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Helping At-risk Students Solve Mathematical Word Problems Through The Use Of Direct Instruction And Problem Solving Strategies

Lurdes Lopez
University of Central Florida

HELPING AT-RISK STUDENTS SOLVE MATHEMATICAL WORD PROBLEMS THROUGH THE USE OF DIRECT INSTRUCTION AND PROBLEM SOLVING STRATEGIES

by

LURDES LOPEZ
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ABSTRACT

This action research study examined the influence mathematical strategies had on middle school students' mathematical ability. The purpose of this action research study was to observe students mathematical abilities and to investigate whether teaching students problem-solving strategies in mathematics will enhance student's mathematical thinking and their ability to comprehend and solve word problems. The study took place in an urban school in Orlando, Florida in the fall of 2004. The subjects will be 12 eighth grade students assigned to my intensive math class. Quantitative data was collected. Students' took a pre and post test designed to measure and give students practice on mathematical skills. Students worked individually on practice problems, answered questions daily in their problem solving notebook and mathematics journals. Results showed the effectiveness of the use of direct instruction and problem-solving strategies on at-risk students.

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CHAPTER ONE: INTRODUCTION

In today's mathematical classrooms, problem solving has many effects on a student's learning. The National Council of Teachers of Mathematics Standards advocated that problem solving is an integral part of all mathematics learning. For many at-risk students, difficulties in problem solving stemmed from several areas (NCTM, 1989). Normally, the resistance at-risk students had with problem solving came from a language barrier, slow learning pace, attention deficit, retention difficulties, abstract reasoning, visual/auditory-processing or perceptual deficits (Geary, Bow-Thomas, & Yao, 1992 & Bernando, 1999). In order to assist at-risk students in problem solving, educators were cognizant of the differences in a student's mathematical abilities and the difficulties they had with problem solving. This included the gifted child who had special needs for more challenging work. Diezmann, Thornton, and Watters (2003) stated, "To provide worthwhile problem-solving experiences for all students in the classroom, we teachers should pay particular attention to the needs of exceptional students, those with learning difficulties as well as those who are gifted in mathematics" (p.169). Educators identified student's learning characteristics and employed strategies that engaged them in problem solving tasks (O'Malley, Chamot, Manzanares, Kupper, & Russo, 1985a). Identifying learning characteristics and employing strategies are important because they assisted students in gaining command over required skills and are associated with language acquisition (O'Malley et al., 1985a). According to the NCTM (2006), all students needed to build new mathematical knowledge through problem solving, solve problems that arise in mathematics and in other contexts, apply and adapt a variety of appropriate strategies to solve problems and monitor and reflect on the process of mathematical problem solving.

In order to increase mathematical abilities of the at-risk student, educators worked on students' mathematical and reading skills (Chamot & O'Malley, 1994). O'Malley et al., (1985a, 1992) implemented metacognitive, cognitive, social affective and problem-solving strategies as part of their daily lesson activities in order to assist students in solving mathematical word problems (Chamot & O'Malley, 1994). Instruction for at-risk students required mathematics teachers to incorporate reading strategies into the classroom. Chamot & O'Malley (1994) confirmed, "Thus, guidelines must be established that will enable teachers of ESL students to build the necessary language supports for students to be able to understand the language in word problems and begin to use English as a vehicle for communication"(p.234). Jerman and Rees, 1972, Kintch and Greeno, 1985, De Corte and Verschaffel, 1987, Carpenter and Hiebert, 198, and Lewis and Mayer, 1987, focused on difficulties that at-risk students had when solving mathematical word problems. Therefore, in order to assist at-risk students, mathematic teachers needed to be prepared in the content of language arts as well. Moats (1999) stated, "A comprehensive redesign of teacher preparation in reading instruction, founded on a core curriculum that defines the knowledge and skills necessary for effective practice, is vital to improved classroom instruction" (p. 8).

Today, with the No Child Left Behind Act, teachers are required to implement effective research based-practices. The use of effective proven instructional strategies is more important now than ever because educational standards were being raised. In traditional classrooms, many variables played a role in effective teaching. According to Chamot and O'Malley (1994), mathematics teachers had not extended students awareness of mathematical concepts further than simple computation and limited application of formulas and principles. Therefore, educators provided classroom instruction designed to build upon and expand students learning beyond simple computation, formulas and principles. "A call for new standards of student performance and new guidelines for teaching has heavily influenced discussion of the appropriate instructional methods in grade-level mathematics classrooms" (Chamot and O'Malley, 1994, p 222).

Purpose

The purpose of this action research study was to observe students mathematical abilities and to investigate whether teaching students problem-solving strategies in mathematics would affect student's mathematical thinking and their ability to comprehend and solve word problems. In particular, I studied at risk students who received direct instruction and were taught mathematical strategies. Through the use of problem-solving notebooks, math journals and interviews, I collected data on at risk students' mathematical comprehension and problem-solving abilities.

Research Questions

1. How did direct instruction affect at-risk students' mathematical abilities?
2. How did the use of mathematical problem solving strategies (Act it out, Draw a diagram, Draw a picture, Make a chart, graph, or list, Guess and Check, Make it simpler, Use logical reasoning. Work backwards and Find a pattern. Polya's problem-solving steps.) affect at-risk students' problem-solving performance?

3. What were students' attitudes toward mathematics?

Students pre-test, post-test, vocabulary logs, mathematical journals, and problem solving notebook were used to observe, collect, record, analyze and explore how students use problem-solving strategies while solving a word problem. These were used to monitor students reading, mathematical and problems solving skills. These observations allowed me to examine students' knowledge and areas of difficulty in solving mathematical word problems. Student journals were created to record and view how students used problem-solving strategies. Math journals were helpful in making meaningful learning connections in mathematics for my students. Interviews were conducted to assists students who had difficulties while solving mathematics word problems. Students who struggled with reading skills due to language barriers and reading comprehension were interviewed to get a better insight on their mathematical understanding and use of problem-solving strategies. In addition, while conducting the interviews I tried to provide students with reading and mathematical strategies to assists while solving mathematical word problems.

Rationale

For the purpose of the study, the target group population was at a middle school located in Central Florida. The school is an inner-city, Title I school. The school has a bilingual center, which provides services for low-income, predominately Hispanic, Haitian, and African American population. As an instructor for this school, I taught 4 intensive math classes for at-risk students. Participants in the study were students whose' reading and mathematics scores, according to the Florida Comprehensive Assessment Test (FCAT) and Sunshine States Standards (SSS), were below grade level expectations.

The need for effective teaching was increasing in our math classes. Seventy-five percent of the eight grade students in the school obtained scores ranking below grade level expectations according to the FCAT and SSS. In our math and reading classes, I was requested by the principal of the school to use a direct instruction approach to help at-risk students who struggled with mathematical concepts and reading comprehension. In addition, I delivered whole and small group instruction. Direct instruction was delivered using the Saxon Math 8/7, Third Edition by Stephen Hake and John Saxon, an adopted textbook used for intensive math classes. For at-risk students, I used direct instruction because it provided the learner with an organized, well-controlled environment in which the individual needs of each student are met. Moats (1999) stated, "To accommodate children's variability, the teacher must assess children and tailor lessons to individuals. She must interpret errors, give correct feedback, select examples to illustrate concepts, explain new ideas in several ways, and connect linguistic symbols with "real" reading and writing" (p.11). This approach to classroom instruction involved much more than finding and using a collection of fun activities. Direct Instruction required students to deal with problems of reading one at a time. Students read vocabulary words, learned the mathematical meaning of the words and applied a vocabulary word to the correct mathematical content.

In order for students to solve mathematical word problems effectively, they needed to be proficient readers so that they can comprehend word problems. Therefore, I viewed reading as a fundamental skill upon which problem solving abilities depend.

Significance of the Study

According to Lloyd and Keller (1989), when instruction is broken down into small units from complex tasks, the learning becomes accessible for all students. The learning becomes more accessible because teachers will tailor lessons to the individual need of the student. In addition, the learning becomes accessible because the teacher will be able to interpret errors, give corrective feedback, select examples to illustrate concepts, and explain new ideas in several ways. Therefore, students will achieve more at mathematical problem solving (Lloyd and Keller (1989)).

It would be presumptuous to say that at-risk students are not successful at problem solving because students lack conceptual knowledge. In many cases, students are familiar with mathematical vocabulary, but may need assistance with the mathematical process. Likewise, students may not know mathematical strategies and reading techniques that can be used in solving mathematical word problems. Under these circumstances, students have a difficult time with the problem solving process because of the inability to relate and/or transfer relevant knowledge (Borasi, Siegel, Fonzi and Smith (1998)).

For at-risk students, the ability to comprehend a word problem appears when the student is not able to make the mathematical connection (Borasi, Siegel, Fonzi and Smith, 1998). Students deficient in the mathematical content fail at problem solving because they are not equipped with the necessary tools to learn how to solve word problems. Hence, students need math strategies and reading techniques. In order for students to become effective at problem solving, students will need knowledge on the uses of mathematical strategies to strengthen the understanding of numbers. Educators must use multiple strategies. Borasi, Siegel, Fonzi and Smith (1998) avowed, "Because students have such difficulties coping with these texts, research on reading mathematics has concentrated on developing and studying strategies that teach students the 'language of mathematics' and ways to interpret word problems" (p. 276). Educators need to teach students mathematical language skills that include the ability to read with comprehension, to express mathematical thoughts clearly, to reason logically, and to recognize and to employ common patterns of mathematical thoughts. Equipping students with the necessary tools in mathematics requires teachers to empower students with reading and mathematics strategies so that they may be able effective at problem solving. Exposing students to strategies will help them become effective problem-solver.

Knowing that students have difficulties with problem solving due to learning barriers, educators will need to take several steps to address their needs. One of those steps could be helping students use reading strategies in a mathematical classroom. Educators cannot help students to transfer knowledge just lecturing alone. At risk students must take an active role in their own learning. To accomplish this, educators in the field of mathematics need to use lessons that incorporate word problems, in which students would have the opportunity to explore, question, discuss, and discover (Chamot & O'Malley, 1994). Mathematics and reading teachers will need to look at teaching strategies that may assist at-risk students in their learning process.

Assumptions

The assumptions in the study are as follows:

1. The students participating in the study will use problem-solving strategies given prior

and during the lesson.

2. The students will use vocabulary words in mathematical problems that will help them understand what they are being asked to do in order to solve a mathematical word problem.
3. The students participating in the study will provide accurate responses to a pre/post test on mathematical abilities.
4. The student participating in the study will take a supplemental part of the mathematical ability test in which focus on the students' "attitude" toward mathematics.
5. The students' participating in the study were not influenced by my views and opinions and the data examined in the study was not hindered by my views and thoughts.

Limitations

There were several limitations in this study. The first limitation to the study was that one student dropped out due to mobility status. Another limitation was that by the end of the study students' maturity level had changed. In addition, the amount of time during the study (9 weeks) was a limited factor.

Terms

Action Research: Research conducted by teachers to gather information and reflect on their own teaching practices (Mills, 2000).

At-Risk Students: Students who for a variety of factors are likely to drop out of school (Waxman & Padron, 1997).

Bilingual Education (Bilingual Center): The use of two languages for the purpose of academic instruction consisting of an organized curriculum which includes at a minimum; continued primary language (L1) development; English (L2) acquisition; and subject matter instruction through (L1) and (L2). Bilingual education programs assist limited-English proficient (LEP) students in acquiring literacy both in English and primary language development to a level where they can succeed in an English-only classroom. Programs may also include native speakers of English (Empowering ESOL Teacher: An Overview Vol 1).

Direct Instruction: A teaching approach that emphasizes lecture and drilling and is done in a formal setting where the teacher had control of all decisions (Schweinhart and Weikart, 1988).

Education Technologies' (formally National Computer Systems (NCS) Learn – SuccessMarker): A computer base program that uses literature based activities to focus on comprehension, vocabulary, phonics, and writing. In addition, the computer base program focuses on math skills (computational and application strands).

English for Speakers of Other Language (ESOL): Referred to students who are learning English as "English as a second language". Students who are were reared in a home where a language other than English was often used or whose first language was not English and who therefore constitute a minority in a general population relative to native speakers of English (Chamot & O'Malley, 1994, Baker, 2000)

Holistic Scale: An alternative assessment instrument used for large scale assessments emphasizing students' strengths and weaknesses (Retrieved July 4, 2006, from http://intranet.cps.k12.il.us/Assessments/Ideas_and_Rubrics/Rubric_Bank/MathRubrics.pdf). Students strength and weaknesses were categorized using four different names:

Novas: The student doesn't understand enough to get started or make progress, uses inappropriate information, applies inappropriate procedures, uses a representation that gives little or no significant information about the problem, no answer or wrong answer based upon inappropriate plan.

Apprentice: The student understands enough to solve part of the problem or get part of the solution, uses some appropriate information correctly, applies some appropriate procedures, uses a representation that gives some important information about the problem, copying error, computational error, partial answer for problem with multiple answer statement, answer labeled incorrectly.

Practioner: The student understands the problem, uses all appropriate information correctly, applies completely appropriate procedures, and uses a representation that clearly depicts the problem, correct solution.

Expert: The student identifies special factors that influences the approach before starting the problem, explains why certain information is essential to the solution, explains why procedures are appropriate for the problem, uses a representation that is unusual in its mathematical precision, correct solution of problem and made a general rule about solution or extended the solution to more complicated solution.

Learning Strategies (Mathematics and Reading Strategies): A combination of metacognitive, cognitive and social/affective strategies that give students alternative ways to solve specific types of learning activities and task (Chamot & O'Malley, 1994, p. 76-77, 236).

Mathematical abilities: When a student has the ability to demonstrate conceptual and procedural knowledge within a given task (Retrieved June 9, 2006, from http://fcit.usf.edu/math/resource/mathpower/abilit.pdf)

Polya's Problem-Solving Steps: Guided steps use to solve word problems (understand the problem, devise and carry out a plan, and look back or evaluate the solution).

Problem Solving: The process of finding a solution path when the path is not obvious.

Rubric Grading Sheet (Appendix K): In general a rubric is a scoring guide used in subjective assessments. A rubric implies that a rule defining the criteria of an assessment system is followed in evaluation. A rubric can be an explicit description of performance characteristics corresponding to a point on a rating scale. A scoring rubric makes explicit expected qualities of performance on a rating scale or the definition of a single scoring point on a scale Retrieved July 4, 2006, from http://serc.carleton.edu/introgeo/assessment/glossary.html.

Small Group Instruction: A conductive learning environment where a small group of students were given clear and explicit instructional objectives to increase understanding and course content. Students were able to discuss and express questions and concerns on lesson taught.

Traditional Teaching Method: When the educator follows a textbook page by page, addresses the students while standing at the front of the room, writes notes on the board for students to copy and/or practice, asks students questions about class work, and waits for students to finish their work (Stanford, 2003).

Whole Group Instruction: When the whole class is engaged in classroom activities. Students participating by sharing responses and giving ideas in whole classroom group setting.

Summary

In this chapter, I mentioned the need to observe the academic performance of at-risk students' mathematical abilities while problem-solving. It was pointed out that educator's needed to incorporate learning strategies to help at-risk students increase mathematical abilities. The literature review stressed the need to increase mathematical and reading abilities implies that teachers need to implement instructional approaches that will benefit the learning process of at-risk students. The review mentions different factors that have an effect on students' ability to solve word problems and observe math and reading strategies that can assist students with the procedural steps of the word problem. The review will address the mathematical and language arts needs for ESOL students. Chapter three addressed the design of the study, school settings, classroom settings, descriptions of the instruments used, data collections format, nine week procedure of the study, and analysis of data. Chapter four explained my interpretations of the data and how it was triangulated to answer six research questions posed. Chapter five leads us to further research.

CHAPTER TWO: LITERATURE REVIEW

Introduction

In the study of mathematics, students often struggle to comprehend and solve mathematical word problems. According to The State of Mathematics Achievement: NAEP's 1990 Assessment of the Nation and Trial Assessment of the States (NRC), about half of the student populations were graduating from high school with little of the mathematics understanding required by today's high-tech occupations (1991). Graduating twelfth graders appeared to have an understanding of mathematics that does not extend much beyond simple problem solving with whole numbers. In recent years, there has been a substantial amount of attention directed to improving the academic achievement in mathematics of at-risk students. Addressing this problem has become an important educational issue.

In order to battle against a student's inability to solve mathematical word problems, educators have studied at-risk students declining math test scores. Although there are external variables that at-risk students face, internal variables such as poor instructional approaches, no prior schooling, language barriers, and reading and math difficulties, play important roles in the students' mathematical learning process while solving word problems (Bernando, 1999). In hopes of finding a solution to help students' mathematical abilities increase, most research educators examine the classroom strategies that can be used to help this problem. Since 1990 there has been an overall gain across all mathematics achievement levels. NAEP's 2003 findings show that the percentages of eight-graders performing at or above basic, and at or above proficiency level were both higher in 2003 than in all previous assessment years. Embedded within a theoretical framework of mathematical problem-solving, topics were looked into from a review of the literature: teaching at-risk students, factors that influence students' ability to comprehend and solve mathematical word problems, reading strategies and math strategies and the need of second language learners and at-risk students.

The purpose of this literature review provided research to data on direct instructional approach as it is related to teaching at-risk students' in problem solving skills. The literature will discuss factors that influence a student's ability to comprehend and solve mathematical word problems. In addition, the literature will examine mathematics and reading strategies beneficial in helping students solve mathematical word problems. Finally, the literature will discuss the need for English as a Second Language (ESOL) within the school population.

Teaching At- Risk Students

Few educators deal extensively with the instructional specifics needed to improve the quality of instruction for at risk students (Waxman & Padron, 1997). Researchers have discussed many instructional approaches over the past few years to determine if a direct instructional approach is effective in teaching at-risk students. Expository instruction creates a passive for learners who are expected to receive information and reproduce them at some point (Cunningham, 1990).General classroom instruction has been found to be a critical factor in improving the educational outcomes for disadvantage students (Silvernail, 1989). The most common instructional method used in schools for at-risk students is direct instruction (Waxmon and Pardon, 1997). Direct instruction, as defined by Schweinhart and Weikart (1988), is an approach that emphasizes lecture and drilling and is done in a formal setting where the teacher has control of all decisions.

One of the most widely debated controversies in instructional research is discovery (inductive learning) versus expository (deductive learning) instruction.
Several studies have shown that at- risk students perform better when a more direct

expository approach is used (Cunningham, 1990). Discovery learning can be distinguished from expository instruction in the type of learning process. For expository learning learners rely, to a certain extent, on superficial processes' such as reading and memorization. Discovery learning assumes that learners takes an active role and construct their own knowledge base (Cunningham, 1991 & Ferguson-Hessler & de Jong 1990). Since both the expository and the discovery instructional approaches are so polemic across all content areas and all grade levels, the research studies that were found were each performed in a scarcely distinct manner, only differing in the ages of the participants and or the area of academic achievement (Alfano, 1985).

In research done by Alfano (1985), three instructional approaches were used: teacher-directed, computer-assisted, and student-centered. The study measured the accomplishments of low achieving at-risk students. In this study, the participants were taught vocabulary units of instruction by means of these three different instructional methods. The results supported that students taught by the teacher-directed group showed substantially better outcomes than the other two groups. This study conveyed that teacher-directed instruction is more effective than student-centered approaches and computer assisted methods.

A study by Lei and Rachor (2000), analyzed an urban public school. The three year program was evaluated annually. Students in direct instructional schools were matched to students in similar schools on the basis of race, gender, free lunch status and their normal curve equivalent score. The program employed grades 4 and 5 in a three-year direct instructional program. Ninety-three fourth grade students, seventy-one fifth grade students and eighty-one sixth grade students were matched with similar students in control groups. Control groups were taught by other instructional methods. Matching revealed that there was an exact match according to race and gender. In some cases a match between free lunch and reading scores were difficult to match. The purpose of the program was to improve the academic performance of at-risk students. Lei and Rachors' (2000) research examines how direct instruction effected the content areas of language arts and mathematics. The assessments showed that direct instruction improved test scores in both content areas and grade levels. They specify that direct instruction can occasionally stimulate dormant students. They also admonished that direct instruction is not appropriate for all occasions.

Another study done by Brent and DiObilda (1993) analyzed an urban school, located in Camden, New Jersey. The school participated in The Follow Through Program to framework a direct instructional approach. The Follow Through Program is a federally funded program designed to extend the benefits of Head Start in providing education, health and social services to low-income children. The study used two urban schools (K through 5) to participate in the Follow Through Project - one school is an experimental school, the other as a control school. Students took a standardize Comprehensive Test of Basic Skills (CTBS) and the Metropolitan Achievement Test (MAT) to assess the effects of the programs independent of the aligned curriculum. The outcomes showed higher scores for students who participated in the Follow Through Project. In both test students who were taught through a direct approach show greater achievement indicating that the direct-instruction programs are effective as traditional programs. Brent and DiObilda (1993) found, “On mathematics concepts and applications, the stable traditional students scored significantly higher than did the traditional mobile students" (p. 335). The outcomes make evident that direct-instruction programs are more effective than traditional programs that are coordinated with specific normalized tests.

Previous research also revealed that direct instruction is effective in improving academic achievement of at-risk students.

Stabbings, Proper, Anderson, and Cerva (1977), found:

> Groups of disadvantaged children served by Follow Through models that give primary emphasis to basic skills training have tended to score higher on basic skills tests than have groups served by models with other emphasis... (p. xxv).

Direct instruction mathematics focuses on what the teachers can do to maximize the likelihood that students will learn. Therefore, the way in which instruction is delivered is important to the students' learning. The studies of Lloyd and Keller (1989) concluded, " Teach students explicit algorithms for solving problems, makes sure that those algorithms are integrated with related algorithms and that students are taught to use them flexibly" (p. 9). Problem solving requires students to transfer or execute solutions in a successful manner. The order in which information and skills are introduced effects the difficulties students have in problem solving. Direct Instruction provides a comprehensive set of prescriptions for organizing instruction so that students acquire, retain, and generalize new learning in an effective manner.

Factors That Influence Students' Ability to Comprehend and Solve Mathematical Word Problems

Students lack problem-solving skills because they are not aware of the problem solving strategies available to assist them in solving word problems (Chamot & O'Malley, 1994). Additional factors such as word problem components and instruction designs are also important topics for discussion. In order for students to acquire learning gains in mathematics, educators need to study the different aspects that impede students from understanding and solving mathematical word problems.

Mathematical problem solving is an important attribute of a student's mathematical development (Bernando, 1999). In the context of mathematics curriculum, a word problem requires that mathematical skills, concepts, or processes be used to arrive at the intended goal. Disappointingly, most students do not master problem-solving skills (Bernando, 1999). Research shows that students face numerous factors while problem solving. According to Bernardo (1999), various studies have documented how difficulties associated with comprehending the problem text are linked with corresponding difficulties in problem solution. The factors are as follows: influence of general structure features of the problem, semantic structure of the problem, and problem-solving process (Bernando, 1999).

The influences in general structure features include the average word length, number of arithmetic operations, and number of sentences in the problem, average number of words in each sentence and the frequency of nouns, verbs and conjunctions (Jerman & Rees, 1972). A general structure feature is referred to how a word problem is formed. Research shows that while solving word problems, students have difficulties and are not able to comprehend or solve these math problems because problems are too long and or require multiple operations (Jerman & Rees, 1972). Jerman and Rees (1972) found, "... combinations of linguistics features and computational demands accounted for nearly 87% of the variability in problem difficulties for a group of fifth graders" (p. 315). Students have more difficulties while problem solving as the number of words between the numerical features of the problem increases (Kintsh & Greeno, 1985). The likelihood of forgetting the first number before reading the second number also increases (Kintsh

& Greeno, 1985). “At the same time, differences in processing load appear to play a role as well. As the size of the chuncks that must be maintained in the short-term buffer increases and the number of active requests increases, solution probabilities generally decrease” (Kintsh & Greeno, 1985, p. 122). Moreover, most mathematical word problems have too many words that the students do not recognize (Kintsh & Greeno, 1985). Due to the high demand of vocabulary words in a word problem many students will become afraid of reading the word problem. Hence, different structure features will predict problem-solving difficulties and students will not attempt to solve the word problem (Kintsh & Greeno, 1985).

