12-1-1998

Students' With Learning Disabilities Perception of Mnemonic Strategies in Mathematics Instruction

Susan C. Moore
Longwood University

Running Head: MNEMONIC STRATEGIES

Students' With Learning Disabilities Perceptions of Mnemonic Strategies in Mathematics Instruction

Susan C. Moore

Longwood College

This Thesis was approved by:

Dr. Ruth Meese: Ruth Ann Meese (Director)

Dr. Stephen Keith: Stephen C Keith

Dr. Patty Whitfield: Patty Whitfield

Date of Approval: Dec. 1, 1998

Abstract

This was a qualitative as well as quantitative study conducted at a middle school in a rural county in Virginia. The researcher examined learning disabled students for their perceptions of mnemonic strategies in mathematics instruction. After direct instruction and instruction involving mnemonics, the seven subjects were tested. The test scores were examined to determine if there was a significant difference between pre and post scores. After interviewing the subjects, the results indicated five themes: unfamiliarity of procedure leads to anxiety, mnemonics improves performance, students desire more mnemonic strategies, division and other multi-step problems are the most difficult, and an increase in confidence decreases anxiety and increases self-esteem. Interobserver reliability was calculated by two professionals.

Acknowledgements

I wish to acknowledge Dr. Ruth Meese for all her contributions and words of encouragement throughout my entire graduate program. Her insistence of my perseverance was a driving force behind my completion of this paper. To my dearest friend and colleague, Mrs. Pat Collier, "thank you" seems so small for all that you do. I would also like to thank Mr. Jason Perry for his technological assistance. Maybe now I'll have some free time to take your computer class, that I so badly need! Finally, I would like to recognize, and thank my son, Jay, and my daughter, Ashley, for being so very special. You both are my proudest possessions.

This thesis is dedicated to the memory of my aunt, Anna Sanders, who devoted her life to her family, and to the education and guidance of young people.

Table of Contents

List of Appendices by Title

List of Tables by Title

Students' With Learning Disabilities Perceptions of Mnemonic Strategies in Mathematics Instruction

Educators today agree that in order to thrive, or even survive, in our fast paced society, one must be able to exhibit mathematical problem solving abilities in nearly all daily activities. For many individuals, confrontations with word problems create anxieties that lead to lapses of even the most basic principles of mathematics. These anxieties are tremendously increased when the confronted individual has a learning disability. The anxieties are often traced to a singular incidence of failure or humiliation resulting from a negative response by a teacher.

Research demonstrates a high correlation between reduction in math anxiety and successful mathematical problem solving (Caine & Caine, 1994). Any tool that would effectively reduce math anxiety, and hence build confidence, would be a valuable resource to educators, especially those who are educators of students with learning disabilities.

Mnemonics, procedures or operations utilized to improve memory, were used thousands of years ago by the Greeks (Scruggs & Mastropieri, 1990). They had limited access to writing materials and relied instead on a set of "loci" with which they could associate

information in sequence. When needed, the information was easily retrieved. Today, similar strategies have proven to be successful for students with learning disabilities in certain circumstances (Scruggs & Mastropieri, 1990). If mnemonic strategies were incorporated with the introduction to multi-step mathematical procedures, anxiety directly related to this type of mathematical problem solving may be reduced, and perhaps, even eliminated. Mathematical successes are often thwarted by anxiety, but by using mnemonics to remember important sequential steps for solving problems, students with learning disabilities will build confidence that may lead them to experience mathematical success.

The Importance of Math

Mathematics has always played a key role in the higher occupational levels (Tibias, 1978); however, the trends are changing to include mathematical expertise as a necessity in nearly all employment fields. The academically advanced students from advantaged homes are no longer the only ones expected to go as far as possible in their formal mathematical training. All individuals now must attain a broad knowledge of mathematics if they expect to acquire employment and achieve advancement.

The realm of employment is not the sole area where mathematical knowledge is required. Daily living requires the

application of math skills in many areas, (e.g. planning and monitoring time, computing percentages for on-sale purchases, making estimations, interpreting recipe measurements, measuring for carpeting purchases, computing scores in games, handling banking transactions, and maintaining a checkbook) (Mercer & Miller, 1992). Alley and Deshler (1979) pointed out that mathematical competency is important not only in functioning in nearly all areas of adult life, but also to prevent oneself from being taken advantage of by others.

Many students leave the world of formal education thinking they are finished with mathematics. They are sadly mistaken, for they soon find out that functioning as an adult requires mathematical application of concepts. Bos and Vaughan (1991) identified mastery of eight areas of mathematics as being needed for survival in the real world (See Appendix A, Table1).

The Impact of Math Anxiety on Students

The importance of math is quite obvious; however, millions find learning math to be very difficult, regardless of their teacher's teaching style. Many attempts to improve math learning, such as the "New Math" curriculum of the 1960's (Tibias,1978), have been unsuccessful. Researchers (Wigfield & Meece, 1988) have suggested that math anxiety plays a major role in poor math performance

among students. Joseph Martinez (1987) stated that "anxiety may be a greater block to math learning than any supposed deficiencies in our school curricula" (p.125).

