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The Effects of Teaching Problem Solving Strategies to Low Achieving Students

Abstract

In this action research study of an eighth grade Math Intervention class, we investigated the following:

- *the direct teaching of problem-solving strategies to low achieving students;*
- *the effect the academic achievement has on these students; and*
- *students' perceptions of themselves as problem solvers.*

We discovered that students tended to have a positive experience with problem-solving activities when given direct instruction on a variety of strategies. Through the use of a four-point rubric, students' written responses tended to be more comprehensive about their understanding of the problem. Over a span of four weeks during the spring semester in 2006, the researchers provided instruction on specific problem-solving strategies in Math Intervention class. Then students were given the opportunities to apply these strategies to several "Habits of Mind" problems presented in the Math 8 classrooms. As a result of this research, we plan to expand the current curriculum to include more problem-solving challenges for low achieving students.

Kristin Johnson and Anne Schmidt

Math in the Middle Institute Partnership

Heaton/Action Research Project

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Currently in Lincoln Public Schools every middle school offers a Math Intervention class, which is designed for students who have been previously unsuccessful in the regular math class and have low standardized test scores in math. There are two district-wide objectives for the course. First, to support the regular math curriculum so students in Intervention maintain a “B” average in Math 8. Secondly, to improve the basic arithmetic skills, like basic addition, subtraction, multiplication and division. Previously, this course has been team taught by a math teacher and a special education teacher. In 2006, two math teachers, Kristin Johnson and Anne Schmidt, were given the opportunity to work together to develop the curriculum. Kristin had taught 14 years in Lincoln Public Schools, including nine years at Quade Middle School. Anne had taught for 21 years at Quade Middle School.

We introduced problem-solving warm-ups to the class that were directly related to the regular math curriculum. Although we saw some pretty compelling evidence that the Intervention students grades in Math 8 are comparable to non-Intervention students grades in the same class, there was a gnawing feeling that we were just getting through a curriculum instead of helping students to develop a deeper understanding of mathematics. Students still want a "step by step" process that they can apply to all problems and were uncomfortable when asked to find their own way to solve a problem.

PROBLEM OF PRACTICE

Many students in this class lack not only accuracy with basic mathematical operations but they have a deep-rooted belief that they will never be very good at solving math problems. One of the goals for this class is for students to develop confidence in their own ability by helping them to become better problem solvers. By helping to boost not only their problem-solving

abilities but their own perceptions of their mathematical abilities, we hoped they would become a bit more tenacious when dealing with a difficult problem and thereby improve their scores.

Problem solving has been identified by the NCTM as an area of emphasis in any math curriculum. For us, as teachers, this tended to be an area of concern for low achieving students due to increased scrutiny of test results mandated by the federal government. In order to help foster improvement in achievement, some direct instruction of problem solving is necessary. We, as teachers, want to help all of our students, strugglers included, become better problem solvers. If we can show that low achieving students may not be strong in basic facts but, in fact, can solve more intricate problems, perhaps the emphasis in Math Intervention can be altered to include the intellectual challenge so often lacking for some students. The issue of how to help low achieving math students develop their math skills is not unique to Lincoln, Nebraska. Hopefully, a plan of action can be detailed enough to allow other teachers the opportunity to find a new avenue to attempt.

Literature Review

Year after year, there is a constant struggle in classrooms of how best to meet educational needs of low achieving students in mathematics. Many students are enrolled in remedial classes due to poor performance in previous math classes or low scores on standardized tests. Some research suggests that a lack of competency in basic arithmetic operations can have a negative impact on success in math class (Gersten & Chard, 1999). Some students lack motivation to put much effort into learning mathematics or being successful at school at all. One study found that low socio-economic female students are more at risk for failure due to a belief that their intelligence and math abilities are uncontrollable and rigid and that no amount of effort can change it (Schullo & Alperson, 1998). This study used an assessment of students' and teachers'

implicit beliefs of intelligence and math and the relationship of their beliefs to final grades in algebra. Other students may have identified disabilities in math or reading that also affect their performance in class (Bottge, 2001).