Additionally, the semantic structure of a word problem influences a student’s ability to solve word problems (De Corte and Verschaffel (1987)). The semantic structure of a word problem refers to the meaning of the statements in the problem and their relationships. Students have a hard time at problem solving because the differences in the language (example the word product in math means to multiply as for in language arts in means an item) with which the problems are presented give them very different meanings to students. An example would be the word product. In math the word product means the result of the multiplication of two or more quantity. As opposed to language arts the word product could have various meanings such as, something that arises as the consequence of something else, or the goods or services produced by a company. These differences in meaning can influence how the students interpret and represent the word problems. Furthermore, it influences the student’s conceptual understanding of what is being asked as well as what strategies were used to solve the problem. De Corte and Verschaffel (1987) avowed, “They also showed that children’s strategies for subtraction problems are strongly influenced by the semantic structure underlying them. More specifically, children operating at the material and verbal levels tended to solve each subtraction problem with a strategy that most closely models its semantic structure" (p. 378). Students decision making while solving, involves choices. In all, semantic structure of word problems, in particular the action implied in the problem and the manner in which the problem is presented, has considerable influence on the types of strategies that students use in problem solving (De Corte & Verschaffel, 1987). In support, Carpenter and Hiebert (1981) also acknowledged, "Children may develop single strategies for addition and subtraction and use them in all appropriate problems, or they may match their strategies to a given problem's structure by modeling the implied actions or relationships in the problem" (p. 29).

Likewise, the problem-solving process also has an influence on the student's ability to solve mathematical word problems (Lewis and Mayer, (1987)). The problem-solving process occurs in four stages: problem translation and problem integration (student's representation of the problem), solution planning, and solution execution (specific strategies used in the problem). The manner in which students interpret word problems depends on how well the word problems presented (Lewis and Mayer, 1987). Research shows that the order and manner with which the information is presented can make the problem more or less difficult to comprehend. Lewis and Mayer (1987) found, "First, it was shown that subjects are more likely to miscomprehend a problem and therefore commit a reversal error when the problem is presented in an inconsistent language form" (p. 367). The essential problem-solving process requires students to first acquire the meaning of the problem and implications of the text. Next, the student develops an appropriate representation of the problem. Finally, the student links this representation to the best strategy for solving the problem (Jerman & Rees, 1972, Kintsh & Greeno (1985), De Corte & Verschaffel, (1987), Carpenter & Hiebert (1981)).

Reading Strategies and Math Strategies

In mathematics, reading demands are high. The amount of reading required for students in mathematical word problems can be overwhelming for low achieving, at-risk students (Borasi, Siegel, Fonzi, & Smith, 1998). While solving mathematical word problems, students are required to view written text as a set of small units that become meaningful in combination with one another. The inability to perform such task implies that students not only lack problem-solving skills but reading skills as well (Chamot & O'Malley, 1994). There has been an increasing consensus about reading success and failure. Reviews by Hurford, Darrow, Edwards, Howerton, Mote, Schauf, and Caffey (1994) and Mann (1993) have reported that the presence or absence of phonemic awareness predicts reading proficiency, and separates proficient readers from nonproficient readers. "If young at-risk children can be accurately identified and trained before phonological processing deficits impede their ability to engage in reading acquisition, it may be possible to prevent many of them from experiencing reading failure" (Hurford et al. (1994), p. 648).

Reading researchers such as Maggie Bruck (1992), infer that phonemic awareness involves more than making students self-conscious of the alphabet. Phonemic awareness is the ability to hear and manipulate sounds in words. Inadequate phonological awareness causes the child to be cognizant of the sound chronological succession common to spoken and written words (Bruck, 1992). The word algebraic is one of the many common words students have a difficult time associating the sound of the word to its written format. According to Hurford et al. (1994), children with reading disability have been characterized as having pervasive deficits in phonological processing. By definition, "Phonological processing refers to a cluster of skills, all pertaining to an individual's ability to understand that words contain sounds or phonemes and to use those sounds as linguistic building blocks" (Hurford et al., p. 647). Proficient readers have better skills on phonemes and syllable segmentation than students who lack reading skills. Therefore, non-proficient readers lack the ability to combine individual segments into recognizable words. Poor readers lack explicit awareness of sound segments and difficulties with encoding phonological information.

Similarly, Clay (1993) makes emphasis on how the low progress reader works on a restricted magnitude of strategies.

Clay (1993) stated:

> On the other hand, the low progress reader or reader at risk operates on a narrow range of strategies. He may rely on what he can invent from his memory for the language of the text but pay no attention at all to visual details. He may disregard obvious discrepancies between his response and the words on the page. He may be looking so hard for words he knows and guessing words from first letters that he forgets what the message is about. Unbalanced ways of operating on print can become very resistant to change. This can begin to happen in the first year of formal instruction. (p. 9).

It is evident that one can enhance phonemic awareness skills through the implementation of a dedicated phonemic awareness program. To some degree for some students, this is likely to enhance beginning reading development. However, it is not yet clear what implications the phonemic awareness research has for older children who struggle with reading. For older children, O'Connor, Notary-Syverson, and Vadasy, (1996) affirmed strongly that phonemic awareness is not the appropriate focus, as students are more in need of whole word reading strategies rather than phonemically-based approaches. Students in general kindergarten classes scored above repeating kindergarten students and children with disabilities. General kindergarten students had better receptive vocabulary sound repetition ability (O'Connor et al., 1996).

Another study done by Pratt and Brady (1988) argued that without the induction of the alphabetic principle, the use of a generative strategy capable of decoding novel words would not occur. Pratt and Brady (1988) stated, " that at least 40% of the variance between reading groups at both age levels was accounted by measures involving phoneme manipulation. This strongly suggests that concepts of phonemic awareness are essential to understanding the principle of an alphabetic orthography" (p. 8).

Bruck (1992) also supports the views of Pratt and Brady. Bruck (1992) found dyslexic adult readers, even those with strong orthographic capacities still demonstrate phonemic awareness deficits, and struggle to decode novel words. Bruck (1992) stated, " Finally, both dyslexic children and dyslexic adults do not use orthographic information when performing phonological tasks to the same extent as normal children with equivalent or lower levels of word recognition skill" (p. 9).

The next problem faced by students learning to read is the relation of the next largest unit of language (words) to their meaning (Greenberg, Ehri, & Perin, 1997). Learning the meaning of words is dealt with by teaching what has come to be known as "decoding and encoding" techniques. According to Greenbreg, Ehri, and Perin (1997), the acquisition of decoding skill involves acquiring not just one, but a number of related processes and knowledge sources that readers apply to written words.

Researchers, who argue for the meaning-driven approaches for older students, provide evidence for the location of the fundamental problem areas and support a code-based intervention focus. Shankweiler, L'Undquist, Dreyer, and Dickson (1996) found significant deficiencies across all the groups in decoding. They also noted the differences in comprehension were largely reflecting levels of decoding skill, even among such senior students. On the other hand, Bruck (1992) stated, “Performance on the orthographic items suggests that dyslexics of all ages do not use orthographic information to the same extent as normal readers when performing phonological awareness tasks” (p. 7). Therefore, even adults lack decoding techniques.

The last problem associated with learning to read is more of an interpretive problem, faced by readers of all ages. Learning the relations between sentences is the study of “structural” or “comprehension” instruction. Reviews of early research paid close attention to what is known as metacognition. Metacognition refers to theory and research on learner’s knowledge of and use of their own cognitive resources (Gardner, 1987). Metacomprehension involves the metacognition abilities required for understanding oral and written text (Miller, 1985). Interest in direct teaching metacomprehension skills resulted in a number of studies that involved training normally achieving and above-average students. These studies taught students to monitor comprehension by detecting semantic inconsistencies, which lead to significant results when compared to non-instructed controlled groups (Miller, 1985).

Similarly, Reis and Spekman (1983) successfully taught middle-lower performers to detect semantic inconsistencies. The rationale behind these empirical studies was to find out if students who lack reading comprehension have equal complexities identifying text-based and reader based inconsistencies while reading. Another purpose was to examine the outcomes of direct training of comprehension monitoring on those subjects who established inadequate monitoring skills. According to Reis and Spekman (1983), students who lack comprehension skills will show inadequate monitoring skills despite the types of inconsistency. Subjects who participated in the study were reading at a 4.5 grade level. The results showed the subjects' scores for the reader-based stories were significantly greater than for the text-based stories. Reis and Spekman (1983) stated, "In other words, poor comprehenders appear to evaluate their comprehension from a reader-based perspective, especially when the task requires them to "make sense" of their reading" (p. 58).

An additional meta- analysis study done by Stahl and Fairbanks (1986) also focused on the instructional approaches that would help students' comprehension. The model based meta-analysis studies of Stahl and Fairbanks were done to find out if vocabulary instruction had considerable effect on a child's understanding. The meta-analysis of the vocabulary instructional study conveyed that using vocabulary as a pre-instruction means would help increase reading comprehension and would help look at the components of effective vocabulary instruction.

According to Stahl and Fairbanks (1986), vocabulary teaching methods that present appropriate information and denotative information about a word's meaning or "mixed" methods seem to generate considerably better vocabulary achievement than methods that provide only one type of information. Stahl and Fairbanks (1986) also mentioned that subjects who process information more deeply retain that information better than subjects who engage in more "shallow" processing. Students who explore in dept the meaning of words will use higher order thinking skills more frequently than students who are limited to knowing one meaning of a word. In their study, the results showed that the effective size was .97, meaning that on an average students who received vocabulary instruction scored as well as children who where in controlled groups. Furthermore, subjects who have multiple exposures to different meaningful information about each word, obtain a "decontextualized" knowledge of the word's meaning. Hence, Stahl and Fairbanks (1986) suggest that direct teaching 300 words each year may increase learning from context from 6% to 30%.

Direct teaching of a words meaning can also improve reading comprehension. In a research done by Kameenui, Carine, and Freschi (1982), they presented two experiments involving elementary students and the effects of text construction and instructional approaches for teaching word meaning. One of the main purposes of the study was to investigate whether learning the meaning of words facilitates text comprehension and whether the passage integration vocabulary training strategy is more effective than a vocabulary training that does not include passage integration.

In the study subjects were trained on three out of six vocabulary words at a time. The sequence of procedures consisted of the experimenter and subject repeating to each other the vocabulary word and its meaning. After the vocabulary training was completed, subjects were introduced to vocabulary words from the reading passages. The experimenter stopped periodically to check for comprehension of the word. According to Kameenui et al. (1982), mixed methods that combined additional practices in integrating word meaning into sentence context with synonym/definitional instruction were successful in improving comprehension. Kameenui et al. (1982) concluded, "The results, … suggest that an integration strategy that provides for the rehearsal of vocabulary word meaning during passage reading is a more effective vocabulary training procedure than isolated vocabulary training" (p. 379).

Despite the fact that a number of studies support direct interventions for increasing understanding and vocabulary skills for at risk students, it is known that reading comprehension is a difficult, multifaceted process. The long-term effects of vocabulary limitations of students with diverse learning needs are becoming progressively more noticeable. Learning, as language based activity, is essential and intensely dependent on vocabulary knowledge. With scarce vocabulary knowledge, learners are being requested to develop novel combinations of known concepts with insufficient tools.

Becker (1977) was among the first to emphasize the importance of vocabulary development by relating vocabulary size to the academic achievement of at-risk students. In the field research Becker (1977) talked about the characteristics of the Project Follow Through, examined the significance of teaching reading and language skills to economically at-risk students and asserted that vocabulary deficiency was the primary cause of academic failure of disadvantage students in grades 3 through 12. Becker (1977) mentioned that the project failed because the program was not well designed initially, the instruments used revealed changes caused by maturation rather than school instruction. The project failed to randomly select and assign disadvantage students.

Many comprehension difficulties of diverse learners have been attributed to their deficits in text structure awareness (Englert and Thomas, 1987). According to Englert and Thomas (1987), learning disabled (LD) students who are sensitive to text structure use initial text information to activate text schemata with well-defined slots and nodes. This subsequently serves as a prompt that enables them to fill out the schemata with appropriate details from the text of their own experiences.

The research presented by Englert and Thomas (1987) focused on the diverse skills of learning disable (LD) students and regular class students in differentiating and constructing related details consistent with a given text structure. Elementary and middle grade students were participants in the study. The sample size included 42 LD students, with IQs ranging from 74-150. Students were evaluated on intellectual and academic measures. Groups were created to establish if learning disabled students differed qualitatively from a population of low-achieving pupils, LD students were matched in IQ and reading level to a subset of low-achieving third and sixth-grade regular class students.

Englert and Thomas (1987) determined:

> The question of why LD students performed poorly on the text-structure measures is critical. In explaining the ability-group differences on the reading task, one cannot simply ascribe them to lack of decoding skills since the readability level of the reading test was one year below the younger LD subjects, mean reading level. Besides, the test was read orally to students. Instead, LD students' comprehension difficulties seemed attributable to their failure to apply appropriate metacognitive strategies involving text structure (p. 102).

Another study done by Zabrucky and Ratner (1992) found that poor readers did not differ in the number of times they monitored their comprehension by looking back at sentences for narrative and expository texts. Evaluation and regulation skills are components skills of comprehension monitoring. In the study, Zabruckly and Ratner observed evaluation and regulation skills of 32 sixth grade both proficient and nonproficient readers. Two types of passages were used, narrative and expository texts. On-line measures were used to examine the effects of passage type on comprehension in good and poor readers. In addition, a computer program was used to examine evaluation and regulation skills of understanding.

Reading passages were divided into eight narrative and expository, written on a fourth-grade level. Two individual testing sessions occurred one week apart. Because narrative is easier to comprehend than expository text, Zabrucky and Ratner (1992) concluded that poor readers did not regulate their understanding when reading difficult text. “Although poor readers were less able than good readers to accurately comment on passage consistency following reading, our on-line measure of evaluation revealed that poor readers detected inconsistencies during reading” (Zabrucky and Ratner, 1992, p. 384).

In addition, there was no difference in poor readers and good readers inconsistencies during reading. However, poor readers had more difficulties than good readers in commenting accurately on passage consistency after reading. The studied showed that students were requested to use a verbal report question to examine students' ability to verbally report text inconsistencies about the passage. Poor readers were no different than good readers in reading problematic or inconsistent text. However, poor readers demonstrated significantly less recall than good readers (Zabrucky and Ratner, 1992). Therefore, Zabrucky and Ratner suggest that more research be done.

The Needs of Second Language Learners and At-risk Students

Since 1990, National organizations such as National Council of Teachers of Mathematics (NCTM) began addressing the educational demands for improving educational outcomes for all students. *Curriculum and Evaluation Standard for School Mathematics* is a document provided by NCTM that addresses one component of the mathematics education community's responses to the call for reform. The document *Curriculum and Evaluation Standards for School Mathematics* (1989), record learning to communicate mathematically as one of its five major objectives. The NCTM authors maintain that all students can benefit from listening, reading, writing, speaking and demonstrating activities. For nonnative speakers of English, the NCTM states, "Students whose primary language is not the language of instruction have unique needs. Specially designed activities and teaching strategies (developed with assistance of language specialists) should be incorporated into high school mathematics program in order for all students to have the opportunity to develop their mathematical potential regardless of a lack of proficiency in the language of instruction" (p. 142).

The Mathematical Science Educational Board (MSBN) (1989) reinforced the calling for an approach to education that emphasizes communication for all students, at all school levels. MSEB agrees that students need more communication; recommending that teachers engage students in the construction of mathematical understanding through the use of group work, open discussions, presentation, and verbalization of mathematical ideas. The MSBN advocates the use of non-traditional teaching models, such as paired classes, that have one teacher for language arts and one for mathematics and science. Therefore, language and content-area educators need to work together in order to adhere to the basic English skills or academic language skills that impede the achievement of students.

Within an academic content, this essential ability is scarce because at-risk students are inexperienced with or need an understanding of the lexis and writing techniques particular to a content area. At-risk students may not be ready to execute the higher order language and cognitive tasks required in rigorous academic content courses. This concept can also apply to language minority students who are frequently not proficient in analysis, argumentation, and evaluation.

Due to the opinions of researchers, it is essential that the need for proficiency is inevitable. The need for language of instruction has negative effects on the students' skills to deal with content area texts, word problems, and lectures. Cuevas, (1984), reveals that the language problems that second language learners face in mathematics are as follows: second language learners learn the language from materials and discussions in math classes, the age in which the second language is learned, the rate at which they learn a second language, the amount of exposure to the new language, and the type of language instruction that is provided.

Many researchers, mathematicians and science educators, propose arguments suggesting that math and science language puts apprehension on all students regardless of the language of instruction. Second language learners must have proficient language skills in order to participate effectively in our schools. According to Cummings (1981) as cited in Spanos, Rhodes, Dale and Crandall (1988, p. 221), learning a second language may take years before the second language leaner becomes fully proficient, "there exists a minimal level of linguistic competence – a threshold – that a student must attain to function effectively in cognitively demanding, academic tasks. This threshold of cognitive academic language proficiency (CALP) can take between 5 and 7 years to develop in students' second language" (p. 221).

The ability to read mathematics in a second language is obviously influenced by a variety of language skills. There is, therefore, a need for a mathematics curriculum that includes attention to second-language skills required for achievement in mathematics. Cuevas (1984) mentioned that mathematics curricular need to be revised in order to include the language skills required for second language learners and suggests that educators use Chamot and O'Malleys guidelines as an appropriate way to adhere to the language needs of first and second language learners. Cuevas (1994) stated, "The mathematics teacher becomes not necessarily an English-as-a-second (ESL) teacher, but rather a teacher of the language needed to learn mathematical concepts and skills" (p. 140).

The Cognitive Academic Language Learning Approach (CALLA) as defined by Chamot and O'Malley (1994) is an instructional model that was developed to meet the academic needs of students learning English as a second language in American Schools. CALLA's three main instructional components are to provide language development, explicit instruction in learning strategies and content area instruction for both second language learners and at-risk students. Chamot and O'Malley (1994) stated, "CALLA's focus on cooperative learning and the development of academic language skills for higher-order thinking skills can make a positive contribution to the progress of remedial students" (p. 179).

The major content topics introduced in CALLA are Science, Mathematics, Social Studies and Language Arts. CALLA uses academic language skills such as listening, speaking, reading, and writing as a learning device in the academic subject matter. Students also learn how to analyze, evaluate, justify and persuade effectively in the content area. CALLA also uses learning strategies to present students with alternative ways in which they can choose strategies they have found to be suitable for specific types of learning activities and task.

In their studies, Chamot and O'Malley (1994) proposed three categories of learning strategies: Metacognitive Strategies, Cognitive Strategies and Social/Affective Strategies. As defined by Charmot and O'Malley (1994), Metacognitive strategies are used in planning for learning, self-monitoring, and evaluating how well one has achieved a learning objective. The Metacognitive strategies are as follows: self-management, functional planning, advance organization, directed attention, selective attention, delayed production, self-monitoring and self-evaluation. Cognitive Strategies are used to manipulate the materials to be learned mentally or physically. Cognitive strategies used by students are repetition, translation, deduction, recombination, contextualization, elaboration, and questions for clarification. The cognitive strategies related to classroom activities are resourcing, grouping, note taking, imagery, auditory representation, transfer, and inferencing. Social/Affective strategies is when either interacting with another person in order to assist learning, as in cooperative learning and asking questions for clarification, or using affective control to assist in the learning task. Social/Affective strategies are questioning for clarification, cooperation and self-talk.

According to O'Malley and Chamot (1994), instruction should emphasize mathematical literacy: a communicative approach involving discussion, application, and analysis of alternative paths to problem solution. CALLA for mathematics presents four major goals: learning the value of mathematics, becoming confident in one's own ability, becoming a mathematical problem solver and learning to reason mathematically. CALLA for mathematics uses problem-solving strategies to help second language learners with word meaning and their applications while solving mathematical problems. CALLA instruction for mathematics is derived from four key ideas linking language of word problems and solutions, having mentally active students verbalize the steps to problem solving, and incorporate learning strategies and problem solution steps.

Chamot and O'Malley (1994) support the use of learning strategies in order to help students. They believe that when learning strategies are used students will learn academic language and content more effectively. "Results indicate that instruction in learning strategies is effective in producing increased use of strategies and enhancing learning, and that transfer of strategies can be developed provided that there is ample training for metacognition awareness of task characteristics and demands" (Chamot and O'Malley 1994, p. 59). The learning views of Chamot and O'Malley (1994) advocated that learning strategies make students active learners and better learners, learning strategies can be learned, academic language learning is more effective with learning strategies and learning strategies transfer to new tasks.

Chamot and O'Malley (1994) believed that learning strategies will be used by students in a new task, and transfer will be facilitated with metacognitive training. In the study, *Learning Strategies Used by Beginning and Intermediate ESL Students*, O'Malley et al. used collected small group interviews of 70 high school ESL students from beginning and intermediate levels, and 22 teachers. The 45-minute interviews had nine specific language activities. Seven of the activities were derived from an analysis of typical ESL curricula at the secondary level: pronunciation, oral drills and grammar exercises, vocabulary, following directions, listening for main ideas and facts, inferencing while listening, and making an oral presentation or report. The other two activities involved communication outside the classroom.

Students were asked to describe any learning strategies they used in social interactions outside of the ESL class, and in operational communication, or language used in a functional setting such as work. For ESL beginning level Hispanic students' interviews were conducted in Spanish. The instruments used in the study were Student Interview Guide, Teacher Interview Guide, and Observation Guide. Observations were conducted for one hour in both Language Arts and content area classes. Descriptions of the learning strategies were recorded to assure the accuracy of the classification of the strategy. The results showed that metacognitive and cognitive learning strategies proved useful for the 26 strategies identified in the study. Among the cognitive strategies, attempts to use the classification schemes failed to prove mutually exclusive categories. The study concluded two reasons why the interaction of strategies with learning activities appeared low in frequency. One reason given was that students did not regularly engage in more complex language activities such as social communication or oral classroom presentation. Another reason stated that complex activities required full attention and left little opportunity to reflect on cognitive processes that occur. O'Malley et al. (1985a) proposed,

"Findings from this study suggest that the extension of recent research on learning strategies in second language acquisition is warranted. The validity of learning strategies with second language tasks needs to be established, and the types of students and tasks with whom the strategies are effective need to be identified" (p. 43).

In addition, the study ***Learning and Problem Solving Strategies for ESOL Students,*** emphasized that explicit instruction in a problem solving sequential procedure is effective for second language learners. The instructional model used was the CALLA applied to mathematics. The aim of the study was to view the effectiveness of cognitive instruction in mathematics and the approach to problem solving for second language learners. The objectives of the study were to identify the learning and problem solving strategies used by second language learners in solving mathematical word problems, compare problem-solving approaches by groups who were instructed by teachers who use the CALLA approach versus teachers who use a lesser approach and to describe the differences in strategies.

The study was done in an urban school with a population of 15,500 students. The subjects in the study were 32 low achieving second language learners. The CALLA Mathematics project focused on the importance of providing direct instruction in learning and teaching problem solving procedures. They encourage teachers to use the five problem solving steps based on Poly (Understand the Problem, Find the Needed Data, Make a Plan, Solve the Problem and Check back). Students were requested to describe their thoughts in a think aloud interview. All students were receiving CALLA instruction for a full year. An interview guide was developed to detect uses of problem-solving strategies. The results of the study showed differences by level of implementation and level of students' math ability. Also, significantly more students in high implementation class scored correctly on the problem compared to those in low implementing classes. Students who were rated high in problem-solving ability got the problem right significantly more often than those rated average or low in ability.

O'Malley et al., (1992) stated,

> Although level of implementation did not appear in the total number of problem solving steps mentioned by students, implementation had a significant influence on the sequence in which the problem solving steps were mentioned. Students in high implementation classrooms produced responses with the correct sequence of problem solving steps more often than students in low implementation classrooms. In addition, there were significant differences between the students at the different ability level (p. 16).

In order to reduce the level of stress that students have while solving mathematical word problems, educators need to apply comprehensible instruction in terms which students are able to understand and perform effectively. Furthermore, interaction between Language Arts and content area educators is needed. Content teachers need to employ strategies for increasing teacher-student cooperation in the classroom and emphasize inter-group communication of the concepts. Language Arts teachers need to address content language in their classes. Content and language teachers' joint effort can be advantageous to students. Language Arts teachers can make accessible communicative activities for overcoming linguistic problems. Content teachers can give topics for the language courses that reinforce the content the students face. These joint efforts can help students evolve in language proficiency and concept mastery.

Summary

According to The State of Mathematics Achievement: NAEP's 1990 Assessment of the Nation and Trial Assessment of the States (NRC) students' mathematical performances had declined (1991). This chapter discussed several reasons why students' lack of problem-solving skills in mathematics. It has been suggested that problem-solving approaches can help students' increase mathematical abilities and increase outcomes to mathematical education. Problem-solving approaches focuses on teaching mathematical topics through problem-solving contexts. In order to help students' increase mathematical abilities, teachers needed to apply different instructional approaches to help reach at-risk students. Hence, teachers needed to interact with students, have mathematical dialogue, guide, coach and encourage students to make use of strategies and explain their mathematical reasoning (Lester et al., 1994). Lester et al., 1994, p.154) stated, "helping students construct a deep understanding of mathematical ideas and processes by engaging them in doing mathematics: creating, exploring, testing, and verifying".