Wigfield and Meece (1988) conducted a study that confirmed there are two separate components of math anxiety. The two separate areas of concern are the cognitive component and the affective component. Students suffering from failure in math often experience negative emotional outcomes (Rental & Ferris, 1993); therefore, a resounding reason for math anxiety is fear of failure (Wigfield & Meece, 1988). Rental and Ferris (1993) found that the affective factors of anxiety that accompany the fear are dread and nervousness. Children who experience these affective factors believe they must exhibit a greater effort to do well on math performance. The cognitive component of math anxiety, as expressed by Wigfield and Meece (1988), is worry. Regardless of the component, be it affective or cognitive, these anxieties can be triggered by a "slight discomfort" (Tibias, 1978, p. 24) with mathematics in elementary school, and grow into a full-blown "disease" by the time the student reaches high school.

Students remember math as being taught in a tense atmosphere where the emphasis is placed on the correct answers. Teachers who are patient at first often become frustrated and quick

to criticize when simple problem solving techniques are forgotten by students. Math anxieties develop at these critical times of embarrassment, often resulting in long-term effects (Tibias, 1978).

Teachers can not accept sole responsibility for math anxieties among students. Parental attitudes and emotional problems also are contributing factors (Martinez, 1987). Teachers, however, can play a very big part in preventing math anxiety from occurring. Programs should be implemented during the elementary years, before the anxieties are established (Wigfield & Meece, 1988). If math anxieties already exist, the goal of the teacher should be to reduce or eliminate the anxiety, so as not to interfere with further math achievement (Martinez, 1987).

Mnemonic Strategies in Instruction

According to Deschler and Schumaker (1993), teachers today are being asked to diversify their instruction to include not only content material, but also strategy instruction, or more simply put a curriculum focused on "how to learn" (p.154). Scruggs and Mastropieri (1993) noted that strategy instruction is effective in many areas, including reading comprehension, listening comprehension, note taking, memory for content, essay writing, and successful test taking.

From their research, beginning in the late 1970s, Deshler and Schumaker (1993) found that strategy instruction is very beneficial, particularly to students with learning disabilities. Their findings indicate that with intensive instruction at risk students "can master learning strategies and apply them to tasks that are similar to those assigned in regular mainstreamed classes" (p.157).

Scruggs and Mastropieri (1990) conducted extensive research involving students with learning disabilities and the learning strategy known as mnemonics. Their definition of a mnemonic, or procedure used to improve memory, is "a specific reconstruction of target content to tie new information more closely to the learner's existing knowledge base and, therefore, facilitate retrieval" (p.271).

Researchers Heaton and O'Shea (1995) demonstrate that teachers who use mnemonic strategies to link new concepts to previously, well-learned material improve student retention of material. They note that the benefits of using mnemonics include a higher percentage of recalled material on comprehension tests, increased performance when compared to rote skills, and increased written production. In fact, the overall effects of utilizing mnemonic strategies have been so positive that researchers Scruggs and Mastropieri (1993) cited this form of instruction as an "essential

component of effective content area instruction for students with learning disabilities" (p.394).

Mnemonics, or "content enhancements" as they are referred to by Hudson, Lignugaris-Kraft, and Miller (1993), are beneficial to all students in content classes when incorporated into an effective teaching cycle. Mnemonics are typically integrated into the presentation and guided practice phase of instruction. A detailed search of the types of mnemonics yields a numerous and varied list, but Heaton and O'Shea (1995) categorized them into four sub-headings: rhymes with visual imagery, story inventions, loci and keyword methods, and acronyms.

Rhymes with visual imagery ask the student to rhyme words in association with pictures. David Baine's (1986) research of this mnemonic strategy points out that its role may be either implicit or explicit. Story inventions ask students to recall a list of words by making up a story that includes all of the words in the assigned list. The loci method was first used by the Greeks. By initially memorizing the location of a set of loci in the temple, they would associate each new piece of incoming information with the previously memorized loci, and thus remember the sequential order of the new information (Scruggs & Mastropieri, 1990). Keyword mnemonics ask the student to conjure up a visual image for remembering the English

meaning of foreign words. Lastly, acronyms, the most familiar mnemonic (Scruggs & Mastropieri, 1990), use the first letter of several words to form a single word. Syntactic mnemonics are in this category also, and incorporate the first letters of words in a sentence in order that lists may be recalled sequentially (Baine, 1986).

Teachers are the key ingredient in introducing learning strategies to their students. With creative talents and sound teaching principles, teachers can assist even students with learning disabilities to utilize learning strategies automatically and thus become independent learners (Lombardi, 1995).

Mathematical Disabilities

The research devoted to learning disabilities tips the scale heavily toward disabilities in areas associated with reading. A small group of researchers, however, have concentrated their efforts on disabilities in the areas of mathematics. Few students experience difficulties solely in computation. The majority of mathematical deficits lie in the area of problem solving, thus relating these difficulties with reading and language disabilities (Rothman & Cohen, 1989).

David C. Geary (1993) studied the cognitive, neuropsychological and genetic components of mathematical disabilities (MD) and concluded that there are "two distinct functional lower order deficits

in MD children, procedural and memory development" (p. 348). Geary's (1993) findings indicate that the procedural deficits are due to immature arithmetic procedures, and also a high frequency of errors when following procedures. The deficits affiliated with memory development revolve around "faulty retrieval of arithmetic facts from long-term semantic memory" (p.346). These two deficit areas, although treated as two different disabilities by Geary (1993), often occur together and have a cause-and-effect relationship. The poor working memory of some students often contributes to errors in procedure.