One of the mandates issued by the National Council of Teachers of Mathematics (NCTM) is working to improve problem-solving strategies for all students of all grade levels (NCTM, 2000). Students at risk or with specific learning disabilities could benefit from an equity model of providing “mathematics for all” (Bottge, 2001). Students who have experienced little success in mathematics can learn various problem-solving strategies that will help develop mathematical skills and build confidence in their own abilities as problem solvers (Pajares, 1996). This study was based on 8th grade students who completed an attitude and confidence survey related to problem solving.

Problem solving is the process of building new mathematical knowledge through the application and adaptation of appropriate strategies used to solve problems. Not only will students’ abilities with basic facts influence problem-solving accuracy, students’ ability to read and understand the question will directly impact student success with a given mathematical task. Students who are able to translate the written problem and use appropriate symbols and unit clues are less likely to make errors during the problem-solving process (Pape, 2004). In this study, individual students were presented with problems to solve. Students worked through the problems and they were asked questions by a research assistant about the problem-solving process they were using.

Students with special needs tend to have a difficult time with the kind of translations some problems require (Bottge, 2001). Without the ability to interpret and break down a problem, students may be impatient in their pursuit of a solution and will ultimately be

unsuccessful. Often problems found in a typical curriculum may employ a strategy that is not true problem solving. Looking for key words in the text does little to foster the connections authentic problem solving seeks to build (Woodward & Montague, 2002). Explicit instruction of meaningful problems can help struggling students be more successful in mathematics classes.

A lack of experience with problems with multiple solutions or multiple methods of solution can be difficult for some students to digest. Providing a framework for students to experiment with their own solutions requires a teacher who is willing to allow students to utilize previous learning in a unique way in order to solve a problem (Fraivillig, Murphy & Fuson, 1999). This was a five-year longitudinal study that involved eighteen first grade teachers as they implemented a problem-solving mathematics curriculum.

Math Intervention offers a unique opportunity to double the amount of time for math instruction. According to a study that looked at student, teacher, and parent surveys as well as standardized test scores, student achievement is affected directly by instructional time. This study also stated there was a direct effect of instructional quality on student attitude toward mathematics (Reynolds & Walberg, 1992). Student perception of instructional quality was one factor measured in this study.

Students with mild disabilities or those who were at risk improved their achievement in solving word problems by shifting the emphasis from instruction of key words and computational skills to instruction in problem comprehension (Jitendra, et al, 1998). This study was used with elementary students, who were given focused instruction on problem solving following a pre-test which was then compared to post-test data. This provides a springboard for the development of our problem-solving curriculum. An article describing mathematical Habits of Mind listed characteristics of effective problem solving such as: pattern sniffers,

experimenters, describers, tinkerers, visualizers, conjecturers, and guessers (Cuoco & Goldenberg, Mark, 1996).

Research clearly suggests improvement of problem-solving skills will lead to higher student achievement. By targeting a class comprised of students who struggle with mathematics, we hope to determine whether the direct instruction of problem-solving skills will have an effect on students' attitude, self-perception, and achievement in their regular math class.

Helping low-achieving students should be a major component in Math Intervention classrooms. By improving our students' problem-solving ability, they are more likely to be more engaged and motivated in their Math 8 classroom. "If we want to empower our students for life after school, we need to prepare them to be able to use, understand, control, modify, and make decisions about a class of technology that does not exist. That means we have to help them develop genuinely mathematical ways of thinking" (Cuoco, Goldenberg & Mark, 1996, p. 40).

Purpose Statement

The purpose of the study was to determine whether the direct teaching of problem-solving strategies to low achieving students in Math Intervention class improved student understanding of problem-solving strategies and their self perception as problem solvers. Data collection took place during the spring semester in 2006 in the eighth grade Math Intervention class at Quade Middle School, Lincoln, Nebraska.

This study will attempt to answer these research questions:

- How did the teaching of problem-solving strategies to Math Intervention students transfer to a regular Math 8 classroom?
- How did students' perceptions of their own problem-solving abilities change as a result of increased exposure to problem-solving activities?