In the next chapter the design of the study, school setting, classroom setting, instruments, data collection, procedures and data analysis will be presented and described.

CHAPTER 3: METHODOLOGY

Introduction

This mix-method study took place in an urban school in Orlando, Florida in the fall of 2004. The subjects were twelve-eighth grade students assigned to my intensive math class. The purpose of this study was to examine the influence mathematical strategies had on middle school students' mathematical ability. Students participated in nine weeks of explicit/direct instruction in mathematics. Also, students were instructed based on lessons aligned to the Florida Sunshine State Standards in Mathematics. Students were explained each problem-solving strategy. Student's took a pre-instruction test designed to measure and give students practice on mathematical skills. Students participated in this study by taking a pre-test designed to measure their problem solving abilities. Student's worked individually on practice problems, answered questions daily in their problem solving notebook and mathematics journals and finally took a post-test.

The data collected included a pre-test and post-test on students mathematical ability. Students' pre and post raw scores were use to measure and categorize student's mathematical abilities into five perspectives: vocabulary skills, computational skills, general information, story problems and attitude towards math. In addition a computerized program (Pearson education Technologies – formally NCS) was used as a pre-instructional and post-instructional assessment. Problem-solving journals, math journals and student interviews were used to help and get better insights on students mathematical thinking skills.

Design of the Study

Action Research is research conducted by teachers to gather information and reflect on their own teaching practices (Mills, 2000). I observed how reading and mathematical strategies affected at-risk students increase problem-solving skills. I used a direct instruction approach to help at-risk student and listen to student interviews to get a feel for students' thinking process while solving word problems. Action research is the appropriate research in this study because it allows teachers to share ideas and teaching practices with peers (Mills, 2000). It allows teachers to challenge and explore classroom practices. I used qualitative data to get better insights on students' mathematical thoughts and understanding. The qualitative aspects of this research allowed me to see and interpret things in their natural settings, attempting to make sense of it. Qualitative data are important because they provided important viewpoints, and explanations to students' problem-solving abilities.

In addition, I used quantitative data to establish if any teaching practices affected students' problem-solving abilities. Quantitative researched used numbers to quantify the cause-effect relationship (Mills, 2000). The use of quantitative data was important because it allowed me to see analysis and effective display of both numeric and textual data.

Trustworthiness and creditability were obtained by the use of multiple data sources: Problem-solving journal, math journals, students' interviews, pre and post tests, and students' attitudes. Data sources were triangulated and themes became apparent to students problem-solving abilities.

School Settings

The total student population of the school was over 1,264. The ethnicities of the students' were predominately Hispanic, and Haitian Creole. Included were also

African American, White and Asian. Nearly fifty percent of the students were enrolled in the English as a Second Language (ESOL) program. In addition, 169 students were enrolled in the Exceptional Education (ESE) program and 90 percent of them received free or reduced lunch. The study was conducted in a bilingual center. A bilingual center is a place where students were taught in both languages, primary language (L1) and secondary language (L2), for the purposes of academic instruction consisting of an organized curriculum.

In an effort to improve the students' reading and math skills school wide, the school developed classes to address the academic needs of its students. Students were enrolled in a regular math class and an Enrichment math class or Intensive math class. Mathematics classes were divided into 4 groups: Regular, Intensive, Enrichment and Algebra classes. Language Arts classes were divided into 4 groups: Regular and Advance, Intensive reading and ESOL - low beginners, beginners, intermediate and advanced. Students were assigned to A, B day schedules. On A-days students reported to their regular or enrichment math classes. Students would also report to their Language Arts classes on A-day schedule. On B-days students reported to their Intensive Mathematics and Corrective Reading classes.

Classroom Setting

The study was conducted in my 8th grade Intensive Mathematics class in an urban school in central Florida. This study sample included 12 students from six Intensive Math classes. Student ages ranged from 13-14 years. The students were level one (at-risk) student according to the Florida Comprehension Assessment Test (FCAT) and Norm Reference Test (NRT). The participants were heterogeneously grouped consisting of Haitian Creole, White, Hispanic, African American and Asian both male and female. The study consisted of 1 Asian student, 1 Haitian Creole student, 1 Utopian student, 7 Hispanic students, and 2 African American students. Ten out of twelve students from the study were enrolled in the ESOL program. Students who were assigned to these intensive math classes came from a diverse group of programs such as the English as a Second Language Program (ESOL) and Exceptional Variance Program (ESE). The pupil/teacher ratio for my intensive mathematics class was 25:1. For ESOL, the average class size was 35:1. The average size class for bilingual classes was 30:1. Actual class size of regular mathematics classes was 36:1.

All students were taught using traditional teaching style. A normal day consisted in a teacher lecturing to students in an organized, well-controlled, and simple to assess environment. For example, students were taught using a direct instruction approach. Student used an adoptive textbook called Saxon Math 8/7, Third Edition by Stephen Hake and John Saxon. Students received instruction in a whole group and small group setting. Students were given a pre-test named The Test of Mathematical Abilities, 2nd edition, design to measure students' mathematical abilities. Students' abilities were categorized into five perspectives: vocabulary skills, computational skills, general information, story problems and attitude towards math.

Instruments

Test of Mathematical Abilities

The Test of Mathematical Abilities (TOMA-2) is a test that measures students' mathematical abilities. This test was constructed by Virginia Brown, Mary E. Cronin and Elizabeth McEntire. The test had been peer reviewed in: Impara, J.C., & Plake, B.S. (Eds.) (1998). The thirteenth mental measurements yearbook. Lincoln, NE: Buros Institute of Mental

Measurements. TOMA-2 was used to identify students who are significantly below in mathematical achievement and abilities. TOMA-2 determined students' strength and weaknesses in math. The TOMA-2 has five subtests: vocabulary, computation, general information, and story problems, and one supplemental subtest - attitude towards math).

Vocabulary (VO) - a 25 word subtest that measured how students defined math vocabulary words.

Computation (CO) - a 25 item subtest that measured the ability to solve arithmetic problems.

General Information (GI) – a 30 item questionnaire that measured the students' knowledge of math as used in everyday situation

Story Problems (SP) – 25 problem subtest presented in a story format. As students read they needed to solve the problem.

Attitude Toward Math (AT) – 15 item supplemental subtest that measured students' attitude towards math.

The test was used as a pre and post test assessment during the study.

<u>Education Technologies' (formally NCS Learn - SuccessMaker)</u>

A computer base program that uses literature based activities to focus on comprehension, vocabulary, phonics, and writing. In addition, the computer base program focused on math concepts and skills (computation and application strands). The software offered self-paced preK-8 math. The Intial Placement Motion determined students' learning pace and adjusted instructional difficulties accordingly. SuccessMarker also offered a tutorial intervention and a retention check that varied in instructional strategies and retained acquired skills. The computer program was used daily in class. Students also had the opportunity to use the program during after school activities.

Vocabulary Word Log

A teacher constructed worksheet designed to help students build key skills in phonemic awareness, increase vocabulary skills and improve student's critically thinking skills. The purpose of this vocabulary log was to help students build relevance in word meaning. It was introduced as a writing practice to enhance attention to the vocabulary words in their textbooks. It was also used to activate students' prior knowledge, to encourage students' to use the vocabulary word within correct content and to pose students to think up definition and give examples on their own. Student used the worksheet every time new vocabulary words were introduced. Students were encouraged to use the worksheet as often as needed.

Problem-solving notebooks

A problem-solving journal notebook in which students were encouraged to explore, record, use, practice and identify which problem-solving strategies they needed to use in order to solve the given word problems. Students recorded given word problems based on 6th and 7th grade standards and benchmarks. The follows standards where addressed: Number Sense, Concepts, and Operations, Measurement, Geometry and Spatial Sense, Algebraic Thinking, and Data Analysis and Probability. Each page in the problem-solving journal book had two different sections that needed to be filled in by the students. The problem-solving journal book had a section in which the student placed a check mark under which problem solving strategy they used to solve the word problem. Students showed their work in the space provided in their problem-solving journal.

Mathematical journals daily

A teacher worksheet designed to document students' mathematical thinking and communication skills in mathematics. This worksheet was used so that students could use what they had learned after the lesson had been taught. Mathematical journals provided features that allowed students to solve problems and link written language to numbers, graphs, visual thinking, and written explanation of the solution. Students work samples described which types of problem solving strategy they used in order to solve the mathematical task. Student work samples included a space for students to describe the process they used to solve the word problem, show what they know, clarify their understanding, check their solutions and develop flexible problem solving skills. Students used metacognitive skills to reflect on their learning process. Metacognitive skills were planning a task, monitoring how successfully the task executed and evaluating the success of learning.

Interviews

Interviews were conducted to gain deeper understanding of how each student thinks while problem-solving. Interviews were semi-structured based on how students solved selected problems. Interviews were constructed in a classroom setting. I used a teacher made questionnaire to guide students into solving mathematical word problems.

Methodology

Data Collection

After receiving Internal Review Board (IRB) approval (Appendix A), I contacted the principal of the school where the study took place. After I was granted permission to begin my study, I received permission from a company name Pro-Ed, to use the Test of Mathematical Ability, second edition (1994)-TOMA-2 (Appendix B). At the beginning of the academic year, I piloted a pre-test – (Test of Mathematical Abilities, second edition). After administering the test, I analyzed and recorded the data collected and categorized student's abilities into five perspectives: vocabulary skills (VO), computational skills (CO), general information (GI), story problems (SP) and attitude towards math (AT).

Prior to all instruction, I administered a pre-instruction assessment in order to be familiar with the student's abilities– Pearson Education Technologies' (formally NCS Learn - SuccessMaker). I analyzed, recorded data collected and categorized students' level of mastery for each mathematical and reading skill. I used two different sheets to record areas in which students had difficulties with their mathematical skills and areas for a plan for improvement (Appendix F & G).

For all math classes in the school, direct instruction was delivered. For the purpose of the study, mathematics instruction took place for nine weeks. In addition, I taught students reading components such as the meaning of vocabulary words in the content area, and lexicon components in mathematical sentences. All students participated in mathematics instruction for 50 minutes per day. For all Intensive Math classes teachers used an adopted textbook named Saxon Math 8/7 by Stephen Hake and John Saxon. Throughout the lessons, students were exposed to math problem-solving strategies. These problem-solving strategies were as follows: Act it out, Draw a diagram, Draw a picture, Make a chart, graph, or list, Guess and Check, Make it simpler, Use logical reasoning. Work backwards and Find a pattern. As part of the lesson a vocabulary word log (Appendix E & F) was designed to improve student's critical thinking skills and increase vocabulary skills. I provided the necessary instructional procedures on a daily basis to help students solve mathematical word problems by giving an explicit explanation of each problem-solving strategy in order to expose students to the terminology that was used. Each problem-solving strategy was divided into components, steps, and presented to the students by modeling of the procedure. This same format continued throughout duration of the study.

After a whole group instruction, students worked individually on practice problems. I worked with small groups to reinforce mathematical skills discussed in class. The two main skills in which students had difficulties in were number sense skills and algebraic thinking. In small group, the students were given a word problem. They read, analyzed, and wrote the information given to them in their mathematics journal (Appendix G). Emphasis was placed on the importance of reading the problem carefully to assess whether or not they had enough information to solve the problem. Students were encouraged to use problem-solving strategies to solve the problems. Students were asked to highlight key information in the word problem that would assist them with solving the problem and to write down any words that might hinder their success in solving it.

Students answered questions in their problem-solving journals, and mathematical journals daily. By monitoring students' work, I was able to see how students approach new ideas, and how students connect prior learning to new concepts, describe a problem solving strategy, and justify a method used to solve a problem. I used corrective feedback to assists and guide students in their learning process.

Procedure

Week One: I administered the pretest and gave an orientation of the program. I explained the course of study to the students, emphasizing the use of the vocabulary logs, math journals and problem-solving journals.

A copy of the vocabulary log form was distributed to each student and I explained and discussed the way the form was to be used. In the vocabulary log, seven components needed to be filled out. In the vocabulary log there were four sections in the front and three sections in the back. In the front section, students were instructed to include a list of vocabulary words that where posted on the classroom wall. Another section was dedicated to prior knowledge. The next section included a brief sentence on what they thought the vocabulary word meant after the chapter readings. The last section included the definition for each vocabulary word. On the back of the page, one section was dedicated to giving an example of each vocabulary word.

Next, students were introduced to problem-solving strategies. A brief summary informed students about the importance of using problem-solving strategies.

Students also received a math journal worksheet designed for students practice problem-solving strategies taught in the class and increase critical thinking skills. In the math journal worksheets students were required to answer one word problem and use the problem-solving strategies taught that day in assisting them solve the problem.

Problem-solving journals were issued to students. Students were given two sets of word problems for them to solve. The first set of word problems were based on 6th grade benchmark mathematical skills and the second sets of word problems were based on 7th grade standards and benchmarks (Number Sense, Concepts, and Operations, Measurement, Geometry and Spatial Sense, Algebraic Thinking, and Data Analysis and Probability).

Week Two: Students were introduced to 4 vocabulary words (factors, prime numbers, composite number and prime factorization). Direct instruction was delivered on these 4 words. Students recorded in their vocabulary logs each word and its meaning.

Strategy number one was introduced (Drawing a Picture/Diagram). Students were told benefits of drawing a picture or diagram in order to help solve word problems. The benefits of visualizing a picture or diagram were presented to the students as a way to help them replace numerical and symbolic representation expressions. Students were encouraged to use marks, sticks, figures, circles, triangles, and/or visual representation. Students were encouraged to draw or make a picture when attempting to solve word problems. Students were informed that drawing a picture allows for them to show relations between what is known and unknown about the word problem and helps them visualize different elements of a word problem. Students were informed that labeling their diagrams helps make number sense and solution easier.

During whole group instruction, students were given an example of how drawing a picture and a diagram can help them better understand the skill being taught. For example, I used Venn diagrams to show the relation of prime and composite numbers. Students were given a word problem and were asked to create a Venn diagram to show their answer.

During small group instruction, I worked with students individually. During 15 to 20 minute intervals, I worked with students on Number Sense skills. I gave students corrective feedback on mathematical problems in which they had difficulties. I provided guidance to the problem-solving process that leads them to the solution of the problem. I helped students clarify any misconception they may have had when solving the word problem. Students rotated in groups of 5 to different stations and work on different mathematical skills including using the computer program NCS learning. Data were collected and recorded. Students continued to work individually on their problem-solving notebook and were reminded to use and record problem solving strategies.

Week Three: Students were introduced to three new vocabulary words – multiples, greatest common factor and least common multiples. Direct instruction was delivered on each word. Student recorded in their vocabulary log the meaning of each word.

The second sets of problem-solving strategies were introduced (Guess and Check, and Logical Reasoning). Guess and Check and logical reasoning are when a student provided an answer to a problem and checks to see if the answer is the solution to the problem. Students were informed that guess and check is used the most in solving mathematical word problems Lester et. al. (1994) Students were encouraged to try each solution until they found something that worked for them. Students were informed that "Guess and Check", allows them to make mistakes and learn from their experiences. Students learn from their previous experiences by looking at what problem-solving steps were correct or helped them get close to the solution. Prior attempts would give the students clues to help them arrive at the answer to the word problem. Students were informed that if one solution did not work, try another one. Students were advised to make inferences about the strategy the needed to use.

During whole group instruction, students were given an example of how guessing and check works. I used a jar full of M&M's and had students guess how many M&M's were in the jar. Students needed to complete the sentence "My estimate for M&M's is __________. If the count were incorrect students would change their answer and try again. As part of the main lesson students were to count all the M&M's separately by color and find the least common multiple and greatest common factor. Next, students were given a different word problem and asked to complete a number puzzle using guess and check. The number puzzle was composed eight circles in which students needed to put the numbers 0 through 8 in each of the circles. The goal of the puzzle was for students to achieve the sum of 12 points across and down on the puzzle board. Students recorded their answers in their mathematical journals.

During small group instruction, I worked with students once again using guess and check and a problem solving strategy. Although these problems did not relate to the vocabulary of the day, students were encouraged to work on these problems as reinforcement to prior lessons taught. I introduced the algebraic concept of solving a two-step equation using guess and check. Students were asked to solve for the algebraic equation $3x + 2y = 10$ by guessing what was the value of the two unknown variables. They checked to see if their answer/guess was correct. When using NCS Learn we focused on Number Sense skills that were reported to be in delayed presentation (mathematical skills that students had difficulties on in their previous computer sessions). Finally, students worked on their problem-solving notebooks and were given reinforcement on previous problem-solving strategies through the use of an additional word problem.

<u>Week Four</u>: Students were presented with four new vocabulary words (fraction, decimals, percents, ratio and proportions). Direct instruction was delivered on each word. Student recorded in their vocabulary log the meaning of each word.

The third problem-solving strategy was presented (Make a Table and/or Graph). Students were informed that making a table or graph would help them organize data into display. Students were also taught that in problem-solving concepts and skills, table and graphs would help them to collect, analyze, display data and interpret information from problems. Students were instructed to use tables and graphs to record data so that they could remember what they had done and look for patterns and relationships.

During whole group instruction, students were given an example on how making a table and/or graph works. I used another jar full of M&M's and had students tell me how I could represent the number of M&M's in a table. Students' responses included making columns and rows and recording M&M's by colors and by the total amount of M&M's per color. I proceeded in instructing the students on how to make fractions decimals and percents out of the M & M's results. Next, students were given a different word problem and asked to create a table and record all the possible combinations in which they could make 17 cents with pennies, nickels and dimes. Students recorded their answers in their mathematical journals.

During small group instruction, I worked with students once again using tables and graph. Students were given items from a cereal box and were requested to create a mini foldable on fractions, decimals and percents. I continued to use NCS Learn – SuccessMaker. When using NCS Learn we focused on Number Sense skills that were reported to be in delayed presentation. Delayed presentation was referred to computerized stored information that kept individualized student performances that were below a seventy percent. The stored information allowed me to view students who had performed below a seventy percent on a specific skill. Students worked on their problem-solving journals and reinforcement on previous problem-solving strategies was made.

Week Five: Students were presented with three new vocabulary words (perimeter, area, total surface area and volume). Direct instruction was delivered on each word. Student recorded in their vocabulary log the meaning of each word.

The fourth problem-solving strategy was introduced (Make It Simpler). Students were informed that when problems are complex or contain numbers that seem overwhelming, taking a problem and breaking it into parts or solving similar problems with smaller numbers, would give them a place to start. Students were informed that when actual numbers are too cumbersome, smaller numbers could be substituted.

During whole group instruction, students were given an example of how making a word problem simpler works. I presented a word problem in which students needed to calculate the perimeter, area, total surface area and volume of the classroom). I demonstrated how the room was too large and complicated for us to find each of these results. I continued by showing the students that if I used a model that was smaller in size, it would help us arrive at an answer without becoming overwhelmed. I took a cereal box, cut the sides and placed it flat on a surface. As a group we measured each of the sides and calculated the perimeter, area, total surface area and volume of our figure. Students were given a similar task of finding the perimeter, area, and total surface area of the school building. Students were requested to use a simpler model to represent how they arrived at their answer. Students used 3D model blocks, and geometric model blocks to infer appropriate size of the school. Students used a printed scale model map of school to help them appropriately size the model.

Students recorded their answers in their mathematical journals.

During small group instruction, I worked with students once again using "Making It Simpler". Students were given a floor plan of a house. Students were requested to create a mini foldable representing the perimeter, area, and total surface area. I continued to use NCS Learn – SuccessMaker with the students. When using NCS Learn we focused on Algebra skills that were reported to be in delayed presentation. Students worked on their problem-solving journals and reinforcement on previous problem-solving strategies was made.

Week 6-7: Students were presented with three new vocabulary words (integers, rational number and irrational numbers). Direct instruction was delivered on each word. Student recorded in their vocabulary log the meaning of each word.

The fifth problem-solving strategy was introduced (Using Several Strategies). Students were encouraged to use several strategies in solving a problem. Students were informed that when problem solving, unexpected things may occur. Combining strategies were helpful because they provided several alternatives in solving long word problems. The use of multiple strategies showed all possible combinations. Students were instructed that combination of model a drawing and/or diagram helped them show all possible combination. How? The combination of strategies helped students show the problems-solving process through pictures first and then these pictures changed to represent numerical answers.

During whole group instruction, students were given an example of how the use of several strategies would work. I presented a word problem in which students needed to explore the patterns in Pascal's Triangle. Students were requested to guess what numbers were in each row. I demonstrated each row and students explained their thinking. Students were asked if they had seen a pattern in the sum of each row. Students saw how the Pascal's Triangle let us use number pictures to illustrate patterns. Students learned how a Pascal's Triangle who is a triangle made of numbers represented patterns of numbers. Students were given a word problem on making ice cream combinations. Students needed to show all possible combinations using different strategies. Students recorded their answers in their mathematical journals.

During small group instruction, I continued to use NCS Learn – SuccessMaker with the students. When using NCS Learn we focused on Number Sense, Algebra and Probability skills that were reported to be in delayed presentation. Students worked on their problem-solving journals and reinforcement on previous problem-solving strategies was made.

Week 8-9: Students were presented with seven new vocabulary words (coefficient, variables, algebraic expression, algebraic equation, one-step equations, two-step equations and inequalities). Direct instruction was delivered on each word. Student recorded in their vocabulary log the meaning of each word.

During the last two weeks students were exposed to the four Polya's Problem-Solving Steps (understand the problem, devise and carry out a plan, and look back or evaluate the solution). Students were informed that word problems may not have a solution or a previously known strategy. Therefore, students were given 6-steps (Identify the problem or question, propose a solution, organize an experiment or observation, gather data and analyze them and interpret and evaluate the solution) to follow while problem solving in mathematics. Interviews were done to help students use Poly's Problem-Solving Steps. I conducted interviews with individual students to gain a deeper understanding of how they thought while problem solving. Interviews (Appendix H) were semi-structured based on how students solved selected problems. These interviews were audio taped.

At the conclusion of the nine weeks, I re-administered the post assessment (Test of Mathematical Ability-second edition) in order to compare if students' problem solving ability levels had changed.

During small group instruction, I continued to use NCS Learn – SuccessMaker with the students. When using NCS Learn we focused on making bar, line, circle, box-and-whisker graphs and histograms. Students' skills that were reported to be in delayed presentation.

Students worked on their problem-solving notebooks and reinforcement on previous problem-solving strategies was made.

Data Analysis

In the beginning of my study a pre-test of mathematical abilities was administered to my students. The test included four different subtests: vocabulary, computational skills, general information and story problem. Raw Scores were collected and recorded (Table 7). Student's mathematical ability skills were calculated and recorded (Table 1). In addition, a supplemental part of the test consisted of a student attitude survey. Raw Scores were collected and recorded (Table 2). I used journal entries (Appendix G), and interviews to collect data. These were used to monitor students reading, mathematics and problems solving strategies. These entries allowed me to examine students' knowledge and difficulties while solving mathematical word problems. Student problem-solving journals were analyzed to see whether problem-solving strategies were helpful in making meaningful learning connections in math for my students. Problem-solving journal reports are shown in Table 2. Students received explicit/direct instruction on reading and mathematical skills. Additionally, I used NCS-Learn a computer program that helps students work on reading and mathematical skills, to track, monitor and guide students in area of difficulties (Appendix C & D). Scores were obtained to compare and analyze students' increases in mathematical ability while problem solving. Interviews were used to guide and assists students who had difficulties while solving mathematics word problems. While conducting the interviews I provided students with problem solving strategies to assists them while solving mathematical word problems. Interviews were also used to get a better insight on students' mathematical understanding.

By observing students' pre and post test scores, analyzing problem-solving journals and math journals, and listening to student journals, I examined the data to notice that as the study developed students' problem-solving skills were affected by the use direct instruction. In this study, one of main goals was to help determine if direct instruction helped at-risk students' increase mathematical understanding. Another goal was to help determine if the use of reading, and problem-solving strategies helped students increase mathematical abilities. Student interviews revealed how students' confidence in problem-solving increased when using reading and mathematical strategies.

Chapter three outlined the designed of the study. Analyzed data from the study are discussed in chapter four.