Regardless of the causes of the MD, researchers Cawley and Parmer (1990) feel that efforts should be made to place our educational emphasis on teaching the students to approach and conquer word problems confidently. "It seems incredible to find special education preparing to enter the twenty-first century without making a major shift to problem solving as the basis for school experiences" (Cawley & Parmer, 1990, p. 516). They pointed out that computation needs can be met by the use of calculators, which would then allow for more time to be spent on solving the mathematical problems found in everyday life.

Students with learning disabilities find it difficult to learn a new skill. But according to Bley and Thornton (1981), students with

learning disabilities find it considerably more difficult to apply that skill in a different context as in solving word problems. Solving word problems involves successful integration of many subcomponents of a skill. If the learner is able to execute the correct actions in the proper sequence, word problems do not present themselves as unconquerable obstacles. This, however, is not usually the case with children having math disabilities. These students tend to spend much of their time reasoning about the present conditions and given information before ever attempting to solve the problem. They are unsure of procedure, and their memory deficits are hindered further due to anxiety from the uncomfortable situation (Woodward, 1991).

Children with MD may only represent a small percentage of the class, but researchers Bley and Thornton (1981) stated that "the nature and magnitude of the problems may be large enough to affect presentation of material" (p. 3). Swanson and Rhine (1985) conclude that by teaching strategies to all students, not solely those with MD, quick retrieval of sequential procedure is possible, thus freeing the cognitive system to process more information.

Math Strategies

Math strategies have been used for years, but have only been studied since the late 1970s. They are used to improve the initial learning of math facts and procedures, and later aid in the recall of

this information (Miller & Mercer, 1993). Students with learning disabilities often have memory deficits (Bley & Thornton, 1981). These deficits contribute to difficulties with computation and word problems. "Supplemental instruction, including the use of strategies, enhances the student's likelihood for success in math" (Miller & Mercer, 1993, p. 81). Researchers Frank and Brown (1992) also encouraged the use of strategies in math instruction. They suggested that by using strategies such as mnemonics, a self-monitoring procedure can be learned that "prompts them to remember how to complete a task" (p.52).

Miller and Mercer (1993) referred to the self monitoring procedures as "advance organizers" (p.81) and state that these should be introduced simultaneously with the mnemonic. Then, the teacher should discuss each step in the mnemonic and demonstrate each step with an example. The teacher must be sure each step is introduced at a level that can be understood by the students for whom they are intended (Frank & Brown, 1992).

Acronym mnemonics, words formed from initial letters of other words, seem to be the most applicable mnemonic for math instruction (Miller & Mercer, 1993). They are most useful when a set of sequential steps, or responses, are required such as solving word problems. Once the procedure is taught using a guide or written

checklist of steps (i.e., the self-monitoring device), the instructor introduces the acronym mnemonic and shows how it is associated with each step of the procedure. When the teacher is satisfied that the students can demonstrate their understanding of the procedure, the students are encouraged to use only the mnemonic to recall the steps, and the checklist is removed (Frank & Brown, 1992).

Teachers are encouraged to modify mnemonics to meet the needs of their students. For some, teachers must keep the vocabulary simple so that the students will understand the steps. For others, the number of steps may also need to be limited (Miller & Mercer, 1993). One special education teacher, Kathleen Snyder (1988), used the acronym mnemonic "RIDGES" (p. 261) in her math classes when instructing her students on solving word problems. Snyder's experience with mnemonic strategies suggests not only the modification of mnemonics from a teacher's standpoint when necessary, but also from a student's. Snyder stated that "when students become proficient with the steps, they should be encouraged to modify the steps to meet their own needs" (p. 263).

Students' Perceptions of Mnemonics

Researchers Scruggs and Mastropieri (1992) conducted a study on using mnemonic instruction in the content area of science. An aspect often overlooked, they specifically focused on "the expressed

opinion of the students for whom the treatment was being evaluated" (p.228). Results of their study yielded evidence that students not only prefer mnemonic instruction to traditional instruction, but also see it as being more effective. Hudson, Lignugaris-Kraft, and Miller (1993), from the Department of Special Education at Utah State University, conducted a similar evaluation in the content areas of science and history. Their findings indicated that when compared to traditional instruction, students with learning disabilities significantly prefer instruction that includes mnemonic devices.

Statement of Purpose

As previously noted, learning disabilities are most often associated with reading problems, thus students with deficits in math are sometimes overlooked (Rothman & Cohen, 1989). The specific opinions of students receiving mnemonic instruction in content areas such as science and history have been researched. After reviewing the current literature, this researcher has identified a lack of studies in the area of mathematics. The purpose of this study, therefore, is to examine students' with learning disabilities perceptions of mnemonic instruction in the content area of mathematics.

Method

Subjects

Subjects for this study were students in an eighth grade self-contained, math class for students with learning disabilities, using mnemonic strategy instruction in the 1998-1999 session at a middle school in a rural county in Virginia. The number of individuals in the sample coincided with enrollment in the fall. The students ranged in age from thirteen to fifteen years, and represented the ethnic and cultural composition of the population in the school division.

Procedure

Permission was obtained from the superintendent of schools in the county and the principal of the middle school prior to conducting the research (See Appendix B and C). Also permission was obtained from the parents or legal guardians of each subject (See Appendix D and E). All participants were told that their participation was voluntary and that they could withdraw from the research without penalty at any time.

Using a direct instructional model, long division and conversion of measurement units (e.g., miles to feet, ounces to quarts, etc.) were introduced to the students. They practiced the new material and then were tested on it. After more practice, all students were retested.

