely an effort to explain variation in effect sizes and the particular impact that outcome measures may have on the variation in the effect sizes of the current study overall.

Table 1

Meta-Analysis of Studies

Effect Name	n_{G1}	n_{G2}	ES	Duration	NAEP 4	NAEP 8
Study No.1	34	31	.270	1 year		
Study No.2	182	179	.117	8 weeks	233	278
Study No.3	20	21	.074	4 weeks	239	281
Study No.4	1086	1089	.015	18 weeks	226	266
Study No.5	48	48	.466	6 weeks		
Study No.6	22	18	.635	18 weeks	227	267
Study No.7	37	35	.317	22 weeks		
Study No.8	28	27	.191	8 weeks		
Study No.10	24	24	.267	6 weeks		
Study No.11	16	14	.694	6 weeks		
Study No.12	525	334	.134	1 year 237	277	
Study No.13	69	65	.560	15 weeks		
Study No.15	147	117	.149	1 year		
Study No.16	524	621	.030	15 weeks	238	281
Study No.17	48	45	.000	4 weeks	237	284
Study No.18	19	19	.816	4 weeks	238	281
Study No.19	25	25	.654	1 year 233	277	
Study No.20	24	26	.100	4 weeks	239	282
Study No.22	183	162	.385	18 weeks	236	277
Study No.23	138	148	.222	8 weeks	233	278
Study No.24	83	83	.468	6 weeks		
Study No.25	62	60	.457	8 weeks	239	266
Total	3344	3121	.135			

n_{G1} -treatment group sample size

n_{G2} -control group sample size

ES-Effect Size
NAEP 4-4th grade 2003 Average NAEP Math Proficiency Scores
NAEP 8-8th grade 2003 Average NAEP Math Proficiency Scores