CHAPTER 4: DATA ANALYSIS

The purpose of this action research study was to observe twelve students' mathematical abilities and to investigate whether teaching students problem-solving strategies in mathematics enhanced students' mathematical thinking and their ability to comprehend and solve word problems. Six research questions were invested in this study:

1. How did direct instruction affect at-risk students' mathematical abilities?
2. How did the use of mathematical problem solving strategies (Act it out, Draw a diagram, Draw a picture, Make a chart, graph, or list, Guess and Check, Make it simpler, Use logical reasoning. Work backwards and Find a pattern. Polya's) affect at-risk students' problem-solving performance?
3. What were students' attitudes toward mathematics?

In the beginning of my study a pre-test on mathematical abilities (Test of Mathematical Abilities) was administered to my students. The test included four different subtests: vocabulary, computational skills, general information and story problem. In addition, a supplemental part of the test consisted of a student attitude survey. I used students' pre and post test scores to collect data. In addition I used a computer-based program (National Computer Systems (NCS) Learn to record and collect data. Journal entries, and interviews were used to monitor students reading, mathematics and problem solving strategies. These entries allowed me to examine students' knowledge and difficulties while solving mathematical word problems. Student journals were analyzed to see whether problem-solving strategies were helpful in making meaningful learning connections in math. Interviews were used to guide and assists students who had difficulties while solving word problems. While conducting the interviews, I tried to provide students with positive feedback and encourage students to use problem solving strategies to assists them while solving word problems. Interviews were also used to get additional insights on students' mathematical understanding.

Research question #1 used one data sources: Pre and Post Math Quotient Scores.

Students Mathematical Abilities Score

Research Question #1: How did direct instruction affect at-risk students' mathematical abilities?

Data Source 1: The Test of Mathematical Ability -TOMA-2 (1994) Pre and Post Test Scores:

The TOMA-2 subtest was administered to students prior to math instruction to assess if students' mathematical skills in vocabulary, computational skills, general information and story problem would increase. In order to document change in mathematical skills a Math Quotient was calculated. Pre and Post math quotient scores were derived by calculating standard scores of each subtest. Standard scores of each subtest were compared to standard scores provided by the TOMA-2 test booklet (Normative Conversion Tables-pg 44-49). The standard scores for each subtest were then added altogether and compared to standard scores provided by the TOMA-2 test booklet (Normative Conversion Tables – pg 50). The sum of all 4 subtest provided math quotient scores. Results are shown in Table 1.

Table 1: Math Quotient (MQ)

	Math Quotient (MQ)	
	Pre-Test	Post-Test
Domingo	100	128
Minerva	100	132
Patricia	100	112
Dulce	100	117
Jenny	85	100
Evelyn	78	85
Idalgisa	77	87
Dorcas	72	97
Luis	70	93
Carmen	78	98
Ruthy	83	98
Madelyn	100	115

The Math Quotient (MQ) provides a general index of he student's overall math abilities and permits meaningful comparison with other measures that also yield global scores on the same scale. The scale used in this case ranges from 1-200 and has a mean of 100 and a standard deviation of 15. Scores on this scale are classified according to the following descriptors provided by the TOMA-2 booklet (pg 18):

Quotients	**Descriptive Ratings**
+130	Very Superior
121-130	Superior
111-120	Above Average
90-110	Average
80-89	Below Average
70-79	Poor
Below 70	Very Poor

Pre-test scores showed that forty-two percent (5/12) of the students rated average on their mathematical abilities. Seventeen percent (2/12) of the students rated below average. Disappointedly, forty-two percent (5/12) of the students rated poor on their mathematical abilities. This meant that a total of fifty-nine percent of the participants in the study needed some type of remedial help and lacked mathematical abilities in all subtest areas. According to TOMA-2, students who score low generally are students who are "impaired intellectually" meaning students who are second language learners (ESOL students), students who come from backgrounds that lack sufficient academic stimulation in the home, who lack motivation, who are poorly taught, and/or who have learning disabilities (Brown, Cronin, & McEntire, (1994). All these factors contributed to the fact that proper care academically needed to happen and quick. Therefore, in order to provide proper care for my students' individualized learning needed to occur in order to address their academic needs.

Post-test scores showed that one percent (1/12) of the students rated very superior, and one percent (1/12) of the students rated superior. Twenty-five percent (3/12) of the students rated above average. Forty-two percent (5/12) of the students rated average. Seventeen percent (2/12) of the students rated below average. One student was dropped from the study due to mobility. These post-test scores revealed that over ½ of the students had increase in mathematical abilities. The increase was a major increase in the rating scales of poor to average. This increase meant that students were demonstrating mastery in vocabulary meaning, computational skills, general information about math, and/or story problems. Overall, students' scores were increasing gradually and steadily. Graph 1 and 2 illustrate the increase in scores. The graph shows how forty-two percent of the students who scored poor on the pre-test where now in other ratings. This meant that students were either in a higher rating such as below average or higher.

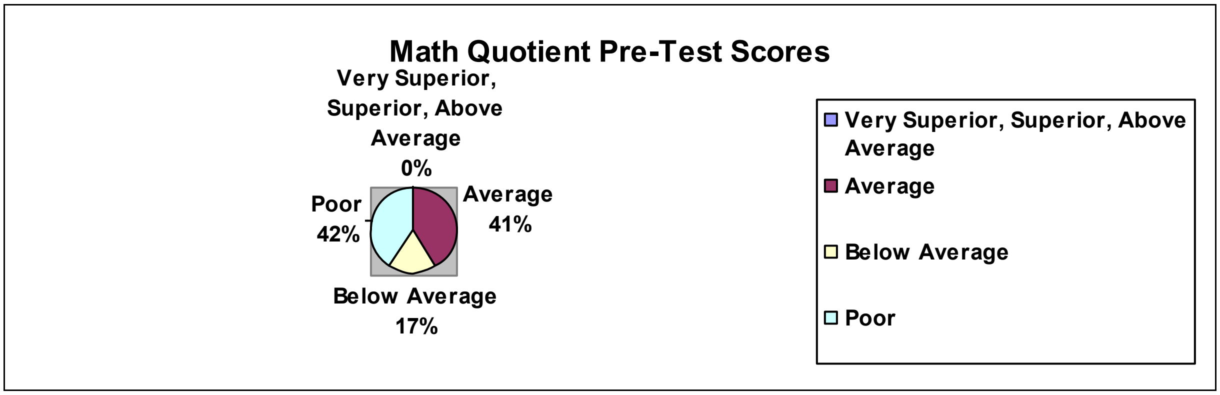


Figure 1: Math Quotient Pre-Test Score

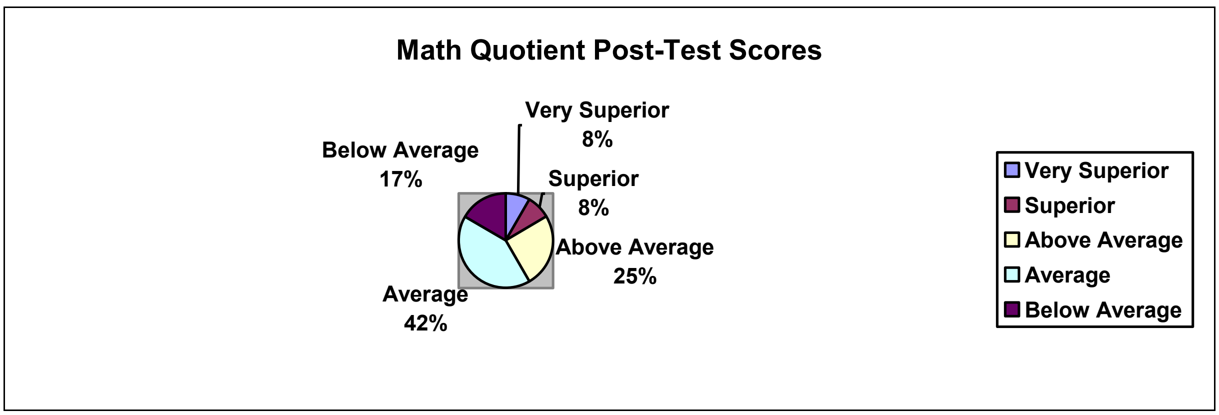


Figure 2: Math Quotient Post-Test Score

Research questions #2 used three data source: Math Journals, Problem-solving Journals and Student interviews

Students Problem-solving performance

Research Question #2: How did the use of mathematical problem solving strategies (Act it out, Draw a diagram, Draw a picture, Make a chart, graph, or list, Guess and Check, Make it simpler, Use logical reasoning, Work backwards, Find a pattern and Polya's problem-solving steps) affect at-risk students' problem-solving performance?

Data Source 1: Math Journals:

Math Journals were use to monitor students use of problem-solving strategies. A holistic scale was used to evaluate students' math journals (Appendix I). Math journals were scored based on students mathematical, strategic, and communication knowledge. During the first 5 weeks of the study, students' math journals revealed that students barely understood the problems-solving task at hand and used problem-solving strategies ineffectively. Twenty-five percent (3/12) of the students scored a 4 on the holistic scale. Thirty-three (4/12) scored a 3 on the holistic scale and fifty percent (6/12) scored a 2 on the holistic scale. In general, eighty-three percent of the students scored on or below average on their math journals. Students' mathematical knowledge showed nearly completed understanding of the problem's concepts and principles, and computations were generally correct but may contain minor errors. Students' strategic knowledge revealed that students used relevant information of a formal or informal nature, identified important elements of problems and showed general understanding, gave clear evidence of a solution process and solutions processed were completed or nearly completed. Students' communication skills showed fairly completed responses with reasonable explanations, used appropriate strategies, presented arguments with logical sound but minor errors.

Immediate remedial intervention was used. More direct instruction was delivered to help students use problem-solving strategies effectively. Students who showed difficulties in their mathematical, strategic and communication skills were given in depth instructions about the goals and purpose for these math journals. Students were instructed to clarify their thinking process and present thoughts and ideas more clearly. At the end of the study, I evaluated the ending 5 journals. Student scores revealed that thirty-three percent (4/12) of the students scored a 5 on the holistic scale. Forty-two percent (5/12) of the students scored a 4, and twenty-five percent (3/12) of the students scored a 3 on the holistic scale.

Overall, students' scores revealed an increase in the correct use of reading and math strategies. By the end of the study, all students were on or above average on the holistic scale. This increase revealed that students performed mathematical, strategic and communication knowledge effectively. Students gave clear insights and to their understanding, gave organized thoughts, new ideas and constructed mathematics for themselves.

Data source #2: Problem Solving Journals:

Throughout the study students used problem-solving journals to practice and apply reading and math strategies. While using their problem-solving journals students were encouraged to highlight keywords, identify and use problem-solving strategies learned throughout the study. I recorded and noted several student practices that influenced students' mathematical abilities to comprehend and solve word problems. Problem solving journals were examined thoroughly, and questioned to discover features or meaning to problem solving solutions.

While grading and analyzing students journals, I notice that students applied strategies incorrectly. For example, I encouraged students to highlight key words. For students, high lighting key words was misleading. Students' problem–solving journals reflected how the students ignored the context of the whole problem when they highlighted the whole word problem. Students did not use the strategy carefully and needed me to reinforce the key concepts of what items needed to be highlighted. Figure 3 illustrates students work.

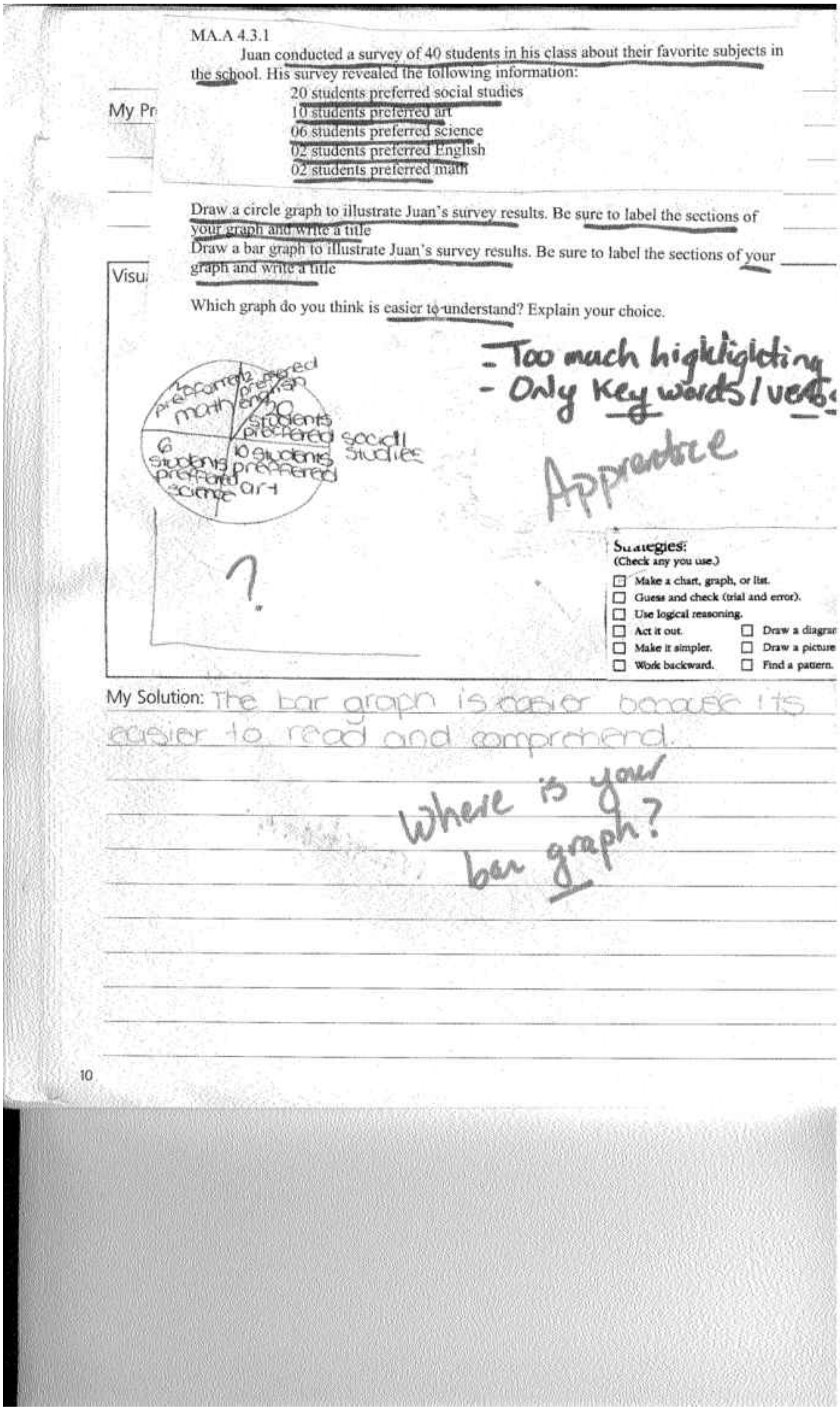
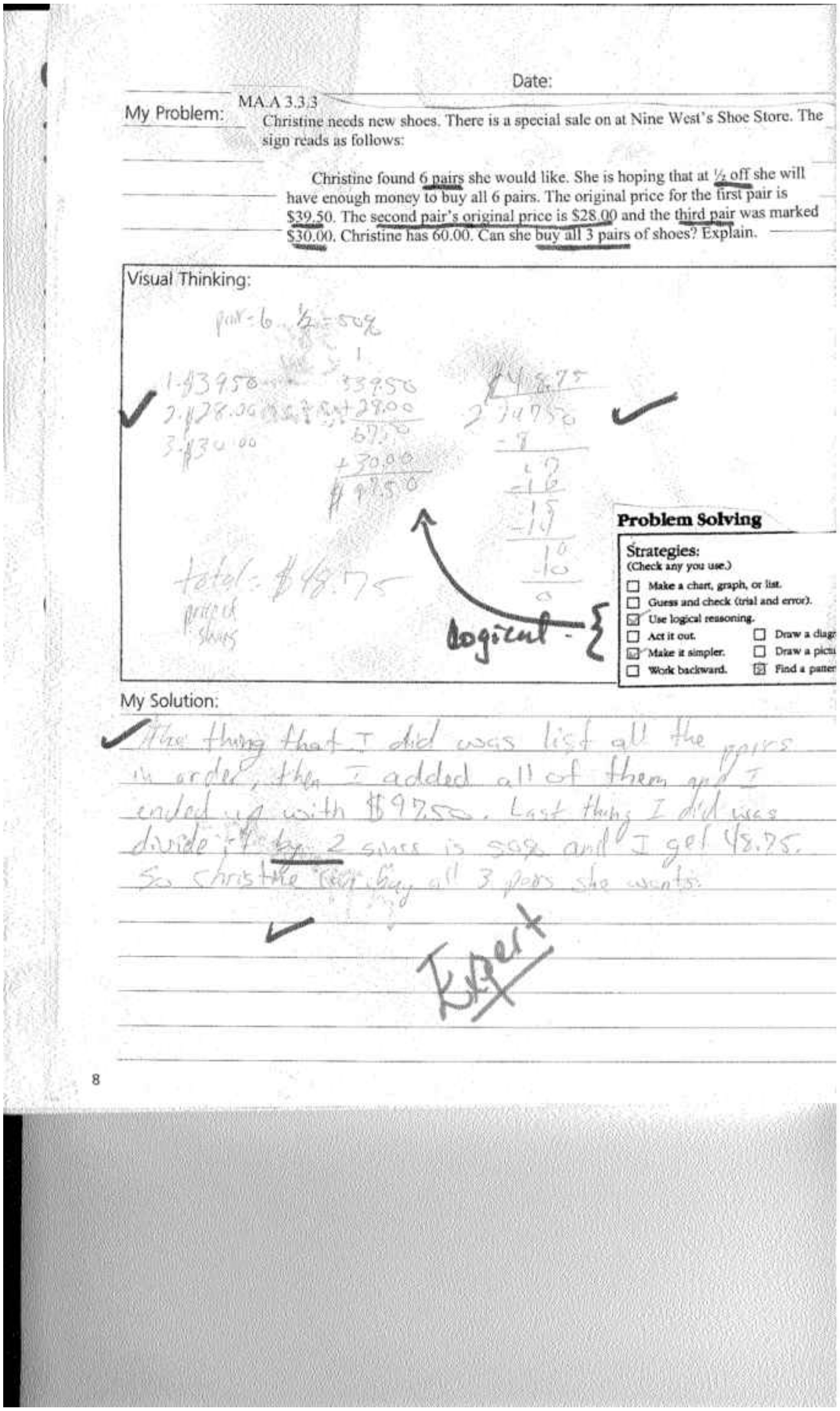


Figure 3: Students Misconceptions about Highlighting Key Words

In order to address students' misconceptions about highlighting key word, I encouraged students to be more detailed by only selecting action verbs and key math terms such as vocabulary words. As students completed their journals a positive outcome was seen. As I graded their journals, I viewed that students continued to use the strategy correctly. Students concentrate on key objects of the word problem and remained focused on the conceptual information that the word problem presented. Figure 3 and 4 illustrates such findings.



Date:

My Problem: MA.A.3.3.3

Christine needs new shoes. There is a special sale on at Nine West's Shoe Store. The sign reads as follows:

Christine found 6 pairs she would like. She is hoping that at ½ off she will have enough money to buy all 6 pairs. The original price for the first pair is \$39.50. The second pair's original price is \$28.00 and the third pair was marked \$30.00. Christine has 60.00. Can she buy all 3 pairs of shoes? Explain.

Visual Thinking:

pair - 6 ½ = 50%

1 - \$39.50 — \$39.50
2 - \$28.00 — + 28.00
3 - \$30.00 — 67.50
+ 30.00
\$97.50

\$48.75
2) 97.50

total = \$48.75 priced shoes

logical

Problem Solving

Strategies:
(Check any you use.)

- ☐ Make a chart, graph, or list.
- ☐ Guess and check (trial and error).
- ☑ Use logical reasoning.
- ☐ Act it out.
- ☐ Draw a diagr
- ☑ Make it simpler.
- ☐ Draw a pictu
- ☐ Work backward.
- ☑ Find a patter

My Solution:

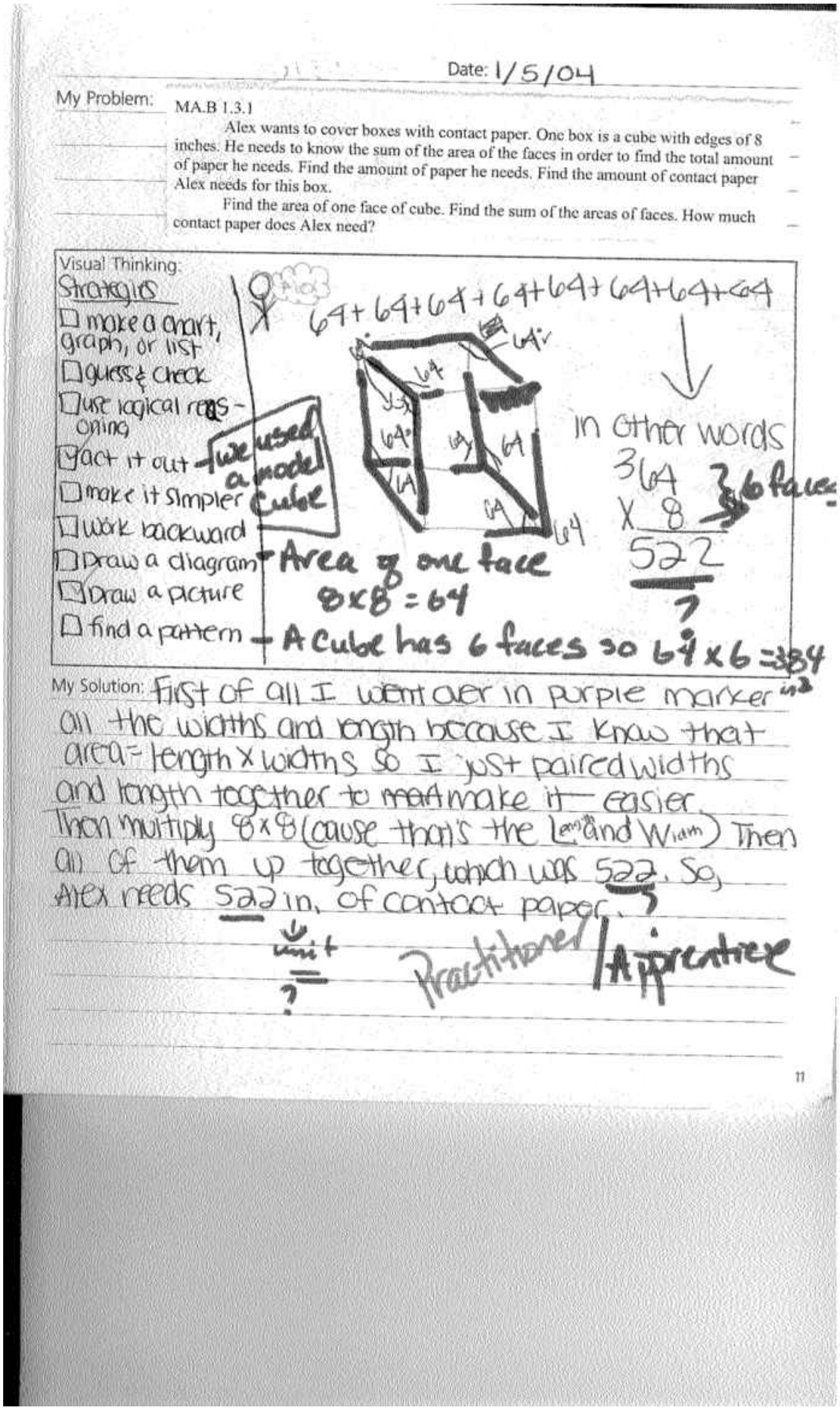
The thing that I did was list all the pairs in order, then I added all of them and I ended up with \$97.50. Last thing I did was divide it by 2 since is 50% and I get 48.75. So christine can buy all 3 pairs she wants.

Expert

8

Figure 4: Students Misconceptions about Highlighting Key Words

Figure 5 shows how the student understood the word problem and was familiar with the task at hand. Student showed a minor error in determining the total area. Student wrote down that the cube had 8 faces instead of 6 faces.


Date: 1/5/04

My Problem: MA.B 1.3.1

Alex wants to cover boxes with contact paper. One box is a cube with edges of 8 inches. He needs to know the sum of the area of the faces in order to find the total amount of paper he needs. Find the amount of paper he needs. Find the amount of contact paper Alex needs for this box.

Find the area of one face of cube. Find the sum of the areas of faces. How much contact paper does Alex need?