The second phase of instruction incorporated the use of mnemonic strategies when solving the same kinds of problems. The students were taught the mnemonic "MAMA, DADDY, SISTER, BROTHER" to assist them in the order of steps for long division problems. "BIG DADDY, LITTLE MAMA" was the mnemonic used to aid in the conversion of units (See Appendix F). After initial instruction using the mnemonic "helpers", the students were tested. They continued to practice these types of problems, using the new strategies, and they were retested.

Interviews

An interview was conducted to obtain the perceptions of students with learning disabilities who had experienced mnemonic instruction in math class. The students were told in advance about the interviews, and they were held in a private conference room at their school. Each student was interviewed individually and each interview lasted approximately fifteen to thirty minutes. Interviews were taped and later transcribed by the researcher. After transcription, the interviews were verified for accuracy and the tapes were destroyed. Fictional names were assigned to each student to assure confidentiality and anonymity.

Instruments

The researcher constructed a self-made table of questions that was used to obtain the student's perceptions of mnemonic instruction in mathematics (See Appendix G). The questions were pilot tested for clarity and breadth among teaching professionals in the special education field prior to the interviews. Requests by students for clarification of questions were honored. The teacher made tests were derived from different forms of text materials, and verified by a special education professional.

Data Analysis

This was a qualitative as well as a quantitative study. Answers to the questions were analyzed for recurring themes. To verify the reliability of the themes determined by the researcher, two individuals not related to the research were asked to analyze the themes. Interobserver reliability was then computed. In addition, math grades and test scores were reported for each subject, and a Wilcoxin Matched Pairs, Signed Ranks value was computed to determine differences between posttest scores for students for both phases of instruction.

Results

Subjects

Out of ten possible subjects for the study, nine had parental permission to participate. Results from two of the nine subjects were omitted. One subject was a severe diabetic, thus low blood sugars adversely affected his performance. The second subject's results were omitted due to his frequent absences. The seven remaining subjects were willing participants throughout the course of research.

Subject A was a fourteen year old male who had been in special education for five years. He was a self-contained student with learning disabilities whose weaknesses lie in the areas of written language and mathematics.

Subject B was a thirteen year old male who has a learning disability, primarily in mathematics. He has been in the special education setting for four years, but has only been at this school for two of those years. Prior to attending this school, he had a history of absences, but this was no longer an issue.

Subject C, the only female subject, was fifteen years old, and had been in the self-contained setting for six years. This student with learning disabilities had weaknesses in the areas of written language and math. She repeated the first grade.

Subject D, a fourteen year old male, entered school as a preschooler in the developmentally delayed program, and was retained in the first grade. He was a self-contained student with learning disabilities who had received speech/language/hearing services throughout his educational experience. His weaknesses were in all academic areas.

Subject E was a fourteen year old male who entered the special education program in the first grade as a student with emotional disturbances. He was also found eligible for speech/language services at that time. Reevaluation in 1993 found him to be eligible for learning disabled services. He has moderate needs in the areas of reading and written language, which create weaknesses in all academic areas. He was retained in the fifth grade.

Subject F was a thirteen year old male who was beginning his third year in the special education setting. This resource student had weaknesses in math and written language. He also received occupational therapy for handwriting and motor skill weaknesses.

Subject G was a fourteen year old male who is a self-contained student with learning disabilities. He entered as a new student to this school and community in the fall of 1998. This subject entered the special education program in 1995 as a resource student. He was home-schooled two years prior to the 1995 school year. At his last

eligibility, he was found eligible for services in the self-contained setting with a learning disability in the areas of reading and mathematics. Subject G was diagnosed with Attention-Deficit/Hyperactivity Disorder at age five.

Test Scores

During the course of research, the subjects were given four teacher-made tests. The first two tests were given after direct instruction, but prior to mnemonic instruction. Through direct instruction, the subjects were taught the procedures for solving long division as well as those required for conversion of measurement. Test results at this point indicated that only two students were able to remember with 50% accuracy the correct order of steps to follow when solving the problems (See Table 1). After additional practice and retesting, test scores for all subjects ranged from 30% to 90% correct with a mean of 65.7% in phase one (See Table 2).

The second phase of instruction incorporated the use of mnemonic strategies, referred to as "helpers", for remembering sequential steps. Subjects practiced the procedures and were tested again. All of the subjects for this research showed improvement in test results after implementation of mnemonic strategies for remembering procedures (See Table 1). After mnemonic strategy

instruction and practice, final test scores for all subjects ranged from 80% to 100% with a mean of 88.5% (See Table 2).

The Wilcoxin matched-pairs signed-ranks test was used to determine if there was statistically a significant difference at the .05 level between scores on the two posttests involving long division for each student.. The second test of each phase was used for the comparison. This test resulted in an obtained score of 21 using a T test, which was interpreted as having no significant difference at the .05 confidence level (See Table 2). The small sample size may have contributed to these results, as well as the practice of procedure.

Interviews

Interviews were conducted after the course of instruction and testing to obtain the perceptions of students with learning disabilities who had experienced mnemonic instruction in math class. A self-made table of questions was the instrument used for research. Follow up questions were asked to clarify subject's responses. The subjects were aware that the interviews were being tape recorded. After careful transcription and verification for accuracy by the researcher, the audio tapes were destroyed.

Themes

After the interviews were transcribed, the subject's responses were analyzed for recurring themes. Five specific themes were

drawn from similar statements made across the seven subjects. Two professionals, non-related to the research, analyzed the themes and interobserver reliability was computed.