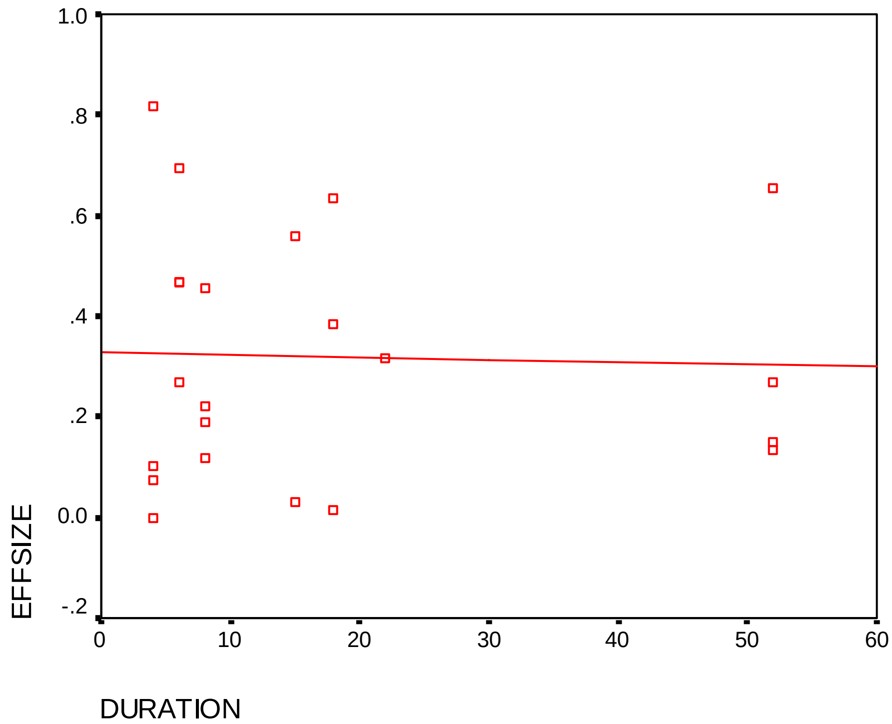


Figure 1. Duration of Study and Effect Size

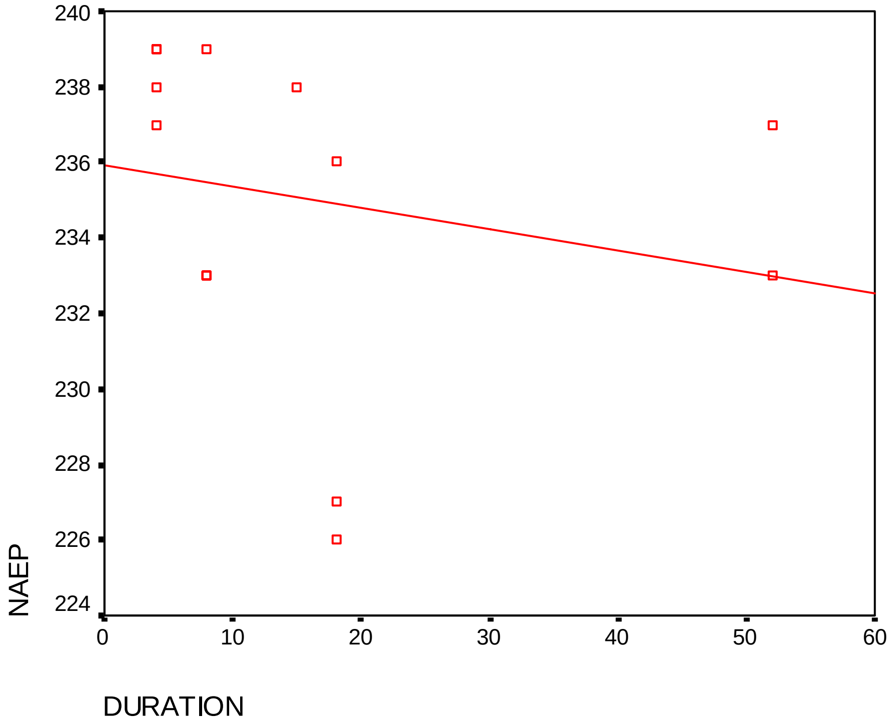


Figure 2. Duration of Study and NEAP Scores – Grade 4

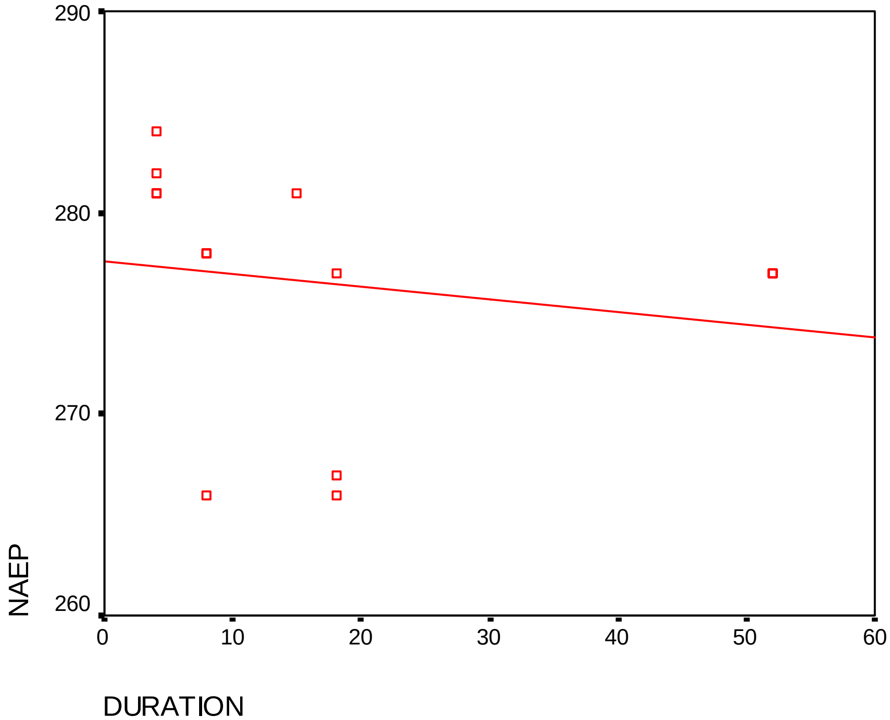


Figure 3. Duration of Study and NAEP Scores – Grade 8

Table 2

Location of Study, Sample Size, and Effect Size

Study No.	Location	SS	ES	NAEP 4	NAEP 8
1	Midwest, US	65	.270		
2	Maryland	361	.117	233	278
3	New Jersey	41	.074	239	281
4	Louisiana	2175	.015	226	266
5		96	.466		
6	California	40	.635	227	267
7		72	.317		
8	Canada	55	.191		
10	Southern, US	48	.267		
11		30	.694		
12	Texas	859	.134	237	277
13	Israel	134	.560		
15		264	.149		
16	Washington	1145	.030	238	281
17	Wisconsin	93	.000	237	284
18	Indiana	38	.816	238	281
19	Illinois	50	.654	233	277
20	Virginia	50	.100	239	282
22	Delaware	345	.385	236	277
23	Maryland	286	.222	233	278
24		166	.468		
25	New Jersey	122	.457	239	266