Visual Thinking:

Strategies
- ☐ make a chart, graph, or list
- ☐ guess & check
- ☐ use logical reas-oning
- ☑ act it out – we used a model cube
- ☐ make it simpler
- ☐ work backward
- ☐ Draw a diagram – Area of one face 8x8 = 64
- ☑ Draw a picture
- ☐ find a pattern – A cube has 6 faces so 64 x 6 = 384 in²

64+64+64+64+64+64+64+64

In other words
364 6 faces
x 8
522

My Solution: First of all I went over in purple marker all the widths and length because I know that area = length x widths so I just paired widths and length together to ~~mat~~ make it easier. Then multiply 8x8 (cause that's the Length and Width) Then all of them up together, which was 522. So, Alex needs 522 in. of contact paper.

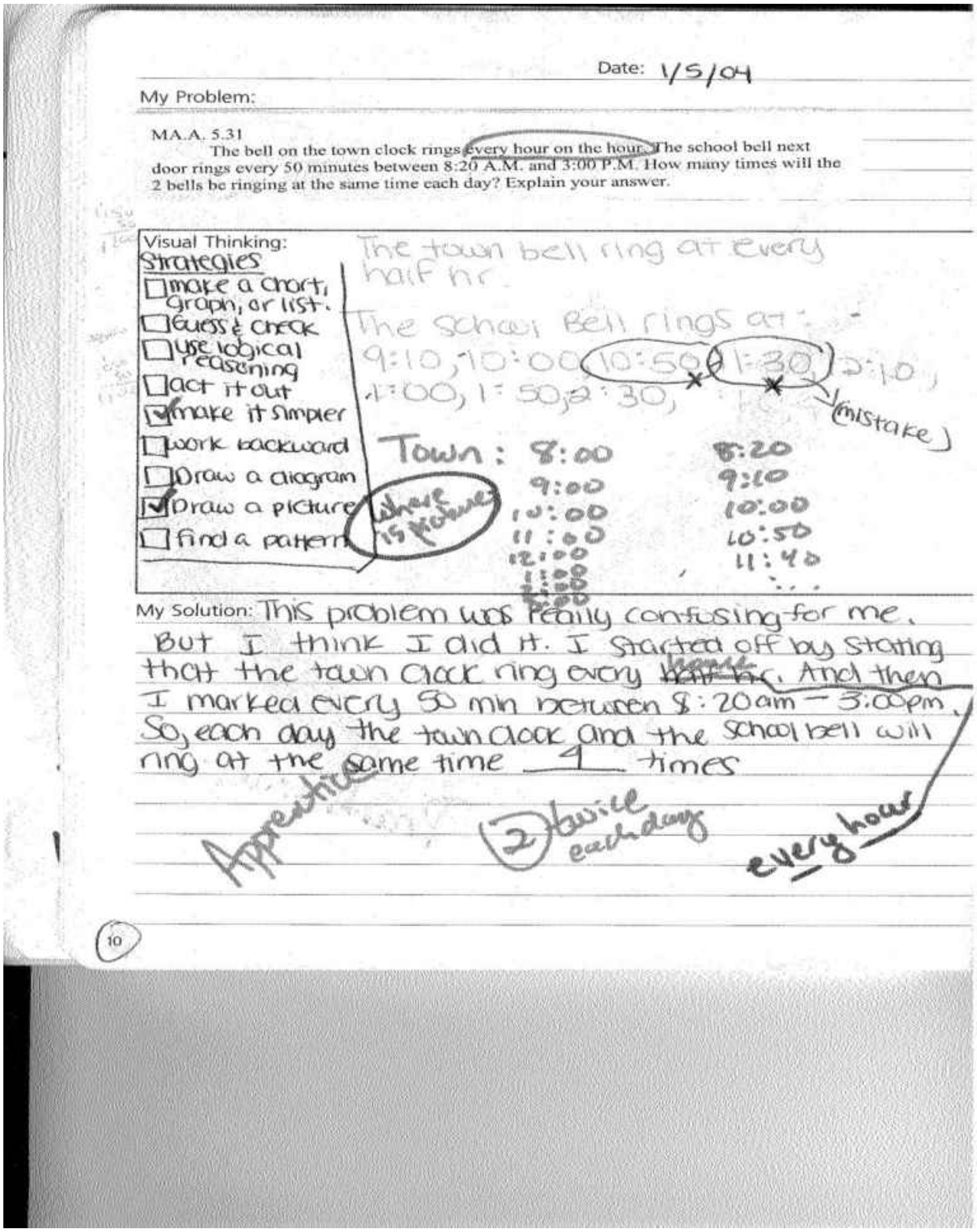
unit ?

Practitioner / Apprentice

11

Figure 5: Students being familiarized with the Task at Hand

Students' problem-solving journals reflected different types of mistakes made by students. Students did not read the directions carefully, used incorrect methods and/or strategy, were confused about the notation of the word problems, used word meaning incorrectly, had difficulties in hand writing skills and did not go over their own work. Figure 6, shows how students would mark the use of a strategy but not use it correctly or not at all. In addition this student was confused about the notation of words because the student misread every hour on the hour for every half hour.



Date: 1/5/04

My Problem:

MA.A. 5.31

The bell on the town clock rings every hour on the hour. The school bell next door rings every 50 minutes between 8:20 A.M. and 3:00 P.M. How many times will the 2 bells be ringing at the same time each day? Explain your answer.

Visual Thinking:

Strategies

- [ ] make a chart, graph, or list.
- [ ] Guess & check
- [ ] use logical reasoning
- [ ] act it out
- [x] make it simpler
- [ ] work backward
- [ ] Draw a diagram
- [x] Draw a picture
- [ ] find a pattern

where is picture

The town bell ring at every half hr.

The school Bell rings at: 9:10, 10:00, 10:50, 11:30, 12:10, 1:00, 1:50, 2:30,

mistake

Town:	
8:00	8:20
9:00	9:10
10:00	10:00
11:00	10:50
12:00	11:40
1:00	...
2:00	
3:00	

My Solution: This problem was really confusing for me. But I think I did it. I started off by stating that the town clock ring every ~~half hr~~ hour. And then I marked every 50 min between 8:20am – 3:00pm. So, each day the town clock and the school bell will ring at the same time 4 times

Apprentice

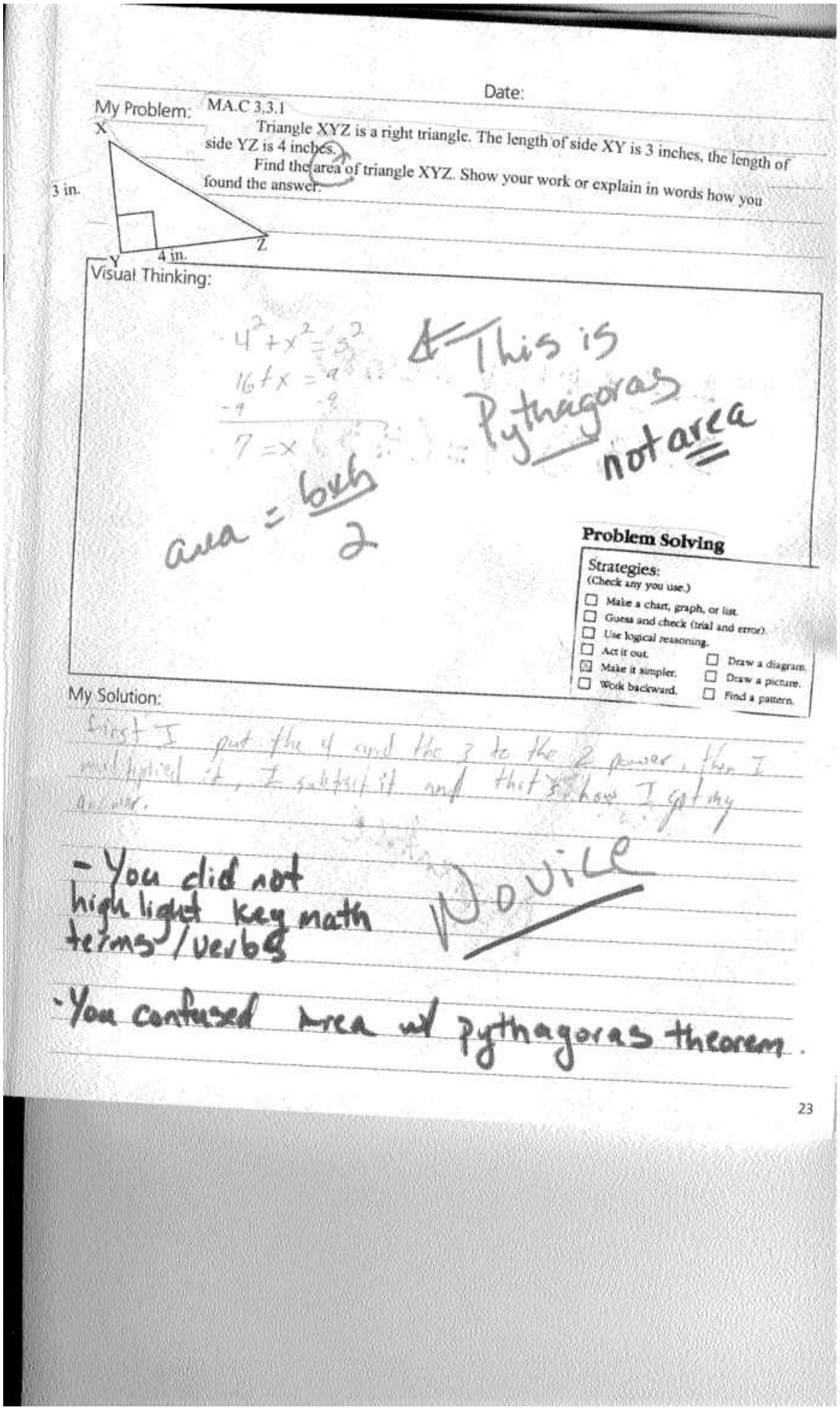
2 twice each day

every hour

10

Figure 6: General Mistakes made by Students

The next example showed that the student did not highlight key math terms or verbs in the word problem word. In addition the student confused the meaning of the word area with the concept of the Pythagoras Theorem. Figure 7 illustrated such findings.



Date:

My Problem: MA.C 3.3.1

Triangle XYZ is a right triangle. The length of side XY is 3 inches, the length of side YZ is 4 inches.

Find the area of triangle XYZ. Show your work or explain in words how you found the answer.

Visual Thinking:

$4^2 + x^2 = 3^2$
$16 + x = 9$
$-9 \quad -9$
$7 = x$

This is Pythagoras not area

area = $\frac{b \times h}{2}$

Problem Solving

Strategies:
(Check any you use.)

- ☐ Make a chart, graph, or list.
- ☐ Guess and check (trial and error).
- ☐ Use logical reasoning.
- ☐ Act it out.
- ☒ Make it simpler.
- ☐ Work backward.
- ☐ Draw a diagram.
- ☐ Draw a picture.
- ☐ Find a pattern.

My Solution:

First I put the 4 and the 3 to the 2 power, then I multiplied it, I subtract it and that's how I got my answer.

- You did not highlight key math terms/verbs

Novice

- You confused area w/ Pythagoras theorem.

23

Figure 7: General Mistakes made by Students

Students who had difficulties with reasoning were encouraged in small groups to use simple methods and to work on errors of communication by writing in their journals that they did not understand the word problem and to state the reason why. Students were also encouraged to use the spaces provided in the journal book correctly and to develop penmanship skills appropriately. At times students work was difficult to grade because their work was not legible. Therefore, students who did not have appropriate penmanship skills developed difficulties in computational skills. Students worked on overcoming weaknesses by highlighting or making circles around unclear wording. Students were encouraged to make pictures when writing difficulties approached. In order to help students go over their work, I had students' read their answers to me and explain verbally how they derived at such conclusions. Figure 8 illustrates students work.

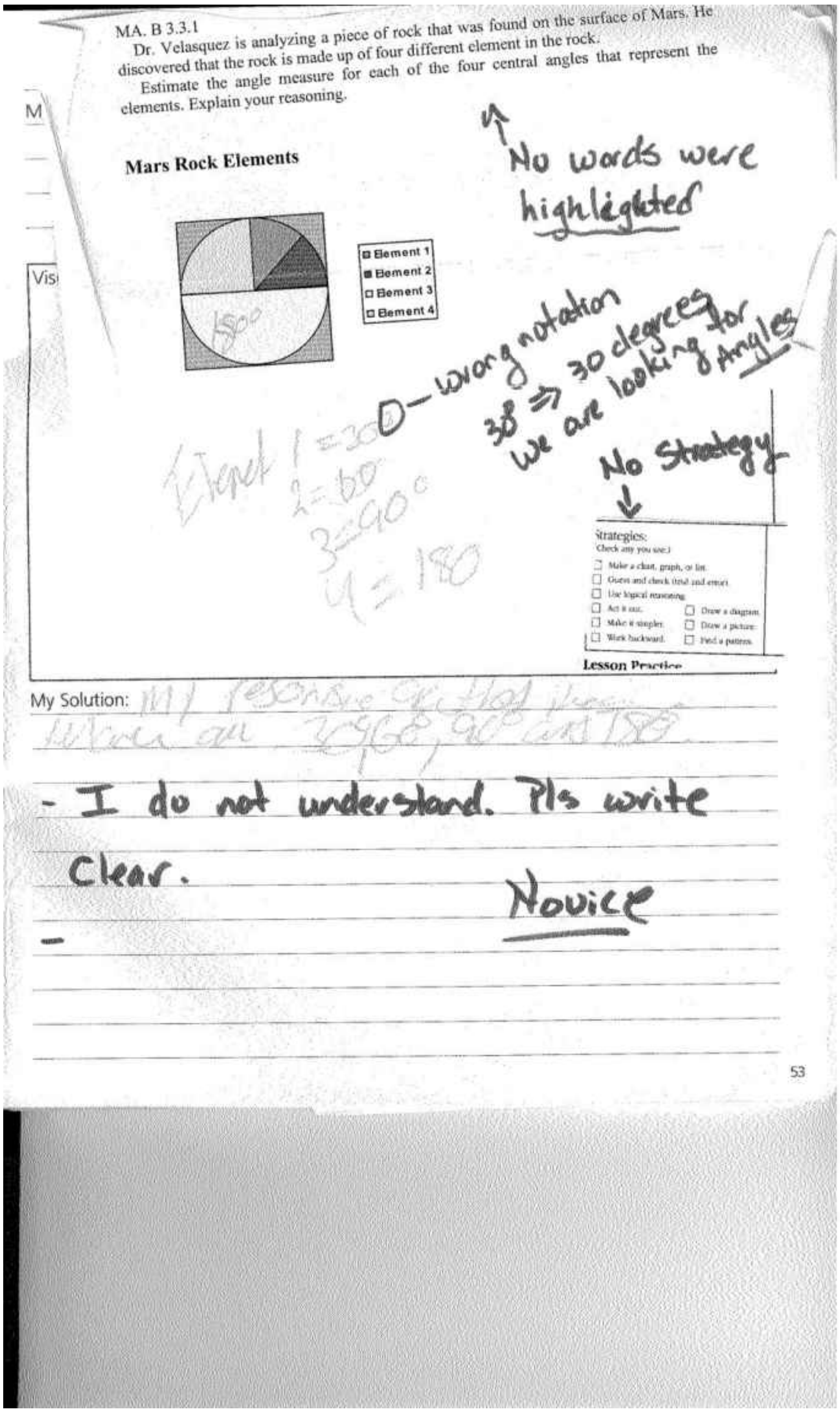


Figure 8: Students Difficulties with Reasoning

Difficulties in conceptual skills were evident when students showed computational weakness. Problem-solving journals indicated that some students were good at understanding the math concept but were inconsistent at computing. I tried to help students computational errors by letting them know that by making use of a calculator as a tool could assist in getting the correct answers. Students' problem-solving journals revealed that students could not recall basic facts. Students were also directed to utilize math journals as a source of notes to help them recall prior learning skills and strategies used. Students made errors included: math terms (words with double meaning), misread signs, carried numbers incorrectly and had difficulties writing numbers clearly enough. Students who had difficulties interpreting math terms were encouraged to use vocabulary word logs to help them recall definitions and proper use of the words according to their correct conceptual tense. Students were encouraged to change the word problem by role playing. For example, students changed names and uncommon words in the word problem making to situation that they can relate to in order to make the word problem relevant to them. In addition, students were advised to split difficult task into smaller ones. Students struggled connecting the abstract aspects to reality. For example, the following student expressed difficulties with this word problem because the student was not familiar with a town clock. Therefore, I suggested to the student to related it to a school bell ringing in a middle school and in high school. Students were unable to employ patterns, reason logically, and comprehend or express mathematical thoughts clearly. Figure 9 illustrates students work.

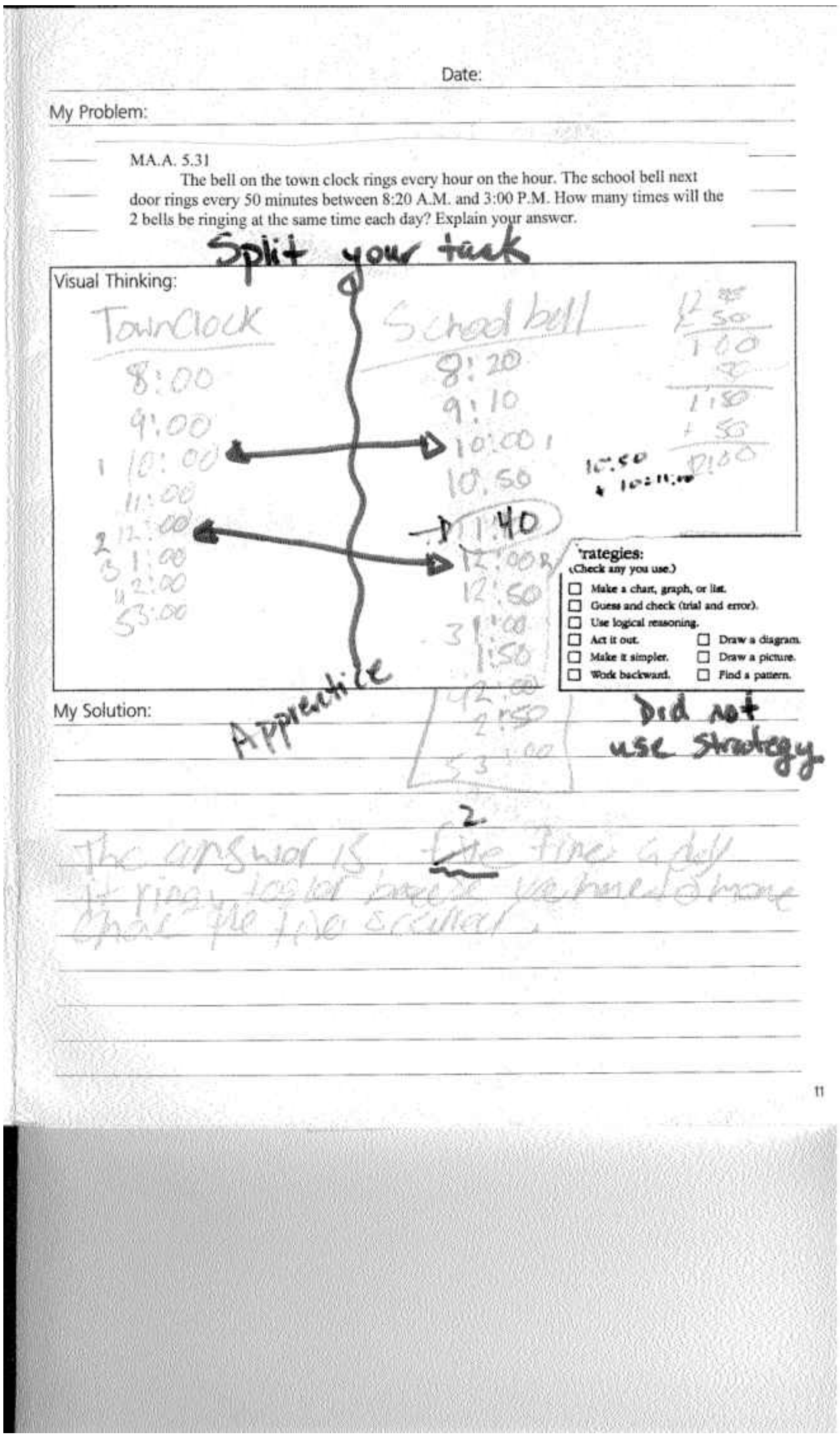


Figure 9: Students Unable to Employ Patterns, and Comprehend or Express Mathematical Thoughts Clearly

In figure 9, student was encouraged to split task into two different pictures. As soon as the student divided each task, she was able to write down the patterns of the hours accordingly. Students demonstrated proper procedural steps but showed minor adding 50 minutes to the hour for the school bell. In addition, student did present a strategy being used (make a pattern) but did not mark it in the proper space of the journal.

Data Source 2: Math Problem-Solving Journals:

In addition, math problem-solving journals were used to monitor students learning gains while using both reading and math strategies. The main focus for these journals was for me to build an effective assessment that will enable students to practice using reading and math strategies. Math problem-solving journals were assessed using a rubric (Appendix J). The rubric used helped me classify students mathematical abilities based on four levels; novice, apprentice, practitioner, and expert. The rubric provided helped me assess and understand the underlying mathematical and strategic knowledge of the students work. In addition, it helped me view students' problem-solving approaches and explanations. Students were given two sets of word problems based on 6th and 7th grade level expectations. Each question was graded based on the rubric provided. An average number of questions answered by students were 31 questions. Students, individual journal reports are showed in table 2.

Table 2: Students Problem-solving Journal Reports (SPJR)

	Novas	Apprentice	Practioner	Expert
Domingo	5	15	5	0
Minerva	5	12	23	0
Patricia	5	5	2	0
Dulce	5	14	10	0
Jenny	5	16	19	0
Evelyn	8	13	9	0
Idalgisa	7	10	25	0
Dorcas	10	11	8	0
Luis	11	13	16	0
Carmen	4	13	17	0
Ruthy	6	8	23	0
Madelyn	10	0	0	0

Overall, students' scores revealed that fifty percent (6/12) of the students answered these questions on a practitioner level. Thirty three percent (4/12) students answered these questions on an apprentice level and seventeen percent (2/12) answered these questioned on a novice level. These scores reflected that Eighty-three percent of the students' were presenting knowledge of mathematical principles and concepts which resulted in correct solutions to the problem. Students' identified the important element of the problems and used models, diagrams, symbols and/or algorithms to systematically represent and integrate concepts. In addition, students' used written explanation and rationale that translated into words the steps of the solution process and provided justification for each step.

Data Source #3: Interviews:

Students' interviews were conducted based on a questionnaire (Appendix H). Student interviews helped me gather first-hand account on the recurring patterns students confronted while solving word problems. Student interviews provided me with insights into their learning and thinking processes. I kept a learning log to help me monitor students' academic needs

(Appendix C & D).

Through these interviews, I was able to identify students' misconceptions and helped them solve mathematical word problems through the use of Polya's problem-solving steps (guided steps to help students understand the problem, devise and carry out a plan, and look back or evaluate the solution). I interviewed several students to determine common problems students had while solving word problems. During all interviews, I began reading the word problem to the student from start to finish. I continued by asking the student to read the problem out loud to me as well. The idea of having students read the word problem after I had read it was to be able to have students get the big picture of what the word problem was about. Students showed improvement in getting the big picture of the word problem as I modeled correct pronunciation of words that were unfamiliar to the students, pause reading when commas and period marks where seen, and use correct toning when a question was being asked. At times, I used my index finger to guide and point important features during the reading process.

Once students read the word problem, I wanted to know if students had an understanding of what they had read. I asked students to retell/or explain the word problem. I also wanted to know if students would be able to tell me what the main task of the word problem was, if students could select important pieces of the word problem and if students could distinguish necessary and unnecessary information. Student interviews revealed the students had reading difficulties. At times students were not able to summarize the word problems, and had difficulties understanding the task being asked. For example I worked with Ruthy on 2 exercises. In her first interview, I was able to see that she did have some knowledge on the task being asked but had problems retelling the word problem in her own words. The first word problem read as follows:

The largest dinosaur might have weighed 60 tons. If each ton is equal to 2,000 pounds, how much might one of the largest dinosaurs have weighed in pounds? Show your answer in standard form and in scientific notation.

I asked Ruthy: "Can you retell what the word problem in your own words?"

Ruthy replied on her first question: "It is explaining that the largest dinosaur weighed 60 pounds. 60 pounds [sic] each times it equals 2,000 pounds. How much might one of the largest dinosaurs weigh in pounds? That means like you divide 2,000 pounds by 60 times."

Ruthy answer reveals that she had conceptual knowledge (able to cover general ideas of numbers, number properties) but was not able to summarize using complete sentences using her own interpretations.