In order for a topic to be considered a theme, at least four of the seven subjects (57%) must have supported the topic with their statements. From a total of fifty-four statements, thirty-eight responses were found that supported the themes. Of the sixteen statements not used to support themes, responses included, for example, "skip it", "I don't know", "I like doing hard problems", and "I just use my head". The majority (n=9) of the responses not used to support a theme were given by Subject G. The five constructed themes and examples of supporting statements follow in the order of frequency of responses.

Theme One: Unfamiliarity of Procedure Leads to Anxiety

This theme was constructed out of statements made by subjects supporting the claim that when they are unaware or unsure of the correct problem solving procedure they become nervous. This theme, comprised of ten statements, was supported by 26.3% of the total statements (See Table 3) and tied with Theme Two for having the most support. Statements representative of this theme included:

- I'm afraid I'll forget the steps.

- Every time I do it, it gives me goose bumps!

- I want to get it right, and I don't like to mess up.

Theme Two: Mnemonics Improves Performance

This theme was the easiest to determine. Besides comprising 26.3% of the total statements, the subjects were observed as most enthusiastic with their responses to this theme (See Table 4). The statements below are a sampling of support for this theme which contained ten statements in all. This theme indicates that students with learning disabilities believe the use of mnemonics improves their math performance among students with learning disabilities.

- Last year I wasn't doing too good, and this year I think I do better.

- I can do a lot faster, and get 100%.

- I feel good about it because it helps me get good grades.

Theme Three: Students Desire More Mnemonic Strategies

This theme was comprised of seven statements, making up 18.4% of the total statements (See Table 5) and represented the subjects' desires to learn additional mnemonic strategies. These desires were made known after the subjects experienced success with mnemonic strategies when doing long division. Examples of responses supporting this theme follow:

- I'd like more "helpers", so I can do math in regular classes.

- want to learn more for harder kinds of problems.

- learn "helpers" for other stuff that's hard to remember.

Theme Four: Division and Other Multi-Step Problems Most Difficult

This theme indicated that students with learning disabilities feel the most difficult math problems are those involving more than one step, particularly long division where three operations and four steps are involved. Six statements were included in this category, and they represented 15.7% of all the statements (See Table 6). Examples of the statements follow:

- division is a problem.

- the hardest part would be division.

- when we started division...I couldn't get into it.

Theme Five: An Increase in Confidence Decreases Anxiety and Increases Self-Esteem

Five of the subjects' responses supported the theme that when they felt confident that they knew the steps required to solve mathematical problems accurately, they were no longer nervous about attempting the problem. These responses indicated that the subjects felt positive about their ability to solve the problems correctly (See Table 7). Statements of this type were supported by 13.1% of the total statements. Examples of these statements

included:

- I don't need the teacher for help.
- It's easier because I know where to put the stuff.

Reliability

Two professionals in the special education field, non-related to the research, were presented the responses in random order. They each assigned the responses to the five categorical themes previously identified by the researcher. Percentages were then established for agreement between the researcher and each professional, and between the two professionals themselves. Reliabilities ranged from 80% to 100% (See Table 8).

Discussion

Previous research (Caine & Caine, 1994) indicated that a reduction in math anxiety yields more successful mathematical problem solving. The results of this research agree and further demonstrate that mnemonic strategies are a successful way to reduce anxiety among students with learning disabilities when doing long division and conversion of measurement units.

Wigfield and Meece (1988) found that the cognitive component of math anxiety is worry. This research shows that worry can be greatly reduced, and often eliminated, by the use of mnemonics. Test results showed an improvement in math performance among all subjects after implementation of mnemonic strategies. This improvement in performance may have increased the self-esteem of the subjects.

Through interviews, the subjects made it known that they were aware of their improvements when using mnemonic strategies. They responded that they felt good about their performance, even prior to being tested, because they were confident when using the new strategies. In addition, they requested more mnemonic strategies for upcoming procedures in their math classes.

This researcher found no inconsistencies with the research literature reviewed; however, she felt there was a need to expand on

student's perceptions of mnemonics to include the area of mathematics. Scruggs and Mastropieri (1992), and Hudson, Lignugaris-Kraft, and Miller (1993) conducted similar studies on student perception of mnemonics strategies in the areas of science and history.

Several limitations in this study should be noted. A random sample was not used because the study was qualitative. The subjects, which were few in number (7), came from only one class, at one school. This reduced the sample size and limited the response rate. Another noted limitation was the use of teacher-made tests. Results from this study should not be generalized to other settings or populations.

This researcher was not surprised by the overall results of the study. Even though Wilcoxin's matched-pairs signed-ranks test showed no significant difference between the pretest (i.e., before mnemonic implementation) and the posttest (i.e., after mnemonic implementation), the actual test scores rose. Of course practice alone could account for the rise in scores, but this researcher was most interested in the students' perceptions of mnemonics. When scores improve, confidence builds, and self-esteem may improve. All of these positive consequences may add to the positive perceptions of using mnemonic strategies.

Recommendations for future research would include a more sophisticated study that would encompass a variety of localities and utilize a larger sample size. Future researchers may also wish to note the perceptions of mnemonics at varying ages and educational levels. In addition, the use of a standardized measurement tool, rather than the teacher-made tests, may produce more generalizable results. For longitudinal research purposes, an interesting study would be to determine what percentage of the current sample continued to use the mnemonic strategies one year and two years after implementation.