Table 3

Study Data Analysis and Effect Size

Study No.	Study Data Analysis	ES
1	ANCOVA	.270
2	ANCOVA	.117
3	ANOVA	.074
4	ANOVA	.015
5	ANOVA	.466
6	t-test	.635
7	t-test	.317
8	ANOVA	.191
10	ANCOVA	.267
11	t-test	.694
12	t-test	.134
13	ANOVA/ANCOVA	.560
15	ANCOVA	.149
16	t-test	.030
17	regression Analysis	.000
18	t-test	.816
19	t-test	.654
20	ANOVA	.100
22	ANOVA	.385
23	regression Analysis	.222
24	ANOVA	.468
25	ANOVA	.457

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

For the past 30 years, since Slavin's studies on cooperative learning strategies in a variety of subject areas revealed positive effects on achievement, many in the field of education have focused their attention towards it as one of the most effective instructional strategies utilized in the classroom. A search of the literature on cooperative learning itself reveals a tremendous bank of information on the subject, however when coupled with mathematics achievement and middle-grades students, the pool of research narrows. There is unfortunately a limited amount of research on cooperative learning strategies and mathematics achievement, especially at the middle-grades level.

The purpose of the current study was to examine the literature on cooperative learning strategies and mathematics achievement in the middle grades and to derive one statistical measure, an effect size which would synthesize the results and provide quantitative analysis as to what degree cooperative learning strategies affect the mathematics achievement of middle grades students. With the use of *Comprehensive Meta-analysis*, a computer software program, Twenty-two effect sizes from 25 studies were computed in order to obtain a mean effect size.

A meta-analysis as defined by Glass (1976) and expanded upon by Holmes (1984), permits a statistical synthesis of a collection of independent experiments. In order to accomplish this, the studies must have reported means and standard deviations; raw scores from which means and standard deviations could be computed; F-values; and t-scores.

For the current study, separate effect sizes were computed by utilizing reported data. An overall effect size was then computed by averaging the individual effect sizes. A mean effect size of .135 was obtained for the current study by averaging the individual effect sizes of the 22 studies. The small quantity of available studies focused on cooperative learning and mathematics achievement for this age level may have influenced the effects on this statistical analysis. A Pearson product-moment correlation was used to examine the relationship between the duration of studies and effect sizes of studies and the relationship between duration of studies and NEAP achievement scores for both grade 4 and grade 8 was also investigated. The Location of the studies was examined to determine commonalities among them and also investigated was the method of data analysis and dependent outcome measure that each study utilized.

Conclusions

One of the most important influences on what students learn is the teacher. For it is what a teacher knows and can do that influences how she or he organizes and conducts lessons that ultimately determines what mathematics students learn and how they learn it (Grouws & Smith, 2000, p. 107). Teachers must realize that the characteristics that they possess as well as the instructional strategies that they incorporate into the mathematics classroom are directly connected to the differential levels of student performance. This is why it is imperative that mathematics teachers, especially those who teach young adolescents, become grounded in mathematical pedagogy, mathematics content knowledge, and classroom discourse; take advantage of professional development opportunities that focus on mathematics teaching and most importantly develop instructional strategies that emphasize oral and written communication of mathematical ideas that cater to young adolescents' developmental processes.

According to the National Council of Teachers of Mathematics (NCTM, 2000) and the National Middle School Association (NMSA, 2003), young adolescents need a curriculum that is developmentally responsive, relevant, challenging, integrative, and exploratory. Students need a curriculum that is rich in meaning and that helps them make sense of themselves and their world. This curriculum should indicate degrees of structure, a varied pace of learning, and a variety of teaching and learning strategies (NMSA, 2003). Cooperative learning strategies appear to be an appropriate instructional practice for this particular age group because its characteristics are consistent with that of young adolescents' learning orientations.