The second world problem read as follows:

The Sears tower in Chicago is one of the world's tallest skyscrapers. It is approximately 485 yards tall. In the United States, however, we often speak of heights of buildings in feet. How many feet tall is the Sears Tower?

Ruthy replied on her second question: "It's saying that the skyscraper is 485 yards tall in the United States but how we speak of heights and building and feet, they want to know how many feet tall is the Sears towers."

Another student Evelyn also showed the same pattern. In her first interview she revealed that she had no notion about what retelling or summarizing a word problem meant. The word problem we work on read as follows:

A rational number is a number that can be expressed as a ratio in the fraction from x/y, where x and y are integers and y ≠ 0. A friend tells you that a decimal can be written as rational number. Is he right? Explain why or why not.

I asked Evelyn: “Can you retell the word problem in your own words?”

Evelyn relied: “A rational number is a number that can be expressed as a ratio in the fraction from x/y, where x and y are integers and y ≠ 0. A friend tells you that a decimal can be a rational number. Is he right? Explain why or why not.

I noticed her inability to retell due to her speech impairment, so I proceeded to ask her in a different manner. “Evelyn, Can you explain what this word problem is about? Do you understand what the word problem was about?”

Evelyn answered: “It’s about rational numbers and how could it be expressed as a rational in fraction form.”

The second word problem read as follows:
If the denominator of a fraction increases and the numerator stays the same, does the value of the fraction increase or decrease? Show an example that illustrates your answer.

Evelyn answered: “It’s about the denominator that it, that the denominator increases or the numerator stays the same.”

Evelyn still showed signs of difficulties retelling due to speech impairment. I noticed that when I changed the wording of the question from retelling to simple questions (what is it that we need to find out?) in which she could answer using simple sentences such as yes or no, she demonstrated a complete understanding of the task being asked and was able to verbally express herself effectively. Evelyn replied, “I need to find out if the value of the fraction still increase or decrease.”

Both students showed difficulties in being able to use their own words to summarize or retell what the mathematical word was about. Although both students were not able to retell mathematical word problems effectively, students revealed basic understanding of the task at hand.

Students' interviews were also used to determine if students were able to select necessary and unnecessary information from the word problems. Student interviews showed that students at times felt that every item in the word problem was important. For example, on Evelyn first interview, I asked her, "Can you state some important pieces from the word problem?" Evelyn replied, "that ratio is x and y, huh, x and y are integers and y does not equal zero." Clearly, Evelyns' statement revealed that she could select the important/necessary information out of the word problem. Ratio, integers and y does not equal zero were words that indicated special attention in order to at least begin solving the mathematical word problem.

On her second interview, she seemed to have stuttered on some words of the word problem. She replied, "That the denominator of fraction increases" student pauses and continues to say, "show the number stays the same. The value of the fractions increase or decrease." Once again Evelyn showed evidence that she was capable of selecting necessary information. The words she selected, "denominator of the fraction increase, show the number stays the same and the value of the fractions increases or decreases" made it apparent that she understood the task of selecting meaningful word out of a word problem.

Although Evelyn was capable of selecting important information from the word problem, I noticed a sense of confusion from Evelyn. The movement in her eyebrows showed facial expression of confusion. Her facial expression gave me a sign that Evelyn had doubt about her answer. In order to clear any doubt that Evelyn may have had, provide positive feedback, build on her self-confidence, I then guided her to approach this section of the interview differently. I asked her to highlight key math terms and key verbs on the word problem with a highlighter. I proceeded to ask her to tell me the words she had highlighted. Evelyn replied, “Denominator, increases or decreases, and show”. The answer she provided reflected that Jasmine was able to select important details of the word problem but needed support and guidance in how to select important pieces. The use of highlighting words in the text made Evelyn confirm that she was correct about her answer.

Ruthy on the other hand showed no difficulties stating important pieces of information from the word problem. When I asked Ruthy to state what where the important pieces of information, she quickly replied, “tons, pounds, standard form and scientific notation.” On her second interview she immediately replied to the question by saying, “485 yards tall, and how many feet tall is the Sears tower?” Overall, the student interviews showed that both students had little difficulties or no difficulties at all stating information that were necessary or unnecessary on the word problems.

In addition, student interviews gave me insights on students’ difficulties in demonstrating conceptual understanding in mathematics. Student interviews showed students inabilities to reason in setting careful representation of the concepts used. Students’ interviews showed how students applied and justified procedures inappropriately. Overall, student journals helped me see how students demonstrated problem-solving situations, how their mathematical knowledge of concepts, procedures, and applications were being applied.

When working with Ruthy, I noticed difficulties in transferring knowledge into math symbols. For example, I asked Ruthy, "How do you write each ton is equal to 2,000 pounds in math?" Ruthy demonstrated the inability to easily connect the words with math symbols. Ruthy answered, "You can divide it or multiply it." I rephased the question and asked her once again, "Can you show me how one or each ton is equal to 2,000 pounds is written in mathematical symbols. She remained silent and could not answer. I proceeded to help by suggesting her to change each word in the sentence to a symbol she thought would fit best. Ruthy replied and wrote in her journal the symbols = and the abbreviation lbs for pounds. I suggested to her to change the word each to the number 1. Therefore, we set up a scale model that reflected words in math symbols. Ruthy was able to see that the scale model 1 = 2,000 lbs can be written in math symbols.

In her second interview, Ruthy showed inability to easily connect that abstract concept with reality. Ruthy could not picture what a foot, nor yard looked like. I asked her, "How many yards are in a feet?" She remained silent. I asked her again, "Do you know how many yards are in a feet?" She replied, "No." At this time Ruthy showed that she lacked prior knowledge in measurement skills. In order to make the learning connection more feasible for Ruthy I used a regular 12 inch ruler and a yard stick to demonstrate the relationship between these measurements.

Once I showed her the two tools used, I asked Ruthy, "Can you tell me how many 12 inch rulers I would need to complete this yard stick?" She replied, "It shows about 4 and 12 inches." I commented, "So, you need four 12 inch rulers. She quickly responded, "No, about 3." As a result of this little demonstration Ruthy was able to make and display her connection very quickly. Ruthy wrote in her problem-solving journal 3 feet = 1 yard. In general, her problem-solving journal showed she had good perceptual skills but lack transferring knowledge to real world situations.

Evelyn showed the inability to memorize to recall facts, and had difficulties understanding the language of math. While working with her I asked her, “What does the word rational number mean?” She stuttered. I tried to help her remember by asking her if she remembered what the word ratio meant. She replied once again, no that she did not remember. I mentioned the words Wal-Mart versus Kmart. She immediately replied, “Yes, uh huh, the comparison of two things. Although, she was not able to recall definitions quickly, I was able to help her remember previous taught lesson to guide her into remembering what these words meant. She completed this portion of the interview by stating, “A rational number can be changed to a fraction, and a decimal form.”

Evelyn second interview revealed difficulties in understanding the task at hand. This student would normally forget what she was doing in the middle of the math problem. The math problem required Evelyn to compare two different fractions with different denominators but with the same numerators and state if the values of the fractions increased or decreased. Evelyn wrote in her journal the following answer: 16/50 = 0.32 = 32%. It was obvious that Evelyn misinterpret the question. She only wrote one fraction and believed that for some how her representation made the fraction increase. In order to help her realize were she had made her mistake, I asked her, “Does your answer seem reasonable to the question being asked? She replied, “Yes, cause, the it, my solution came out right because it decreases. Students’ answered reveled that she did not understand the task at hand. Student had difficulties explaining and communicating about math.

I guided her to look at her problem-solving journal and made it known to her that her denominator indeed was higher than her numerator but she had not adhered to the correct answer yet. In her mind she believed that her answer was correct because her denominator was higher than that numerator. In reality she misunderstood the entire task. Evelyn was supposed to show two different fractions that had the same numerator but different denominators that were increasing and state if these fraction would increase or decrease under these conditions. In order to help her, I gave her two different fraction (16/50 and 16/70) and asked to state whether these fractions where the same of different. Student wrote 16/50 = 0.32 = 32% and 16/70 = 22.8 = 228% in her problem solving journal. She replied, "Different". I asked her, "What makes these fractions different?" She answered, "The second fraction is smaller." I guided her with my index finger to look at both fraction and see that the denominators were also different. She quickly responded, "Uh, yes I get it now".

Overall, student interviews allowed me to identify students' weakness' and strength. Student interviews revealed how students are inconsistent at computing but may be good at understanding of the mathematical task being asked. Student interviews also revealed that students lacked prior knowledge due to students not being able to master number facts and recalling prior knowledge. In addition, students had difficulties solving word problems because they were not able to anchor in any meaningful or relevant information to the outside world.

Research questions #3 examined one data source: Students attitude towards mathematics

Students' attitude towards mathematics

Research Question #3: What were students' attitudes toward mathematics?

Data Source 1: Students' pre and post scores

Prior to the 4 subtest, a supplemental part of the test was administered to see what students' attitude about mathematics. I calculated how many of the total 12 students had an attitude change during the course of the study through administration of a pre and post attitude test. Results are shown in Table 3.

Table 3: Students Attitude Toward Math (AT)

	Attitude Toward Math (AT)		
	Pre-Test	Post-Test	Changes
Domingo	28	35	+7
Minerva	18	20	+2
Patricia	41	26	-15
Dulce	48	43	-5
Jenny	30	28	-2
Evelyn	23	25	+2
Idalgisa	27	27	0
Dorcas	43	31	-12
Luis	26	26	0
Carmen	47	42	+5
Ruthy	40	43	+3
Madelyn	28	33	+5

In the survey students select one of four options that best reflected the way they felt about 15 math situations. The mean score on the pre-survey was 33. Students who scored a 33 or more on the survey reflected a positive attitude towards math. Forty-two percent (5/12) of the students had a positive attitude towards mathematics prior to the subtest. On the other hand, the remaining fifty-eight percent of the student showed a negative attitude towards mathematics prior to the test.

On the post-test the mean score was 32. Students who scored 32 or more showed a positive attitude towards math. To my surprise by the end of the study forty-two percent (5/12) of the students had positive attitude towards math and fifty-eight percent (7/12) had a negative attitude towards math. Overall, the data revealed that only fifty percent (6/12) students showed a positive change in attitude changes, and forty-two (5/12) students showed a negative change, and one student reflected no change. Although students' attitude was not what I had hoped for, scores indicated that some students attitudes may or may not be affect by the use of problem-solving strategies. The purpose of the attitude test was to measure students' attitude toward math and toward instruction. Students' data revealed the same scores for both categories positive and negative attitude towards math and math instruction on both pre and post test.

CHAPTER 5: CONCLUSION

Introduction

In mathematics students encountered difficult experiences while problem-solving and educators were faced with using effective teaching approaches to problem-solving that applied across the curriculum and at all grade levels. Today with the No Child Left Behind Act, teachers are required to implement effective research based-practices. The purpose of this action research study was to observe students mathematical abilities and to investigate whether teaching students problem-solving strategies in mathematics would affect student's mathematical thinking and their ability to comprehend and solve word problems.

The research questions were:

1. Did an expository instruction approach affect at-risk students' mathematical abilities?
2. Did the use of mathematical problem solving strategies (Act it out, Draw a diagram, Draw a picture, Make a chart, graph, or list, Guess and Check, Make it simpler, Use logical reasoning. Work backwards and Find a pattern. Polya's problem-solving steps.) affect at-risk students' problem-solving performance?
3. What were students' attitudes toward mathematics?

Conclusion

This study took place in a middle school in Central Florida. Data were collected from twelve, eighth grade students. For my research, I have several conclusions to research questions posed.

Research Question #1: Did an expository instruction affect at-risk students' mathematical abilities?

Throughout the study a direct instructional approach was used in all intensive mathematic classes. The students in these classes were at-risk students. Throughout the study I used three instructional approaches: students' skill grouping, intense contact with students and teaching to mastery. I found that a direct instructional approach facilitated the learning process and helped at-risk students increase their mathematical abilities. I found that students were able to follow classroom materials and mathematical content better when grouped with peers that had the same ability level. Direct instruction helped students become self-disciplined and confident learners.

Once students were grouped by ability levels, I discovered that presenting mathematical content to be easier to deliver. Ability grouping allowed me to focus on mathematical strands that students struggled with. While delivering instruction, I noticed that math concepts were described and illustrated through examples in which students were capable of understanding. Through whole group and small group instructions, I found that students had achieved content knowledge and mathematical abilities were being affected because students responded orally or as small groups their questions and concerns in regards to what was being taught and any difficulties they may have had while problem-solving. Post-test scores showed that one percent of the students rated very superior, and one percent of the students rated superior. Twenty-five percent of the students rated above average. Forty-two percent of the students rated average. Seventeen percent of the students rated below average. These post-test scores revealed that over ½ of the students had increase in mathematical abilities. Students demonstrated mastery in vocabulary meaning, computational skills, general information about math, and/or story problems. Overall, I found that direct instruction provided individualized attention to students based on their academic needs.

Research question #2: Did the use of mathematical problem solving strategies (Act it out, Draw a diagram, Draw a picture, Make a chart, graph, or list, Guess and Check, Make it simpler, Use logical reasoning. Work backwards and Find a pattern. Polya's problem-solving steps) affect at-risk students' problem-solving performance?

The National Council of Teachers of Mathematics: "Principles and Standards for Secondary Mathematics", (NCTM, 2000) recommends that problem-solving be the focus of schools mathematics. In this study, I used teaching about problem solving as an approach to see if it had any affect on at-risk students' performance. According to Lester (1994), students who were explicitly taught problem-solving strategies had better problem-solving performances than their peers.

In this study, I found out that at-risk students were unaware of what these strategies were and how to apply them while problem-solving effectively. Through math journal and problem-solving journals, I noticed students used these strategies incorrectly and needed instructional guidance on how to use them. Students' performance had a negative affect because student lack knowledge on the use of these strategies. After the study was concluded, I found that teaching about problem-solving strategies (teaching of strategies) helped in teaching that mathematical content. Students were able to connect the use of each strategy to specific word problems and learned how to apply these strategies effectively. Student problem-solving performance had a positive increase and students mathematical skills increased. I found that teaching problem-solving strategies helped improve problem-solving instructions and student performances. I noticed that students' motivation into attempting to solve word problems had changed. Students' problem-solving journal showed how students were stimulated to answer or at least try to answer word problem in general. I noticed students were no longer leaving the word problems unanswered. In general, I learned that teaching about problem-solving can be used as teaching approach where students are likely to be successful at problem-solving. Student scores revealed that thirty-three percent of the students scored a 5 on the holistic scale. Forty-two percent of the students scored a 4, and twenty-five percent of the students scored a 3 on the holistic scale.

Overall, students' scores revealed an increase in the correct use of reading and math strategies. By the end of the study, all students were on or above average on the holistic scale.

Research question #3: What were students' attitudes toward mathematics?

A student attitude test was a supplemental part of the pre and post Test of Mathematical Ability-2 (TOMA). Students attitude towards math affect students' enthusiasm and desire to continue with the study of mathematics as part of the students future plans. Therefore, teachers should provide instruction that is interesting to the student. Chamot and O'Malley mentioned, "Rather than attempt to cover a great deal of content, the teacher should provide opportunities for the students to discover content which they find personally interesting and rewarding" (p.32). The attitude test focused on how students felt about 15 different math situations. Through data collected, I found out that students in the study had the same relationship in positive and negative changes. I found out that students attitude towards math are generally positive. The challenge still remained on changing the attitude of the students' who still continued to reflect negative attitudes or those students who had a negative change in attitude.

In addition, I found out that although students' attitude towards mathematics plays an important role in students' performance, in this study, students attitudes did not produce a negative affect on students' academic performance. By the end of the study forty-two percent of the students had positive attitude towards math and fifty-eight percent had a negative attitude towards math. Overall, the data revealed that only fifty percent students showed a positive change in attitude changes, and forty-two students showed a negative change, and one student reflected no change.

Other Findings: Emergent Themes

1. How did students' mathematics skills compare to reading skills?
2. Did using mathematical and reading strategies affect at-risk students' mathematical abilities?
3. How did second-language learners demonstrate mathematics problem-solving skills?

Emergent theme #1: How did students' mathematics skills compare to reading skills?

Reading and math skills were monitored by a computerized program named National Computer System (NCS) - Learn. Based on the data collected, I found that students had achieved more learning gains in math than in reading. I found out that students needed more monitoring in the areas of percent of correctiveness. Students who performed below a seventy percent on each session needed immediate interventions. Students behavioral and performance patterns needed to be monitored more often. I found out that students would show positive learning quicker when an increase in teacher supervision was implemented while students used the computer program.

NCS Pre-and Post test were used to monitor students' mathematical ability according to grade level, and to assists students while solving word problems. In the beginning, students used a computer program to help me diagnose students' initial processing mode level for both reading and mathematics. Results are shown in Table 4.

Table 4: Comparison of Student Reading & Mathematics Gain (CSRMG)

	Course	IPM Level	Current Level	Gain Since IPM
Domingo	RW	2.86	3.22	.36
	MCS	3.29	4.23	.94
Minerva	RW	3.99	4.91	.92
	MCS	2.91	7.13	4.22
Patricia	RW	3.90	4.14	.24
	MCS	3.59	3.95	.36
Dulce	RW	2.82	3.17	.35
	MCS	3.71	4.29	.58
Jenny	RW	5.00	7.29	2.29
	MCS	5.82	6.66	.84
Evelyn	RW	4.07	4.99	.92
	MCS	6.51	7.92	1.41
Idalgisa	RW	5.03	6.75	1.72
	MCS	5.49	7.32	1.83
Dorcas	RW	2.95	3.48	.53
	MCS	4.30	5.05	.75
Luis	RW	4.93	7.34	2.41
	MCS	4.07	6.02	1.95
Carmen	RW	2.84	3.49	.65
	MCS	4.12	6.29	2.17
Ruthy	RW	6.74	7.50	.76
	MCS	4.40	5.83	1.43
Madelyn	RW	4.08	6.63	2.55
	MCS	4.63	6.57	1.94

RW = Reading Workshop **MCS = Math Computational Skills**

NCS reading current level scores indicated that during the study students reading scores changed. Students scores showed thirty-three percent of the students read at a 3rd grade level. Twenty-five percent read at a 4th grade level. Zero percent of the students read at a 5th grade level. Seventeen percent read at 6th grade level, and twenty-five percent read at a 7th grade level. Figure 10 illustrates such findings.

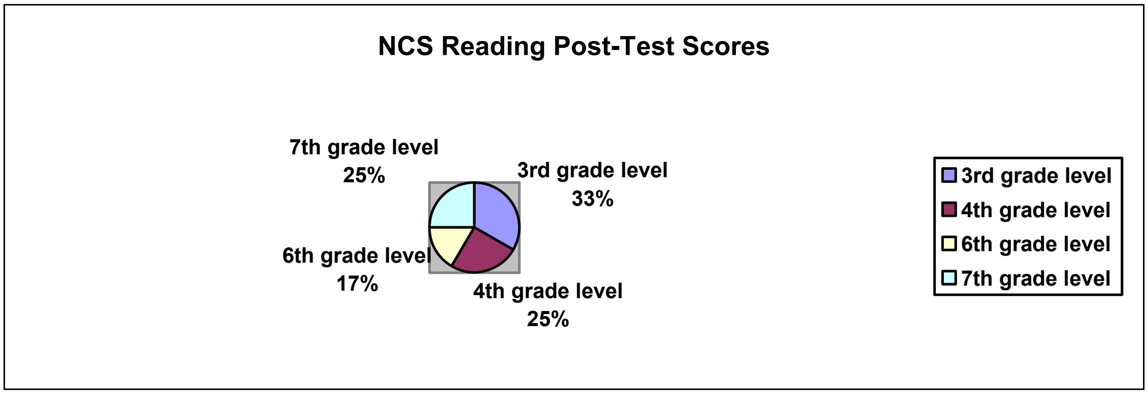


Figure 10: NCS Reading Post-Test Scores

Overall, reading scores revealed that all students achieved learning gains in reading ranging from 0 to over 3 academic years. Thirty-three percent of the students showed 0 to 6 months learning gains. Another thirty-three percent of the students showed 6 months to 1 years of learning gains. One percent of the students showed 1 ½ to 2 years of learning gains. Seventeen percent of the students showed 2 to 2 ½ years of learning gains and one percent showed over 2 ½ years of learning gains. Although students were still not on grade level expectations, scores demonstrated that remedial help was still needed and reading achievement was increasing at a slow and steady pace.

Math current level scores showed that students had increased since IPM. One student was at a 3rd grade level. Seventeen percent was at a 4th grade level. Another seventeen percent was at a 5th grade level. Thirty-three percent was at a 6th grade level and twenty-five percent was at a 7th grade level. Figure 11 illustrated these findings.

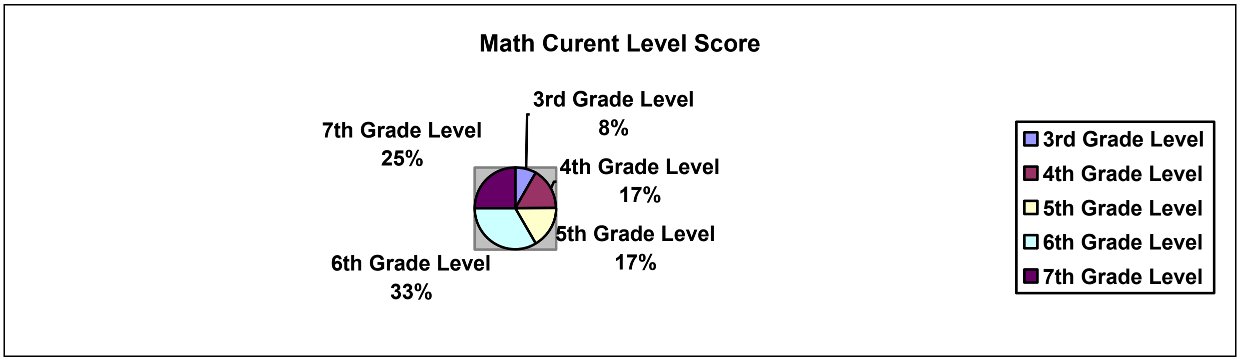


Figure 11: Math Current Level Score

Math scores revealed that all students had learning gains in mathematics ranging from 0 to 4 academic years. Seventeen percent of the students showed 0 to 6 months of learning gains in mathematics. Twenty-five percent of the students showed 6 to 1 year of learning gains. Seventeen percent of the students showed 1 to 1 ½ years of learning gains. Twenty-five percent of the students showed 1 ½ to 2 years of learning gains. One percent of the students showed 2 to 2 ½ years of learning gains and one percent showed 4 to 4 ½ years of learning gains.

Math scores in comparison to reading scores showed that students are getting better in math but making few significant gains in reading. Forty-four percent of the students in the study had gained from 1 to 4 ½ years of learning gains in mathematics and only nineteen percent of the students had gained 1 to 3 years of learning gains in reading.

NCS results were also used to help monitor the use of reading and math strategies against students' mathematical abilities. Results in table 4 showed that students remained, if not achieved more learning gains in math than in reading. Sixty-six percent (8/12) of the students showed greater learning gains in math than in reading. Figure 12 illustrates such findings.