- How did students' communication skills change through the increased use of problem-solving activities in Math Intervention class?
- What problem-solving skills did students develop as a result of this unit?

Method

The primary modification to the Math Intervention curriculum was to include and expand the students' experience with problem solving by:

1. Finding an efficient way to arrive at a solution
2. Helping students effectively communicate their solution by writing and diagrams.

Through examples given on a near daily basis, students were introduced to a number of problem-solving strategies. The student work was kept in binders that were left in the classroom. Each day, a new problem was added as well as a writing prompt designed to allow students to express their process of finding a solution. The problems became more involved as we progressed through the year and eventually culminated with "Habits of Mind" type problems.

Student work was examined for effective use of specific problem strategies and clear explanations of the process given in writing. The daily problems were graded on a rubric (See Appendix A). Students also filled out a pre- and post-attitude survey (See Appendix B). Both instructors also documented classroom interactions and events. Four students were interviewed at the end of this project to provide further insight into their problem-solving experience (See Appendix C).

To answer the question, how the teaching of problem-solving strategies to Math Intervention students will transfer to a regular Math 8 classroom, we examined student work from a problem-solving unit in the Math 8 course. We also looked at specific responses on

problem-solving questions on Math 8 quizzes and tests. We asked students to share what strategies learned in Math Intervention were helpful in the Math 8 class.

The student surveys were also used to give insight as to how student perceptions of their problem-solving abilities changed as a result of increased exposure to problem-solving activities. The use of the four-point rubric to evaluate student work was introduced to Math Intervention students as a way to help students find specific ways in improve the quality of responses. Student interviews also provided a source of information about their feelings about the work completed.

Student written responses to problems given in Math Intervention were evaluated using the four-point rubric to help us answer the question of how students' communication skills changed. In Math 8 classes, we also examined the student responses on quizzes, tests and problem-solving activities.

Teacher observation was the key to help us analyze what problem-solving skills students developed as a result of this unit. Both teachers noted student involvement and understanding in their weekly journals. The four-point rubric and student survey helped us to determine what strategies students understood.

Analysis

What we found was that our unit seemed to be more effective for some students than for others. For example, on the question below given on a Math 8 quiz some Intervention students were able to write a coherent solution to the query while other Intervention students would not even attempt the problem (See Appendix D).

Explain in writing: how you find the number of people who liked the color red. You gave a survey and 25% of the responses said their favorite color was red and there were 200 people who took the survey.

As part of our curriculum in Math 8 class, we worked through a two-week problem-solving unit which involved several “Habits of Mind” type problems (See Appendix E). In Math Intervention class, we worked on a specific strategy with a simpler problem (See Appendix F). The "Habits of Mind" problems tended to be a bit more rigorous than those done in the Math Intervention class. Some of the problems took multiple days to complete. The techniques involved were working backward, finding a pattern, starting with a simpler problem, and using a diagram.

Our observations were that our Math Intervention students were as engaged as other students in the Math 8 class. The Math Intervention students were willing to attack the problem whereas some of the students not in Intervention were more uncertain about how to start to find a solution. Sometimes, the Math Intervention students were able to offer suggestions on how to start. For example, when presented with the Locker Problem, one of the Math Intervention students suggested that making a table would be a good strategy to try.

We were hoping to see our Math Intervention students in more of a leadership role in the class, but that did not seem to be the case. Despite the fact that Math Intervention students knew a number of strategies, students were reluctant to volunteer information to the class without a prompt from the teacher. Students would abandon prior work in favor of using another strategy when their initial efforts were right on track. There is still the residual feeling of not wanting to risk being wrong in front of the class.

We used the rubric throughout the problem-solving unit in Math 8 with the locker, bunny and hexomino problems. Unfortunately, because we had to miss days of teaching throughout the unit, we were unable to give prompt feedback to students. We believe the quality of student responses would have improved had we followed the format of providing a rubric grade and a comment before proceeding to a new problem, as done in Math Intervention class.