It was the purpose of the current study to focus on the effects of cooperative learning on the mathematics achievement of middle-grades students; results indicated that the magnitude of the effect of cooperative learning on the mathematics achievement of young adolescents was positive and moderately small. In the current study, it was determined that the relationship between the duration of studies and effect size of studies was nonsignificant with Pearson $r = -0.31$, $p>.05$. The correlations between duration of studies and NEAP mathematics achievement scores for both grade 4 and grade 8 were also determined to be nonsignificant with $r= -.215$, $p>.05$ and $r = -.169$, $p>.05$ respectively. Also examined in the current study was the location of studies included in the meta-analysis. It was quite interesting that most of the studies in the meta-analysis were conducted in Northeast and Midwest regions of the United States and even more interesting is the fact that according to the National Center for Education Statistics (2003), NAEP data from 2003 revealed that most of the states in these regions such as Delaware, Illinois, and Indiana have some of the highest average mathematics proficiency scores within the United States. Also, the individual effect sizes for the studies conducted in these particular regions were fairly medium to large ranging from .385 to .816. It was also determined that these particular studies occurred in states where Research I Universities are located, which could possibly explain the reason for such a large number of the studies in the meta-analysis being conducted in the Northeast and Midwest regions of the U.S. In addition, the current study investigated the type data analysis and evaluation design that each study utilized to explain variations in effect size values; it was determined that the type of design in which a study uses may influence the effect size of that study.

In an effort to continue to explain variation in effect size, the dependent outcome measures for each study were examined. It was determined that the type of outcome measure that a study employs may in fact have some influence on the computed effect sizes for the current study.

Recommendations

As a result of this study, several recommendations are offered. First and foremost, it is recommended that cooperative learning strategies be used in situations where an effort is being made to improve the academic performance of all students, and middle-grades students in particular. As mentioned earlier, middle-grade students need a curriculum that caters primarily to their developmental needs. The National Council of Teachers of Mathematics (NCTM) along with the National Middle Association (NMSA) both advocate a curriculum that is effective for middle-grades students, but most importantly one that is developmentally responsive for these students as well. Enveloped within the characteristics of a developmentally responsive curriculum for young adolescents is the use of a variety of instructional strategies such as cooperative learning. There is much evidence to show that the implementation of cooperative learning strategies in the classroom have positive effects on young adolescents’ academic achievement, self-esteem, and critical thinking skills (Slavin, 1980; Johnson & Johnson, 1984).

Therefore in order to continuously improve the academic performance of middle-grades students, teachers need to adhere to and incorporate instructional strategies such as cooperative learning and furthermore, teachers of young adolescents should support a curriculum that most appropriately and effectively addresses their developmental needs which in turn will produce higher academic achievement among them.

Secondly, it is recommended that efforts be made to increase the use of cooperative learning in the middle-grades classrooms, particularly in mathematics especially because research on this strategy usually focuses on other subject areas such as social studies, language arts, and science. Presented in the current study were several research studies supporting the fact that the implementation of cooperative learning strategies in the mathematics classroom has positive effects on the mathematics achievement of middle-grades students. Most of the meta-analyses studies that compared experimental groups (cooperative learning groups) and control groups (individualistic groups) revealed that students perform better when they complete their work in cooperative groups versus when they complete their work individually. Although this may be true, as evidence from this meta-analysis indicates, there is simply not enough research being conducted on cooperative learning specifically in the subject area of mathematics and because of this, teachers and researchers should attempt to focus their attention more on cooperative learning strategies and its usefulness in the mathematics classroom.

It was revealed in the current study analysis that a majority of the studies in the meta-analysis were conducted in the Midwest and Northeast portions of the United States. It was also revealed that these particular studies had medium to large effect sizes and higher average NAEP scores than those studies conducted in the Southern and Western regions of the United States. Additionally it was determined that the Midwest and Northeast regions of the U.S. contain more

Research I universities than South and West portions of the U.S., it was indicated that this could possibly explain the reason for the majority of the meta-analyses studies being conducted in the Northeast and Midwest regions of the U.S. With that said, it is also recommended that additional research be conducted on the effects of cooperative learning strategies on middle-grades students in mathematics to determine the efficacy of these methods for increasing mathematics achievement, particularly in the South and West regions of the U.S. where NAEP mathematics proficiency scores are below average levels. This may be easier said than done because the issue at hand is finding the available funding to support this research, which some universities simply do not have. It is suggested that more universities in the Southern and Western portions of the U.S. solicit different agencies within the federal government to obtain more grant money to help assist with this type of research. This suggestion is not only beneficial to the universities, but it also benefits mathematics teachers because it helps them become more knowledgeable of the types of instructional strategies that are effective for young adolescents. It also ultimately benefits middle-grades students because they will receive the type of mathematics instruction that caters to their emotional and social developmental needs and increases their mathematics achievement as well.

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