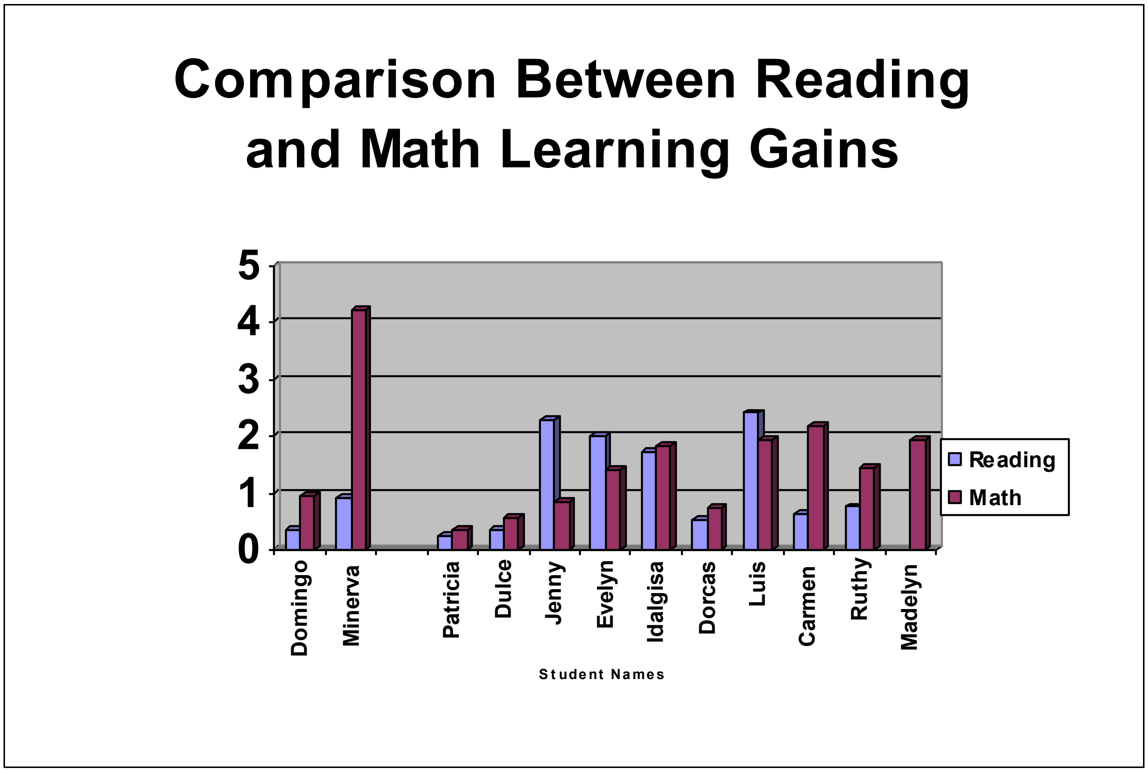


Figure 12: Comparison between Reading and Math Learning Gains

The software program NCS provided support in helping students learn different component skills in mathematics. Students were able to work on mathematics skills based on their IPM and individual needs. Once a skill was completed and mastered students were challenged onto complex skills. In the study the mean number of skilled completed was 178. Results are shown in table 5.

Table 5: Student Math Concepts & Skills Report (SMCSR)

	Number of Skills Completed	Number of Skills Failed	Percent of Skills Mastered	Percent of Computa-tional Retention
Domingo	197	10	95	85
Minerva	188	0	100	92
Patricia	36	2	97	94
Dulce	126	7	94	84
Jenny	125	3	98	70
Evelyn	192	13	93	71
Idalgisa	286	12	96	87
Dorcas	158	12	92	80
Luis	404	8	98	82
Carmen	44	1	98	73
Ruthy	295	16	95	78
Madelyn	80	6	93	83

These scores revealed that fifty percent of the students were completing and increasing mathematics skills on average or above average. Although, students lacked math skills and did not show readiness towards moving onto complex skills, data revealed that students mastered on task skills at an average of eighty percent. Therefore, all students achieved learning gains in math skills. In support, students showed learning gains accordingly to their computational retention. The mean score for students' computation retention was eighty-two percent. Therefore, fifty-eight percent of the students were not only showing mastery but students were also showing subsequent learning through computational retention.

In addition, students' successes were monitored based on percent of correctiveness and number of sessions in math and reading. Results are shown in Table 6. The percent of correctiveness is the percent of correct answers in each course during student's most recent sessions. The number of sessions is the number of exercises the student has attempted to answer.

Table 6: Student Math & Reading Percent of Correctiveness (SMRP)

	Number of Math Sessions	Percent of correctiveness in math	Number of Reading Sessions	Percent of correctiveness in Reading
Domingo	100	66	38	39
Minerva	51	85	23	84
Patricia	34	71	36	70
Dulce	57	73	34	65
Jenny	54	69	46	79
Evelyn	81	66	44	76
Idalgisa	75	70	80	71
Dorcas	52	64	38	63
Luis	118	74	145	80
Carmen	46	70	64	47
Ruthy	56	70	38	Topped Out (students performed all skills on or above grade level)
Madelyn	46	70	36	70

For both math and reading the average percent for percent of correctiveness was set at percent. Therefore, any number below 70 meant that students had a cumulative performance level that was below acceptable standards and was not mastering most of their skills during instruction. In the study, thirty-three percent of the students performed below acceptable standards in both math and reading. Therefore, more monitoring needed to be done in order to find behavioral and performance patterns.

Behavioral and performance patterns were monitored accordingly to students reading and math sessions. The mean number of sessions in math was 64 session. Sixty-six percent of the students performed below the mean in math during the study. The mean number of sessions in reading was 52. Seventy-five percent students in the study were below the mean in reading. Students who had relatively high numbers compared to others showed signs that students might be clicking through exercises or that some students may be quicker at answering questions than other students.

Emergent Theme #2: Did using mathematical and reading strategies affect at-risk students' mathematical abilities?

As part of the study, I used reading and mathematical strategies to help students increase mathematical abilities. I used a reading strategy known as annolighting a text. Students were exposed to the use of annolighting for the purpose of capturing the main idea, key concepts, separate necessary and unnecessary information, and to strengthen reading comprehension. Through student interviews and problem-solving journals, I found out that suggesting to students to use annolighting meant hightlight every word. I found out that students needed some instruction, including modeling and guided practice. I also found out that when students used the annolighting strategies incorrectly, it produced a waste of time, energy and ink. On the other hand when students used the strategy correctly, it provided an effective affect on at-risk students' performance.

A second reading strategy named vocabulary build-up was used to help students build vocabulary knowledge in mathematics. In the study students used a vocabulary log to record word meaning and examples of the words used. Kameenui et al. (1982) agreed that the use of vocabulary strategies removed cognitive barriers that prevented students from grasping new content. I found out that as students develop their capacity for understanding, vocabulary became a cognitive link between the students' mathematical sense of numbers and order, and conceptual learning. I also found out that when vocabulary words are taught at the start of a lesson it provided students with background information. Therefore, students were better equipped to put the new vocabulary words into use.

Through data collected from the TOMA-2 test, mathematical skills were monitored. I found out that students increased in all computational skills. I found out that when modeling vocabulary strategies sixty-six percent of students in the study rated average and/or above average. Overall, the use of reading and mathematical strategies had a positive affect on at-risk students' mathematical abilities.

The effectiveness of using reading and mathematical strategies were monitored through the TOMA-2 test. Students, raw scores on the TOMA-2 test were collected. The test included four different subtests: vocabulary, computational skills, general information and story problem. Results are shown in Table 7.

Table 7: TOMA-2 Pre & Post Standard Test Scores on Students Mathematical Abilities (P&PTS)

	Vocabulary (VO)		Computational skills (CO)		General Information (GI)		Story Problems (SP)	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Domingo	11	18	14	20	12	27	14	17
Minerva	12	15	17	24	10	24	9	18
Patricia	8	13	18	21	15	17	12	13
Dulce	10	15	18	20	13	19	13	15
Jenny	11	13	12	19	9	19	9	11
Evelyn	1	3	13	10	10	10	8	11
Idalgisa	2	2	12	21	13	10	6	6
Dorcas	2	11	13	18	5	11	3	9
Luis	2	5	2	15	5	8	10	13
Hector	5	10	11	20	8	12	4	10
Ruthy	5	9	15	19	8	12	7	11
Marilyn	6	8	10	12	9	10	10	12

According to the TOMA-2 test booklet standard scores for the subtests are reported in terms of a scale that ranges from 1 through 20. The mean average of this scale is set at 10, and the standard deviation is fixed at 3. Student performance in terms of standard scores can be classified according to the following description provided by the TOMA-s test booklet (pg 18):

Standard Scores	Descriptive Ratings
17-20	Very Superior
15-16	Superior
13-14	Above Average
8-12	Average
6-7	Below Average
4-5	Poor
1-3	Very Poor

Pretest scores on the vocabulary (VO) subtest reflected that over ½ of the participants (58%) rated low on the scale and therefore lacked vocabulary skills.

Post-test scores showed significant changes in every rating. One student rated very superior, while seventeen percent of the students rated superior, and above average repeatedly. Twenty-five percent of the students rated average. One student rated below average. One student rated poorly and seventeen percent of the students rated very poorly. By the end of the study, sixty-six percent of the students rated average and/or above average. Scores revealed incremental progress was achieved in vocabulary skills.

Pre-test on the computational (CO) scored reflected that only one percent students rated low on the scale. Therefore, this part of the subtest meant that little emphasis would be made on computational skills. Students scores showed that over fifty percent of the students were rated average and above average.

Post-test scores on the computational (CO) subtest showed that seventy-five percent rated very superior, and one percent rated superior. Seventeen percent rated average. Although little emphasis was made on computational skills, students did show a great increase while rated in the very superior section. All students remained higher or on average scale on computational skills.

Students' general information (GI) about math was weakened by a lack of understanding in connecting math to real life situation. Although fifty percent of the students where rated average, trying to increase students score to become fifty percent or more above average on the general information subtest meant that students conceptual knowledge needed to be linked to basic computational skills, previous math concepts and math concepts that are unknown to the students.

Post-test scores on the general information (GI) showed that forty-two percent rated very superior and fifty-eight percent average. Scores revealed that the number of students had double in the rating of above average or higher. In comparison to the pre-test scores twenty-five percent of the students were at above average or higher. An increase of seventeen percent in the rating of above average or higher had occurred. Forty-two percent of the students were at rating of above average or higher meaning that twenty-five of the students had increased from ratings of average and below to superior ratings.

Pretest scores on story problems (SP) showed no students rated very superior and superior. Seventeen percent of the students rated above average. Fifty percent of the students rated average. Seventeen percent of the student of the students rated below average. One student rated poorly and one student rated very poorly. Scores revealed that sixty-seven percent of the students showed abilities to read and solve written problem.

Post-test scores on story problems (SP) showed some increase. Students' scores continued to show abilities in reading and solving story problems but the amount of students increasing to rating above average and/or above were minimum.

In addition, student interviews were used to document the effectiveness of using reading and mathematical strategies. During the interviews students stated which problem solving strategies needed to be used in order to solve the mathematical word problems. Students were given a list of the strategies. In students' problem-solving journals, students made a check mark next to the strategy they felt best to use in order to help them solve the mathematical word problem. Once students' choose the strategy students needed to use the strategy correctly.

Student interviews also revealed the mathematical process behind using the reading and math strategies. This section of the interview was intended for student to see that by using these strategies all concepts and skills can be practiced daily and over time, students will foster assimilation, mastery, and complete understanding of concepts and skills.

During Evelyns' third interview she confronted difficulties in arriving at a complete answer. The word problem she attempted to solve read as follows:

David drew a tree that has 5 main branches. Each branch has 5 twigs on it. Each twig has 5 leaves on it. How many leaves are on the main branches of the tree?

Evelyn had reached an answer of 25 leaves. According to her problem-solving journal she had arrived at an incorrect answer because she may have misread the word problem and was not focused on the details that were presented. Evelyn did not follow the proper steps to solve the math problems. I asked her to tell me what math strategy she used in the problem. She replied, "Draw a picture". I asked her to describe what items would be included in the picture. She answered, "I have no idea". Clearly, Evelyn statement reflected that she was able to choose a strategy but demonstrated she was not capable of using the strategy effectively. Evelyn showed difficulties in using reasoning skills. Evelyn problem-solving book showed that she overlooked some steps when she drew her picture.

At first, Evelyn was shy of showing the picture she had drawn. She felt that it was ugly, and was embarrassed to show it to me. In order, to assist her I boosted her confidence by telling her that although we were not artist we would make the best of it. The picture she had drawn was a simple tree with 5 branches and 5 leaves on each branch. The picture she drew reflected that she had not read the word problem correctly and missed out on some steps. I continued to ask her, "Can you highlight important information or pieces of the word problem that can be use to include in the drawing?" She replied, "5 main branches. 5 twigs on it. 5 leaves on it. How many are on the main branches of the tree?" I asked to look at each item she had mentioned separately and determine if she had drawn all her items. She, replied, "No, not all items." I asked her to draw 5 main branches, 5 twigs on the branches, and 5 leaves on each twig in the problem-solving notebook. Once completed with her picture, I asked her once again, "Can you tell me how many leaves are on the tree now?" She responded shaking her head, "Oh, no. No wait. Five, ten, fifteen". Student stopped talking and wrote down in her math journal the correct procedural steps to arrive at the correct answer. Student wrote 25 x 5 = 125. In order to view if Evelyn had a complete understanding of how to use this strategy in an effective way, I asked her, "Why is drawing a picture the best strategy to use in order to solve this mathematical word problem?" She answered, "I am able to see much better, 5 twigs and branches, and leaves look like."

Another student by the name Ruthy showed difficulties in applying mathematical strategies effectively. The word problem she attempted to solve read as follows:

The largest dinosaur might have weighed 60 tons. If each ton is equal to 2,000 pounds, how many might one of the largest dinosaurs have weighed in pounds? Show your answer in standard form and in scientific notation.

During her first interview I asked her, "What mathematical strategy could she use to solve this world problem?" She replied, "You can at this out." I made Ruthy aware that if she wanted us to act this problem out we needed to pretend we were large dinosaurs. Ruthy laughed and said, "Ok, no, no, Uhhh. We can make it simpler." Still in a confused state Ruthy continued to answer, "No, no, draw a picture." Obviously, Ruthy had the idea that using mathematical strategies would be helpful but when she tried to select one of the strategies she was undecided in which one would be best.

The next step in the interview process was did Ruthy use the mathematical strategy appropriately? I continued to ask her, "What important information should be included in the problem-solving journal?" She replied, "Each ton is equal to 2,000 pounds." In view of that her problem-solving journal reflected a picture of a dinosaur and a math scale of 1 ton = 2,000 lbs, I saw that she was on the right path to a correct solution. I proceeded to ask, "Can you please tell me how you arrived at your answer?" Ruthy replied enthusiastically, "I multiplied 2,000 pounds by 60 tons."

Evidently Ruthy had obtained the path to arrive at the correct answer but had difficulties in recalling correct definition to mathematical terms. The answer Ruthy wrote on her problem-solving journal was 120,000 lbs. I acknowledge her answer but made it known to her that she needed to represent her answer in scientific format. I asked her, "Can you tell me what scientific notation and standard form meant? Ruthy replied, "No, I forgot." Ruthy had a difficult time defining these two terms so I proceeded to ask her to define them separately. Ruthy stated, "Scientific notation means when you have a lot of zeros and then you turn it into a shorter number."

Ruthy showed an idea of what the definition of this word meant but reflected an incomplete understanding of the language of math." The difficulty of the terminology made Ruthy relate its' meaning to what the number should look like. I continued with the interview process and requested for her to show me what her answer should look like. Ruthy wrote her answer as 120.000 x 10. Ruthy answered now showed that she lacked perceptual skills and obtained some computational weakness. She had made errors because she carried numbers incorrectly, and did not write numerals. Noticeably Ruthy forgot the main characteristics that a scientific number has. In her answer, she had misplaced her decimal and did not include her exponent.

Emergent Theme #3: How did second-language learners demonstrate mathematics problem-solving skills?

Second language learners' mathematical problem-solving skills can be complex. Second language learners may take 6 to 7 years in processing their first language skills to acquire in second language (Chamot and O'Malley, 1994, Cummings, 1981). Therefore, because of the longitude in acquiring a second language, I found out that I needed to be part of the students learning process by applying language arts strategies into my math lessons. Cuevas (1994) stated, "The mathematics teacher becomes not necessarily an English-as-a-second (ESL) teacher, but rather a teacher of the language needed to learn mathematical concepts and skills" (p. 140). Through problem-solving journals and student interviews, I found out that second language learner' cognitive skills and academic development in the first language had an extreme important and positive effect on students performance. I found out that students' train of thoughts were in Spanish while solving word-problems. Students' journal performances reflected misspelled words in English. In addition, students were making translating their Spanish thought to English word verbatim by verbatim. Although, students language arts skills in English, were not fully developed, I found out that when students expand their vocabulary and their oral and written communication skills in the second language daily, they can increasingly, demonstrate their knowledge and problem-solving performances more effectively in both first and second language.

For second language learners audio-taped interviews were used to collect data on their thinking process during problem-solving. Problem solving journals were used to analyze, evaluate and critique the progress of the second language learner.

Problem-solving journals were analyzed, evaluated and critiqued in the same format as all journal entries in the study. I used a rubric (Appendix J). The rubric used helped me classify students mathematical abilities based on four levels; novice, apprentice, practitioner, and expert. ESOL students use reading and math strategies while solving these problems. I looked for details that influenced ESOL students' ability to solve these word problems.

In the study, I focused on two students problem-solving journals. The first student was Minerva. Minerva was a second year ESOL student who was monitored in regular classroom. Minerva problem-solving journal showed abilities sequencing multiple steps. Student journals reflect the ability to work in multiple elements of a word problem. Minervas' problem-solving journal reflected bad handwriting skills but gave good reasoning outputs in the word problems. At times she had difficulties in reading her work to me due to the lack of writing skills.

Minervas' problem-solving journal showed some computational errors. In addition, Minerva showed abilities to recognize and generate examples of concepts. Minerva highlighted key math terms and provided logical explanations to her solution process. Minerva demonstrated proper use of problem-solving strategies. Minerva overall problem-solving journal performance rated as a practitioner. The following examples illustrate her work:

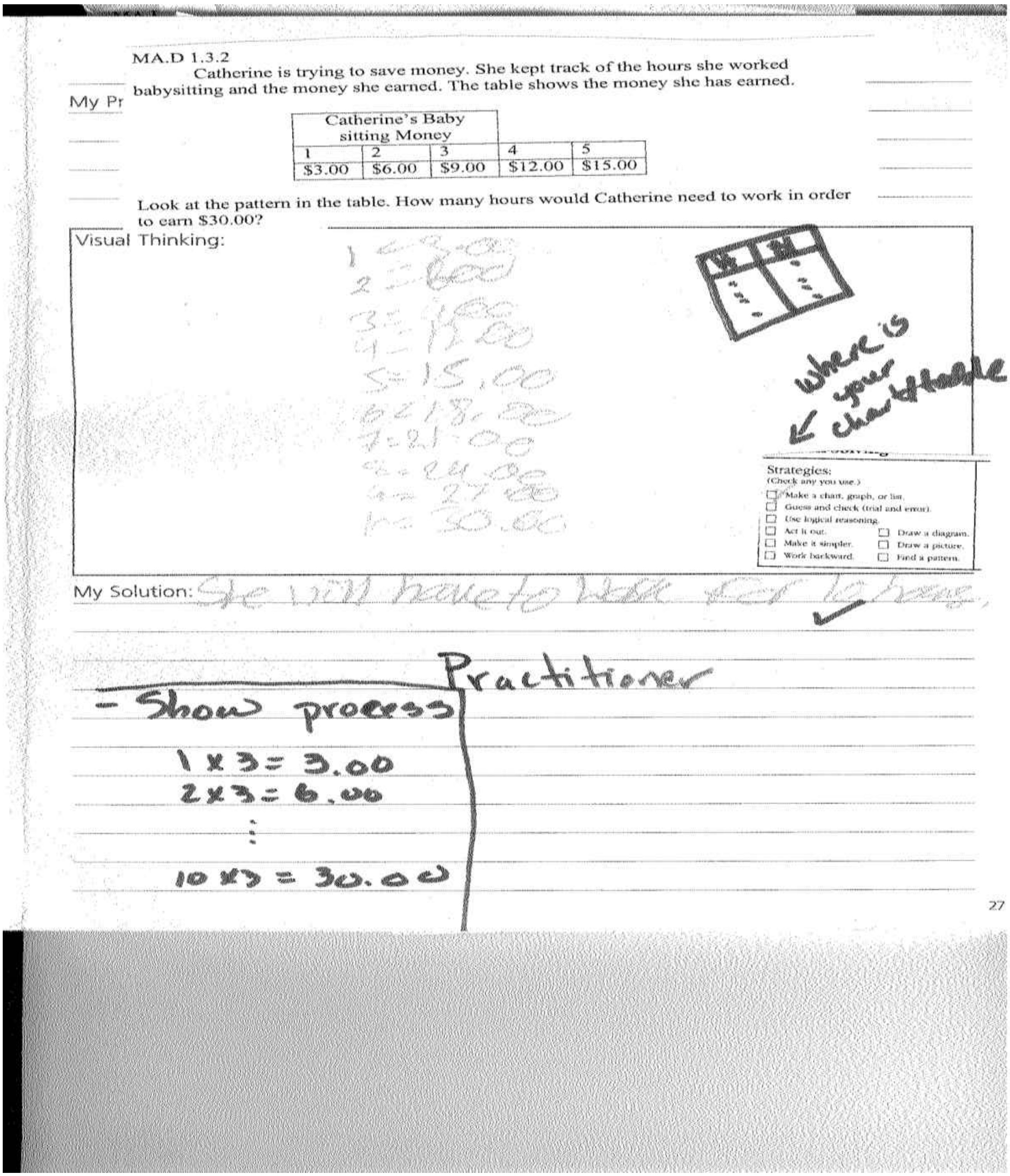
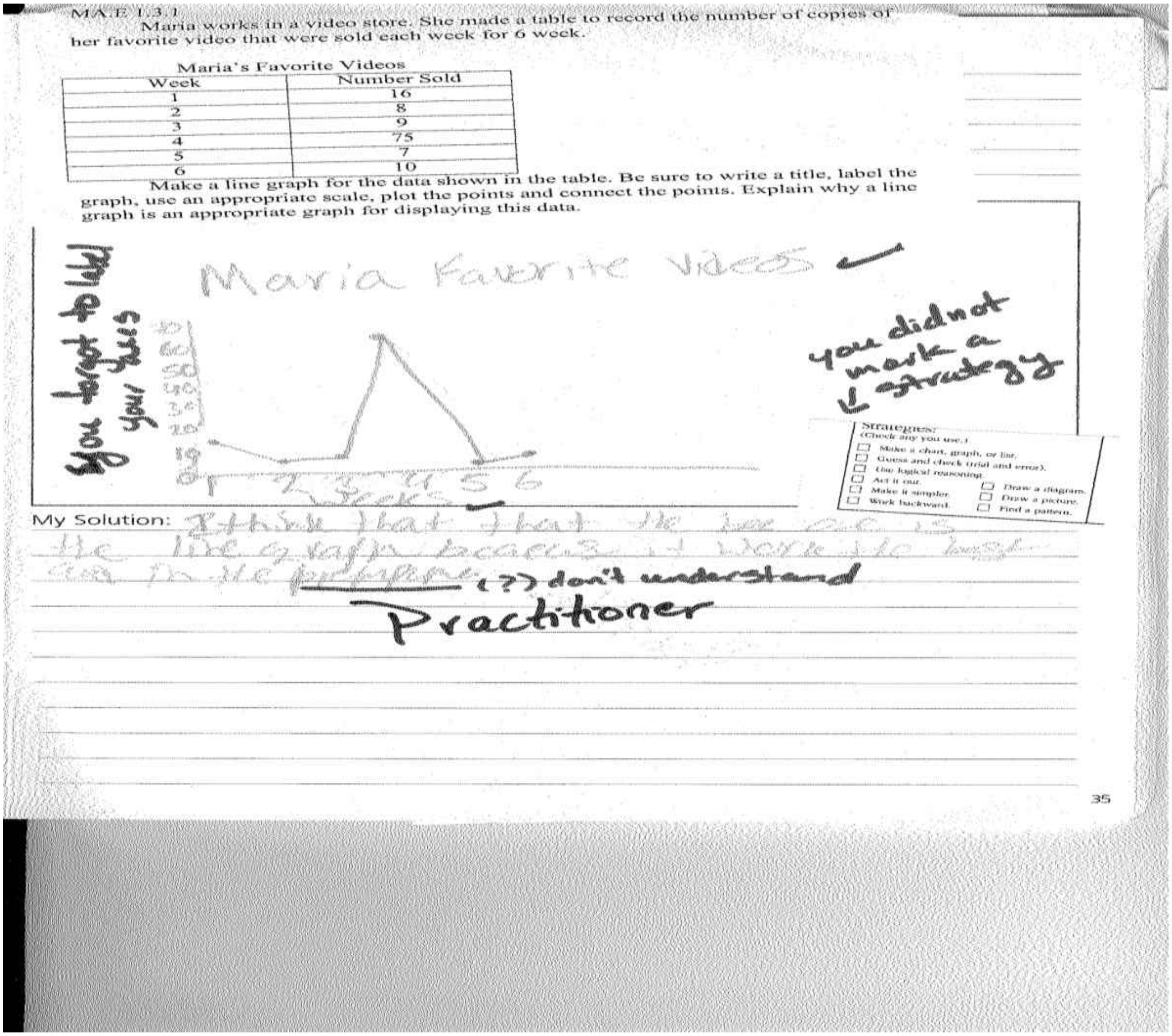


Figure 13: Problem-Solving Journal #1


MA.E.1.3.1

Maria works in a video store. She made a table to record the number of copies of her favorite video that were sold each week for 6 week.