References

Algozzine, B., O'Shea, D. J., Crews,W. B., & Stoddard, K. (1987). Analysis of mathematics competence of learning disabled adolescents'. The Journal of Special Education 21 (2), 97-107.

Alley, G., & Deschler, D. (1979). Teaching the learning disabled adolescent: Strategies and methods. Denver, CO: Love.

Baine, D. (1986). Memory and instruction. Englewood Cliffs, NJ: Educational Technology Publications.

Bley, N. S., & Thornton, C. A. (1981). Teaching mathematics to the learning disabled. Rockville, MD : Aspen Systems.

Caine, R. N., & Caine, G. (1994). Making connections: Teaching and the human brain. Menlo Park, CA: Addison-Wesley.

Cawley, J. F., & Parmar, R. S. (1990). Issues in mathematics curriculum for handicapped students. Academic Therapy, 25 (4), 507-521.

Deshler, D. D., & Schumaker, J. B. (1993). Strategy mastery by at-risk students: Not a simple matter. The Elementary School Journal, 94 (2), 153-167.

Deshler, D. D., Schumaker, J. B., & Lenz, B. K. (1984). Academic and cognitive interventions for LD adolescents. Journal of Learning Disabilities 17 (2), 108-115.

Frank, A. R., & Brown, D. (1992). Self-monitoring strategies in arithmetic. Teaching Exceptional Children, 24 (2), 52-53.

Geary, D. C. (1993). Mathematics disabilities: Cognitive, neuropsychological, and genetic components. Psychological Bulletin, 114 (2), 345-362.

Heaton,S., & O'Shea,D. J. (1995). Using mnemonics to make mnemonics. Teaching Exceptional Children, 28 (1), 34-36.

Hudson, P., Lignugaris-Kraft, B., & Miller, T. (1993). Using content enhancement to improve the performance of adolescents with learning disabilities in content classes. Learning Disabilities Research and Practice, 8 (2), 106-126.

Lewis, A. B., & Mayer, R. E. (1987). Students' miscomprehension of relational statements in arithmetic word problems. Journal of Educational Psychology, 79 (4), 363-371.

Lombardi, T. P. (1995). Teachers develop their own learning strategies. Teaching Exceptional Children, 27 (3), 52-55.

Martinez, J. G. R. (1987). Preventing math anxiety: A prescription. Academic Therapy, 23 (2), 117-124.

McCormally, K. (1990). When numbers make you numb. Changing Times, August, 77-80.

Mercer, C. D., & Miller, S. P. (1992). Teaching students with learning problems in math to acquire, understand, and apply basic facts. Remedial and Special Education, 13 (3), 19-35, & 61.

Miller,S. P., & Mercer, C. D. (1993). Mnemonics: Enhancing the math performance of students with learning difficulties. Intervention in School and Clinic, 29 (2), 78-82.

Rosenthal, D. J. A., & Resnick, L. B. (1974). Children's solution processes in arithmetic word problems. Journal of Educational Psychology, 66 (6), 819-825.

Rothman, R. W., & Cohen, J. (1989). The language of math needs to be taught. Academic Therapy, 25 (2), 133-142.

Scruggs, T. E., & Mastropieri, M. A. (1990). Mnemonic instructionfor students with learning disabilities: What it is and what it does. Learning Disability Quarterly, 13 (4), 271-279.

Scruggs, T. E., & Mastropieri, M. A. (1992). Classroom applications of mnemonic instruction: Acquisition, maintenance, and gereralization. Exceptional Children, 58 (3), 219-228.

Scruggs, T. E., & Mastropieri, M. A. (1993). Special education for the twenty-first century: Integrating learning strategies and thinking skills. Journal of Learning Disabilities, 26 (6), 392-398.

Snyder, K. (1988). Ridges: A problem-solving math strategy. Academic Therapy, 23 (3), 261-263.

Swanson, H. L. (1990). Influence of metacognitive knowledge and aptitude on problem solving. Journal of Educational Psychology,2 (2), 306-314.

Swanson, H. L., Christie, L., & Rubadeau, R. J. (1993). The relationship between metacognition and analogical reasoning in mentally retarded, learning disabled, average, and gifted children. Learning Disabilities Research and Practice, 8 (2), 70-81.

Swanson, H. L., & Rhine, B. (1985). Strategy transformations in learning disabled children's math performance: Clues to the development of expertise. Journal of Learning Disabilities, 18 (10), 596-603.

Tobias, S. (1978). Overcoming Math Anxiety. New York: W.W. Norton & Company, Inc.

Wigfield, A., & Meece, J. L. (1988). Math anxiety in elementary and secondary school students. Journal of Educational Psychology, 80 (2), 210-216.

Woodward, J. (1991). Procedural knowledge in mathematics: The role of the curriculum. Journal of Learning Disabilities, 24 (4), 242-250.

Zentall, S. S., & Ferkis, M. A. (1993). Mathematical problem solving for youth with ADHD, with and without learning disabilities. Learning Disability Quarterly, 16, 6-18.