Maria's Favorite Videos

Week	Number Sold
1	16
2	8
3	9
4	75
5	7
6	10

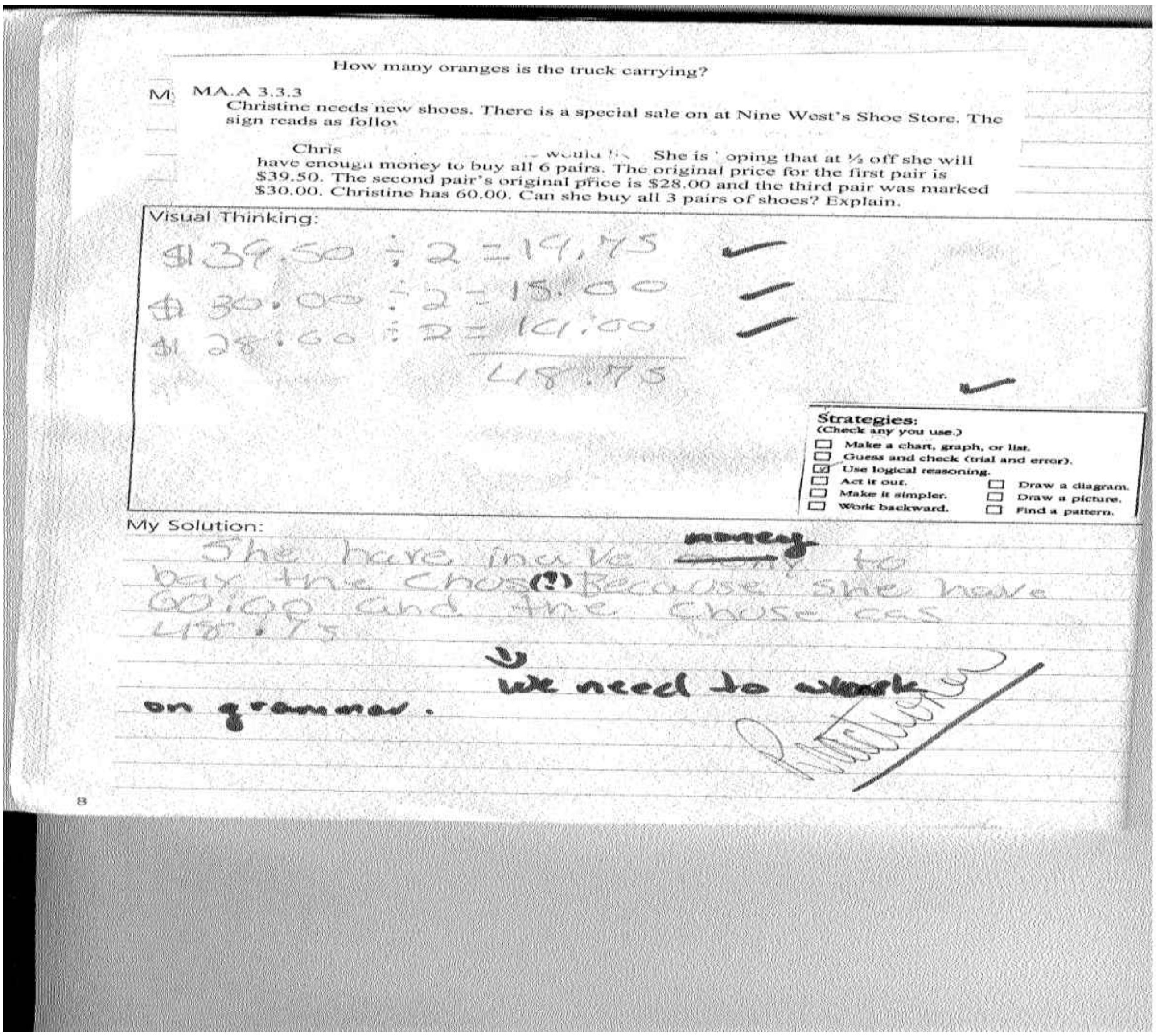
Make a line graph for the data shown in the table. Be sure to write a title, label the graph, use an appropriate scale, plot the points and connect the points. Explain why a line graph is an appropriate graph for displaying this data.

My Solution:

Figure 14: Problem Solving Journal #2

The second student work was Jenny. Jenny was an ESOL student in the regular classroom setting. Jennys' problem-solving journal showed that Jenny needed immediate intervention and additional time to complete tasks. Jennys’ problem-solving journal reflected abilities in highlighting key terms but revealed difficulties and the inability to effectively visualize math concepts. At times, Jennys’ problem solving journal reflected incorrect use of problem-solving strategies. Jenny problems-solving journal reflected her inability to read directions carefully.

Jenny's problem-solving journal showed that she did not go over her work and overlooked steps. On the other hand, Jennys' problem-solving journal showed very good abilities to give written explanation whether her problem-solving solutions were correct or not. Jenny's overall problem-solving journal performance was rated as a low practitioner due to extra time needed in the study. The following examples illustrate her work:


How many oranges is the truck carrying?

MA.A 3.3.3

Christine needs new shoes. There is a special sale on at Nine West's Shoe Store. The sign reads as follo

have enough money to buy all 6 pairs. The original price for the first pair is $39.50. The second pair's original price is $28.00 and the third pair was marked $30.00. Christine has 60.00. Can she buy all 3 pairs of shoes? Explain.

Visual Thinking:

$39.50 ÷ 2 = 19.75

$30.00 ÷ 2 = 15.00

$28.00 ÷ 2 = 14.00

48.75

Strategies:
(Check any you use.)
- Make a chart, graph, or list.
- Guess and check (trial and error).
- Use logical reasoning.
- Act it out.
- Make it simpler.
- Work backward.
- Draw a diagram.
- Draw a picture.
- Find a pattern.

My Solution:

She have inave money to buy the chos(?) Because she have 60.00 and the chose ess 48.75

we need to work on grammar.

Figure 15: Problem Solving Journal #3

In this study three ESOL students were interviewed. Student interviews were used to assists student that had difficulties with transferring knowledge learned in their native language to the second language. The main purpose was to help students analyze, evaluate, and justify word problems effectively in the content area.

Jenny was an ESOL student who was being monitored for one full year in a regular mathematical classroom setting. During her interview she stressed concerns on the following word problem:

Peninsula Citrus Company is hauling truckloads of citrus to the rest of the company. A driver for one of the trucks told the weigh station he was carrying 580 cases of oranges with 2 dozen oranges per cases. How many oranges is the truck carrying?

The interview began when I asked Jenny to retell what the word problem was about? Jenny replied in her own words, “So, I understand that the this truck is transferring orange from this place to another and that the total number of orange in the truck is five, five hoo [sic] hundred eighty and it’s two dooozan [sic] dozen orange per cart.” Jenny first session of the interview revealed that she had difficulties pronouncing words such as dozen and five hundred eighty. At times I would need to her repeat the word with me in order to help her pronounce the word correctly. In addition, Jennys’ interview also showed that she had a fair understanding of the language used in this word problem. As oppose to reading the entire word problem word for word, Jenny used her own words such as “transferring orange from this place to another” to express and summarize the word problem. Hence, Jenny made it known to me that she was able to retell the word problem at hand when she used her own words to speak about the word problem.

I continued to ask Jenny, “What are they asking for us to find out in this word problem? She replied, “To find out how many oranges, umm.” Jenny immediately showed signs of not being able to complete her sentence correctly. I completed the sentence for her by saying, “To find out how many oranges are in the truck.” Jenny had exposed to me what and how her mind tried to say. In Jenny mind, she attempted to answer this question in Spanish, meaning that her thoughts were in Spanish, but the words she used to speak were in English. For ESOL students’ this is very common and with time and immediate intervention students’ will learn to adapt to the new language and be able to learn how to transfer knowledge learned in her native language to her second language.

Minerva was the second ESOL student interviewed in this study. Minerva was in her second year of monitoring process by the ESOL department. Therefore, Minerva had better language skills than Jeanette. During Minerva interview, she expressed concerns on the following word problem:

Patricia is making a bracelet out of colored pieces of felt. She cut the felt into small equilateral triangles with 1 centimeter sides. She wants to sew the triangles together and make a special pattern along the perimeter. Patricia made a table to find the perimeter of the border after she sews the triangles together. What pattern does the table show? Write an expression that shows what the perimeter will be for any number of triangles, t. If Patricia makes a strip of bracelet material that is 25 triangles long, how many centimeters of edge will she have to sew with the special pattern?

Patricia’s Bracelet

Number of Triangles	Perimeter of he Border (in centimeters)
1	3
2	4
3	5
4	6
5	7
6	8
7	9

During the beginning process of her interview, Minerva made it know that she did not have any problems reading the word problem nor understanding what was being said but, had difficulties understanding the task at hand. I asked Minerva to state the main key math terms or verbs that are going to help us solve this word problem? Minerva answered correctly, “Small equilateral triangles, 1 centimeter, triangles, and perimeter. Therefore, Minerva revealed no signs of difficulties understanding the language.

In addition, Minerva showed no signs of difficulties using various strategies. When I asked which strategies she had chosen she stated, “Make-the problem simpler and keep the chart given”. In order to test Minerva’s ability on the application of the given strategies, I asked her, “How can we make this word problem simpler”. Minerva responded, “We can figure out how they took that triangle and made it three sides, follow the chart.” I replied, “What do you understand form the chart?” Minerva answered quickly, “Basically, for one triangle it has three sides, uhh, three, four. That means, well cause, a triangle has three side, so for one triangle they have three sides. I don’t get how they have two triangles four, cause a triangle has only three sides so, I get they got three but I don’t understand how they 4.”

It was obvious that Minerva had complete knowledge on the applications of these strategies. Minerva reflected the inability to read the table and execute the procedural steps embedded in the word problem. In order to guide Minerva, I referred her to the table and told to her, “Do you see a relationship between 1 and 3, 2 and 4, 3 and 5, 4 and 6, 5 and 7, … “Ohhh, I get it”, stated Minerva. Once, I read the chart to her, Victoria eyes opened widely. I interpreted Minervas’ comment as sign that she had connected the readings to the chart and was able to perform the procedural steps to this word problem. I asked her, Can you tell me how to solve this word problem?" Minerva replied, "For every two like, for one triangle they have three so they go on they add one more because two sides of a triangle are already touching so they can't add them up together." Minervas' answered reflected the inability to express her words clearly but Minerva did show the ability to reason logically. According to her statement, "Two sides of the triangle are already touching", and "So you can't add then up together" made it understandable to me that she grasped the gist of the problem meaning that when you combine two triangles together their sides touch and therefore make one side.

Throughout these student interviews, student performances reflected how students solved these word problems verbally step by step. Through the use of learning strategies and student interviews, ESOL students were actively involved in the learning process and became active participants in the content area of mathematics and reading. Overall, students became more confident and functional at problem-solving.

Recommendations

After conducting this action research study, I recommend that research continue to be done on the mathematical abilities of at-risk student. I also recommend that the use of a direct instructional approach be more accepted in our schools. I recommend teachers to have an accurate perception of what and how direct instruction is used. I encourage teachers to believe in the creativity that direct instruction had in attending the needs and progress of all students.

In addition, I recommend that on going professional development for teachers in the areas of problem-solving and students' mathematical abilities. Educators need to be more aware of the effectiveness that learning strategies can offer to students' achievement. I also recommend more research on teaching about problem-solving, problem-solving strategies, and the benefits they offer to students' cognitive level of achievements.

Furthermore, I recommend an increase on the use of technologies in our classroom. Technology had a positive affect in this study because it helped change the learning environment form a teacher center to a student center environment. I became a facilitator when students used the computer program. In addition, a positive computerized program such as National Computational System –Learn helped student acquire learning gains because it addressed students' academic needs according to the students' grade level.

Finally, I recommend teachers to use action research as a mean for leaning about their own teaching practices. Learning about students' problem-solving abilities in mathematics addressed many questions and concerns about the achievement levels of our students and the needs to help students improve their performances. Through action research teachers will compare classroom practices with their own to hopefully change or adapt other teaching practices to help students achieve greater learning gains in the future.

APPENDIX A: UCF IRB APPROVAL

APPENDIX B: PERMISSION TO USE TEST OF MATHEMATICAL ABILITY (TOMA-2)

APPENDIX C: NCS TRACKING CHART 1

Student Name	Starting Level	Number Of Sessions	Skills Reviewed	Ending Level	Comments

APPENDIX D: NCS-TRACTING CHART 2

BLOCK	STUDENT	PROBLEM	PLANS FOR IMPROVEMENT

APPENDIX E: VOCABULARY LOG

VOCABULARY WORD LOG (FRONT PAGE)

WORD	**WHAT DO I THINK IT MEANS?**	**WHAT DO I THINK IT MEANS AFTER READING?**	**DEFINITION**
1.	**1.**	**1.**	**1.**
2.	**2.**	**2.**	**2.**
3.	**3.**	**3.**	**3.**
4.	**4.**	**4.**	**4.**
5.	**5.**	**5.**	**5.**
6.	**6.**	**6.**	**6.**

VOCABULARY WORD LOG (BACK COVER)

EXAMPLE	WORD	NON-EXAMPLE	
1.	**1.**	**1.**	**NAME:**
2.	**2.**	**2.**	
3.	**3.**	**3.**	
			DATE:
4.	**4.**	**4.**	
5.	**5.**	**5.**	
			PERIOD:
6.	**6.**	**6.**	
			GRADE:

APPENDIX F: MATH JOURNAL LOGS

Name________________________________ Block __________

Title: **Math Journals**

Date	Strategy Used	Comments

APPENDIX G: INTERVIEW QUESTIONS

APPENDIX H: HOLISTIC RUBRIC SCALE FOR MATH JOURNALS

Holistic Scale

4	Mathematical knowledge: Shows understanding of the problem's mathematical concepts and principles; uses appropriate mathematical terminology and notations; and executes algorithms completely and correctly. Strategic knowledge: May use relevant outside information of a formal or informal nature; identifies all the important elements of the problem and shows understanding of the relationships between them; reflects an appropriate and systematic strategy for solving the problem; and gives clear evidence of a solution process, and solution process is complete and systematic. Communication: Gives a complete response with a clear, unambiguous explanation and/or description; may include an appropriate and complete diagram; communicates effectively to the identified audience; presents strong supporting arguments which are logically sound and complete; may include examples and counter-examples.
3	Mathematical knowledge: Shows nearly complete understanding of the problem's mathematical concepts and principles; uses nearly correct mathematical terminology and notations; executes algorithms completely; and computations are generally correct but may contain minor errors. Strategic knowledge: May use relevant outside information of a formal or informal nature; identifies the most important elements of the problems and shows general understanding of the relationships between them; and gives clear evidence of a solution process, and solution process is complete or nearly complete, and systematic. Communication: Gives a fairly complete response with reasonably clear explanations or descriptions; may include a nearly complete, appropriate diagram; generally communicates effectively to the identified audience; presents supporting arguments which are logically sound but may contain some minor gaps.
2	Mathematical knowledge: Shows understanding of some of the problem's mathematical concepts, and principles; and may contain serious computational errors. Strategic knowledge: Identifies some important elements of the problems, but shows only limited understanding of the relationships between them; and gives some evidence of a solution process, but solution process may be incomplete or somewhat unsystematic. Communication: Makes significant progress towards completion of the problem,

	but the explanation or description may be somewhat ambiguous or unclear; may include a diagram which is flawed or unclear; communication may be somewhat vague or difficult to interpret; and arguments may be incomplete or may be based on a logically unsound premise.
1	Mathematical knowledge: Shows very limited understanding of the problem's mathematical concepts, and principles; may misuse or fail to use mathematical terms; and may make major computational errors. Strategic knowledge: May attempt to use irrelevant outside information; fails to identify important elements or places too much emphasis on unimportant elements; may reflect an inappropriate strategy for solving the problem; gives incomplete evidence of a solution process; solution process may be missing, difficult to identify, or completely unsystematic. Communication: Has some satisfactory elements but may fail to complete or may omit significant parts of the problem; explanation or description may be missing or difficult to follow; may include a diagram which incorrectly represents the problem situation, or diagram may be unclear an difficult to interpret.
0	Mathematical knowledge: Shows no understanding of the problem's mathematical concepts and principles. Strategic knowledge: May attempt to use irrelevant outside information; fails to indicate which elements of the problem are appropriate; copies part of the problem, but without attempting a solution. Communication: Communicates ineffectively; words do not reflect the problem; may include drawings which completely misrepresent the problem situation.

APPENDIX I: RUBRIC FOR PROBLEM-SOLVING JOURNALS

LIST OF REFERENCES

Alfano, J. (1985). *Seventh grade vocabulary instruction vs classroom instruction.* (ERIC Document Reproduction Service No. ED257053)

Becker, W. C. (1977). Teaching Reading and Language to the disadvantaged-what we have learned from field research. *Harvard Educational Review, 47*(4), 518-545.

Bernando, A.B.I. (1999). Overcoming obstacles to understanding and solving word problems in mathematics. *Educational Psychology, 19*(2), 149-164.

Borasi, R., Siegel, M., Fonzi, J., & Smith, C. F. (1998). Using transactional reading strategies to support sense-making and discussion in mathematics classrooms: an exploratory study. *Journal for Research in Mathematics Education, 29*(3), 275-305.

Brent, G., & DiObilda, N. (1993). Effect of curriculum alignment versus direct instruction on urban children. *Journal of Educational Research, 86*(6), 333-338.

Bruck, M. (1992). Persistence of dyslexis' phonological awareness deficits. *Development Psychology, 28,* 874-886.

Carpenter, T. P., & Hiebert, J. (1981). Problem structure and first-grade children's initial solution process for simple addition and subtraction problems. *Journal for Research in Mathematics education, 12*(1), 27-29.

Chamot, A. U., & O'Malley, J. M. (1994). *The CALLA handbook: Implementing the cognitive academic language learning approach.* MA: Addison-Wesley Publishing Company.

Chamot, A. U., Dale, M., O'Malley, J. M., & Spanos, G. A. (1993). Learning and problem-solving strategies of esl students. *Bilingual Research Journal, 16* (3-4), 1-38.

Clay, M. M. (1993). *An observation survey of early literacy achievement.* . (ERIC Document Reproduction Service No. ED358427).

Cuevas, G. J. (Mar., 1984). Mathematics learning in english as a second language. *Journal for Research in Mathematics Education, 15*(2), 134-144.

Cunningham, A. (1990). Explicit vs implicit instruction in phonemic awareness. *Journal of experimental child Psychology, 50,* 429-444.

De Corte, E., & Verschaffel, L. (1987). The effect of semantic structure on the first graders' strategies for solving addition and subtraction word problems. *Journal for Research in Mathematics, 18*(5), 363-381.

Diezmann, C. M., Thornton, C. A., Watters, J. J. (2003). Addressing the needs of exceptional students through problem solving. In Lester Jr., F. K., & Charles, R. I. (Eds.), *Teaching mathematics through problem solving issues* (pp. 168-182). Bloomington, IN: National Council of Teachers of Mathematics.

Englert, C. S., & Thomas, C. C. (1987). Sensitivity to text structure in reading and writing: a comparison between learning disabled and non-learning disabled students. *Learning Disability Quarterly, 10,* 93-104.

Greenberg, D., Ehri, L. C., & Perin, D. (1997). Arc word reading processes the same or different in adult literacy students and third-fifth graders matched for reading level? Journal *of Educational Psychology, 89,* 262-275.

Geary, D. C., Bow-Thomas, C. C., & Yao, Y. (1992). Counting knowledge and skill in cognitive assition: a comparison of normal and mathematically disabled children. *Journal of Experimental Child Psychology, 54,* 372-391.

Hurford, D. P., Darrow, L., Edwards, T., Howerton, C., Mote, C., Schauf, J., & Caffey,

P. (1993). An examination of phonemic processing abilities in children during their first grade year. *Journal of Learning Disabilities, 26*(3), 166-177.

Jerman, M., & Rees, R. (1972). Predicting the relative difficulty of verbal arithmetic problems. *Educational Studies in Mathematics, 4,* 306-323.

Kameenui, E. J., Carine, D. W., & Freschi, R. (1982). Effects of text construction and instructional procedures for teaching word meaning on comprehension and recall. *Reading Reseach Quarterly, 17*(3), 367-388.

Kintsch, W., & Greeno, G. (1985). Understanding and solving word arithmetic problems. *Pyschological Review, 92*(1), 109-129.

Lei, Y., & Rachor, R. (2000, April). *Two year evaluation of the three year direct instruction program in an urban public school system. Paper presented at the Annual Meeting of the American Educational Research association, New Orleans LA.* (ERIC Document Reproduction Service No. ED305170)

Lester, F.K.Jr., Masingila, J.O., Mau, S.T., Lambdin, D.V., dos Santon, V.M. & Raymond, A.M. (1994). Learning how to teach via problem solving. In Aichele, D. and Coxford, A. (Eds.) *Professional Development for Teachers of Mathematics* , pp. 152-166. Reston, Virginia: NCTM

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

Lloyd, J. W., & Keller, C. E. (1989). Effective mathematics instruction: Development, instruction, and programs. *Focus on Exceptional Children, 21*(7), 1-10.

Mann, V.A. (1993). Phoneme awareness and future reading ability. *Journal of Learning Disabilities, 26,* 259-269.

Mathematical Sciences Education Board. (1989). "Everybody counts: a report to the nation on the future of mathematics education." Washington, D.C.: National Academy Press.

Mills, G. E. (2000). Action Research: *A guide for the teacher researcher* (2nd ed.). Upper Saddle

River, NJ: Merill Prentice Hall.

Moats, L. C. (1999). *Teaching reading is rocket science.* (ERIC Document Reproduction Service No. ED445323).

National Assessment of Educational Progress (1999). "Report card for the nation and the states. National Center of Education Statistics." Washington, D. C.: U.S.

National Council of Teachers of Mathematics (1989). "Curriculum and evaluation standards for school mathematics." Reston VA: National Council of Teachers of Mathematics, Inc.

National Council of Teachers of Mathematics (2000). "Principles and Standards for Secondary Mathematics." Reston VA: National Council of Teachers of Mathematics, Inc.

O'Connor, R. E., Notary-Syverson, A., & Vadasy, P. F. (1996). Ladders to literacy: the effects of teacher-led phonological activities for kindergarten children with and without disabilities. *Exceptional Children,* 63, 117-130.

O'Malley, J. M., Chamot, A. U., Stewner-Manzanares, G., Kupper, L., & Russo, R. P. (1985a). Learning strategies used by beginning and intermediate esl students. *Language Learning 35*(1), 23-45.

Pratt, A. C., & Brady, S. (1988). Relation of phonological awareness to reading disability in children and adults. *Journal of Educational Psychology, 80,* 319-323.

Reis, R. & Spekman, N. J. (1983). The detection of reader-based versus text-based inconsistencies and the effects of direct training of comprehension monitoring among upper-grade poor comprehenders. *Journal of Reading Behavior, Vol. XV,* No. 2.

Schweinhart, L., & Weikart D. (1988). Education for young children living in poverty: Child initiated learning or teacher-directed instruction. *The Elementary School Journal, 89,*(2) 213-223.

Shankweiler, D., Lundquist, E., Dreyer, L. G., & Dickinson, C.C. (1996). Reading and spelling difficulties in high school students: causes and consequences. *Reading and Writing: An Interdisciplinary Journal, 8,* 267-294.

Silvernail, D.P. (1989, March). *Teaching styles as related to academic achievement.* Descriptive Report, NEA professional Library. (ERIC Document Reproduction Service No. ED316526).

Spanos, G., Rhodes, N. C., Dale, T. C., & Crandall, J. (1988). Linguistic features of mathematical problem solving. In R. Cocking and J.P. Mestre (Eds), "Linguistic and cultural influences on learning mathematics." Hillsdale, NJ: Lawrence Erlbaum.

Stahl, S. A., Fairbanks, M. M. (Spring, 1986). The effects of vocabulary instruction: a model-based meta-analysis. *Review of Educational Research, 56*(1) 72-110.

Stebbings, L.B., St. Pierre, R. G., Proper, E. C., Anderson, R.B., & Cerva, T.R., (1997). *Education as experimentation: A planned variation model, Vol. IV A.* Cambridge, MA:ABT Associates.

Waxmon, H., & Padron, Y. (1997). Improving the quality of classroom instruction for students at risk of failure in urban schools. *Peabody Journal of Education, 70,* 44-65.

Zabrucky, K., & Ratner, H. H. (1992). Effects of passage type on comprehension monitoring and recall in good and poor readers. Journal of Reading Behavior, Vol XXIV, No. 3.