Appendix A

Eight Areas of Mathematics Mastery

Eight Areas of Mathematics Mastery

1. Numbers and numerals
    a. Express a rational number using a decimal notation.
    b. List the first ten multiples of 2 through 12.
    c. Use the whole numbers (four basic operations) in problem solving.
    d. Recognize the digit, its place value, and the number represented through billions.
    e. Describe a given positive rationale number using decimal, percentage, or fractional notation.
2. Operations and properties
    a. Write equivalent fractions for given fractions such as 1/2, 2/3, 3/4, and 7/8.
    b. Use the standard algorithms for the arithmetic operations of positive rational numbers.
    c. Solve addition, subtraction, multiplication, and division problems involving fractions.
    d. Solve problems involving percentages.
    e. Perform arithmetic operations with measures.
    f. Estimate results.
    g. Judge the reasonableness of answers to computation problems.
3. Mathematical sentences
    a. Construct a mathematical sentence from a given verbal problem.
    b. Solve simple equations.
4. Geometry and measurement

a. Recognize horizontal lines, vertical lines, parallel lines, perpendicular lines, and intersecting lines.
b. Recognize different shapes.
c. Compute areas, surfaces volumes, and densities.
d. Understand similarities and congruence.
e. Use measurement devices.

5. Relations and functions
   a. Interpret information from a graphic representation.
   b. Understand and apply ration and proportion.
   c. Construct scales.
6. Probability and statistics
   a. Determine mean, average, mode, and median.
   b. Understand simple probability.
7. Mathematical reasoning
   a. Produce counter examples to test the invalidity of a statement.
   b. Detect and describe flaws and fallacies in advertising and propaganda.
   c. Gather and present data to support an inference or argument.
8. General skills
   a. Maintain personal bank records.
   b. Plan a budget and keep personal records.
   c. Apply a simple interest formula to calculate interest.
   d. Estimate the real cost of an item.

e. Compute taxes and investment returns.

f. Appraise insurance and retirement benefits.

Appendix B

Cover Letter To Administrators

(Principal and School Superintendent)

Address of
Researcher

Address of
the School

Dear Administrator,

My name is Susan C. Moore. In addition to being employed as a middle school special education teacher, I am a graduate student of Longwood College in Farmville, Virginia.

My course work is complete, and I am currently working on my thesis concerning learning disabled student's perceptions of mnemonic instruction in mathematics. I am writing to you requesting to conduct research at your facility. Confidentiality and anonymity will be assured. I am also obtaining consent from the parents of each student who will participate.

The research will be conducted using an interview format, and will last 15-30 minutes. The interview will be audio taped and later transcribed. Fictional names will be used when reporting responses. All materials will be destroyed at the end of the research.

I am thanking you in advance for considering my request.

Sincerely,

Susan C. Moore

Appendix C

Administrator Consent Form

Longwood College
Consent for Participation in
Social and Behavioral Research

I, _____ , consent to the participation of the facility in the research entitled: Students' With Learning Disabilities Perceptions of Mnemonic Strategies in Mathematics Instruction.

I acknowledge that the purpose of this study, the procedures to be followed, and the expected duration of the participation have been explained to me.

I acknowledge that I have had the opportunity to obtain additional information regarding this research project, and that any questions I have raised have been answered to my full satisfaction. Further, I understand that the participation of the facility is voluntary, and is free to withdraw consent at any time and to discontinue participation in this project without prejudice. I understand that no information will be presented to identify the facility unless permission is given in writing.

I understand that if I have any concerns or complaints about the treatment in this study, I am encouraged to contact the Office of Academic Affairs at Longwood College at (804) 395-2010.

Finally, I acknowledge that I have read and fully understand this consent form, and I sign it freely and voluntarily. A copy has been given to me.

Date: _____ Signed: _____
(Administrator from Facility)

Appendix D

Cover Letter to Parent or Legal Guardian

Dear Parent/Legal Guardian,

As you are aware, I am your child's mathematics teacher. In addition to teaching, I am a graduate student working on my Master's of Science degree.

Currently I am working on my thesis concerning learning disabled students' perceptions of mnemonic instruction in math class. I am requesting permission from you for your child's participation in this research.

The research will be conducted using an interview format, and will last no longer than 30 minutes. The interview will be audio taped, and later transcribed, if you agree to the participation. Your child will have the right to refuse to answer any of the questions, and the right to terminate the participation at any time without penalty. Fictional names will be used when reporting the responses, and all materials will be destroyed at the conclusion of the research.

I am thanking you in advance for your consideration concerning my request.

Sincerely,

Susan C. Moore

Appendix E

Parental/Legal Guardian

Consent Form

Longwood College
Consent for Participation in
Social and Behavioral Research

I, _____ , consent to allow my child, _____ , to participate in the research project entitled: Students' With Learning Disabilities Perception of Mnemonic Strategies in Mathematics Instruction.

I acknowledge that the purpose of this study, the procedures to be followed, and the expected duration of my child's participation have been described to me.

I acknowledge that I have had the opportunity to obtain additional information regarding this research project, and that any questions I have raised have been answered to my full satisfaction. Further, I understand that my child's participation in this research is voluntary, and I am free to withdraw consent at any time and to discontinue participation in this project without prejudice. I understand that no information will be presented which will identify my child as the subject of this unless I give permission in writing.

I understand that if I have concerns or complaints about my child's treatment in this study, I am encouraged to contact the Office of Academic Affairs at Longwood College at (804) 395-2010.

Finally, I acknowledge that I have read and fully understand this consent form. I sign it freely and voluntarily. A copy has been given to me.

Date: _____ Signed: _____
(Parent/Legal Guardian)

Appendix F

Mnemonic Strategies

Mnemonic Strategy for Long Division

"Daddy, Mama, Sister, Brother" uses the first letter of each word to instruct the student as to the proper procedure for solving long division. The "D" means to divide; the "M" means to multiply; the "S" means to subtract; and, the "B" means to bring down the next number.

Mnemonic Strategy for Conversion of Measurement Units

"Big Daddy, Little Mama" is used by the students when they are converting units of measurement. If you are changing a small unit to a larger unit, you end with "Big Daddy", and the "D" in "Daddy" clues you to divide. If the unit you are converting is large, and you are changing to a smaller unit, you are ending with "Little Mama". The "M" tells you to multiply.

Appendix G

Table of Questions

Table of Questions

1. Do you enjoy coming to school? Why, or why not?
2. Do you enjoy math class? Why, or why not?
3. What part of math is hardest for you?
4. Do math problems with lots of steps, like long division, make you nervous? Why, or why not?
5. How do you approach math problems that require you to do more than one thing to solve the problem?
6. How do you feel when you are sure you know the steps in order?
7. You have been taught "DADDY, MAMA, SISTER, BROTHER" to help you remember the steps in long division, and "BIG DADDY, LITTLE MAMA" to help you convert units. How do you feel about these "helpers"?
8. Describe how you feel about taking a test when you know you will be able to use "helpers"?
9. Give an example of how you can use the "helpers" on your own, when your teacher is not around to remind you to use them.
10. Do you think the "helpers" have helped to improve your grades? Why, or why not?
11. How long do you think you will remember these "helpers"?

12. Would you like to learn more "helpers" for solving other kinds of math problems? What kinds of problems?

13. If you could choose between learning math with "helpers" and learning math without "helpers", what choice would you make? Why?

Table One

Test Results

Table 1

Test Results

	Results Prior to Instruction of Mnemonic Strategies		Results After Instruction of Mnemonic Strategies	
Subjects	Test #1	Test #2	Test #3	Test #4
A	20%	90%	100%	100%
B	50%	80%	70%	90%
C	10%	80%	60%	80%
D	absent	30%	40%	80%
E	10%	50%	70%	90%
F	50%	70%	80%	100%
G	30%	60%	90%	80%

Table Two

Mean and Standard Deviations

for Posttest Scores

Table 2

Mean and Standard Deviations for Posttest Scores

Group	Number	Mean	S.D.	T
Posttest 1	7	65.7	20.7	21*
Postest 2	7	88.5	8.9	

*p < .05

Table Three

Supporting Statements for

Theme 1: Unfamiliarity of Procedure

Leads to Anxiety

Table 3

Statements Supporting Theme 1: Unfamiliarity of Procedure Leads to Anxiety

- I forget all the steps.
- Skip the problem.
- I want to get it right and I don't like to mess up.
- I only can do what parts I know.
- I'm afraid I'll forget the steps.
- Every time I do it, it gives me goose bumps.
- Sometimes I forget my place.
- I ask the teacher alot.
- I'm not sure...I'm just not sure.
- It takes me awhile to catch on, and I don't finish.

Table Four

Supporting Statements for

Theme 2: Mnemonics Improve Performance

Table 4

Statements Supporting Theme 2: Mnemonics Improve Performance

- I get good grades.
- I feel like I'll get an "A".
- I feel good that I can use them (helpers).
- I remember the order and that stuff.
- I feel okay about tests, now.
- Last year I wasn't doing too good, and this year I think I do better.
- I just write them down and remember the steps.
- It helps me alot.
- I can do alot faster and get 100%.
- I feel good about it because it helps me get good grades.

Table Five

Supporting Statements for

Theme 3: Students Desire More

Mnemonic Strategies

Table 5

Statements Supporting Theme 3: Students Desire More Mnemonic Strategies

- ...want to learn more math with "helpers".
- They help me out a lot.
- ...want to learn more for harder kinds of problems.
- ...like fractions and problem solving "helpers".
- "Helpers" help me learn more.
- I'd like more "helpers" so I can do math in regular classes.
- ...learn "helpers" for other stuff that's hard to remember.

Table Six

Supporting Statements for

Theme 4: Division and Other Multi-Step

Problems are Most Difficult

Table 6

Statements Supporting Theme 4: Division and Other Multi-Step Problems Most Difficult

- Division is a problem.
- ...alot more numbers.
- The hardest part would be division.
- ...um...division.
- I get really confused.
- ...division with steps.
- When we started division, I couldn't get into it.

Table Seven

Supporting Statements for

Theme 5: An Increase in Confidence

Decreases Anxiety and Increases Self-Esteem

Table 7

Statements Supporting Theme 5: An Increase in Confidence Decreases Anxiety and Increases Self-Esteem

- I know them now.
- ...feel good...
- I don't need the teacher for help.
- I do my best.
- It's easier because I know where to put the stuff at...like what comes next.
- ...feel good...

Table Eight

Reliability In

Recurring Themes

Table 8

Reliability In Recurring Themes

Theme	Researcher and First Professional	Researcher and Second Professional	First Professional and Second Professional
1). Unfamiliarity of Procedure Leads to Anxiety	100%	80%	100%
2). Mnemonics Improve Performance	80%	90%	90%
3). Students Desire More Mnemonic Strategies	100%	100%	100%
4). Division; Multi-Step Problems Most Difficult	83%	100%	83%
5). An Increase in Confidence Decreases Anxiety, and Increases Self-esteem	100%	100%	100%
TOTAL	92%	92%	89%