With increased exposure to problems where the paths to a solution may not be initially evident, we saw some of the Math Intervention students develop the confidence to attack the problems given. During the first week of our unit, we noticed that some students would not even attempt the problem unless we were in direct contact with individuals. One or two students would jump right into the problem, but most of our students were reluctant to try a method that could be “wrong.” We also noticed some students who wanted to fall back on previous ways of solving a problem and not attempt to practice a new method. The reluctance to expand the problem-solving bag of tricks was a bit of a surprise to us. Even after we would demonstrate a technique and ask students to try to utilize the new method, a few students would prefer to stay with their own tried and true ways. For example, one particular student resisted using the method of drawing a diagram. Instead, he used other less efficient methods like guess and check and struggled. Many of our students have a perception that they will know the right way to proceed when presented with a problem, but some still need reassurance from us before they will proceed.

By the third week, we were seeing more students jump into the problems without hesitation. There were still a few who seemed to need constant reassurance or a prompt to get started. We were expanding students’ problem-solving bag of tricks, but some students were not yet able to open the bag without help. Toward the end of the quarter, we developed a packet of

eight problems that any of the problem-solving techniques could be effectively used to find solutions. When we handed out the packet, we did not hear one complaint. All students attempted to start right away without prompting, and only one problem seemed to require teacher assistance (see Appendix G). This problem required students to look at a three dimensional relationship from information given in two dimensions. We suggested to students that they may want to make a model to illustrate the situation more clearly.

When the Math 8 classes were presented with a new problem, it was more likely we would hear complaints from non-Math Intervention students like “this is too hard” or “I don’t get it.” The Math Intervention students were less negative about being presented with these challenges. One of the problems given was to find all possible hexomino shapes, that is, shapes made up of six squares. As students were walking out the door, they were asked to find all solutions. Nicole did find 33 out of 35 solutions, working alone. Nicole was asked if the problem was hard for her. She said, “Kind of, but it was fun...it was challenging to find all of them.” We saw students more willing to stick with it, working until they had found as many as possible.

We gave the Math Intervention students a pre-survey and post-survey relating to learning problem-solving techniques. The questions were rated on a five-point scale with 5 being high and 1 being low. What we found is that the majority of students either improved or maintained their perception of “I know and can use a variety of problem-solving strategies.”

In retrospect, we felt that the use of the pre-survey was not as helpful as we had anticipated. Many students did not yet know what problem solving meant. The results did not seem to agree with what we observed in class, possibly due to students not understanding what the strategies were until instruction was provided. However, when students rated themselves on

the use of a particular strategy, we found that the frequency with which a particular strategy was used increased. When given the prompt “nothing creative about math, just memorizing facts and formulas,” survey results showed students disagreed with this statement more strongly at the end of the problem-solving unit than at the beginning. The survey was scored on a 1-5 scale, with 1 being the student “strongly disagreed” with the statement and with 5 being “strongly agreed” with the statement. The means were computed for both the pre- and post-survey results shown below.

Statement	Pre-Survey mean	Post survey mean
1. I enjoy trying to solve new problems in mathematics.	3.29	3.17
2. Mathematics makes me uneasy and confused.	2.64	2.67
3. Mathematics helps develop a person's mind and teaches them to think.	3.92	4.17
4. Mathematics is not important in everyday lives.	1.92	2.25
5. I am confident in my ability to solve new problems.	3.77	3.58
6. There is nothing creative about mathematics, it's just memorizing formulas and facts.	2.54	2.27
7. When I get stuck solving a problem I stop working.	2.29	2.50
8. I know and can use a variety of problem solving strategies.	3.38	4.09
9. I like to solve challenging math problems.	2.86	2.83
10. I keep working at a problem even when I feel frustrated.	3.00	2.83

With the introduction of the four-point rubric and with feedback provided on problems done in class, students did show improved skills in writing out their solutions. We elected to not only emphasize the specific strategy to solve a problem but also how a good solution is written. We decided to pick problems that our students would be able to figure out different ways (Appendix H). The strategies we emphasized were:

1. Working backward
2. Guess and check
3. Draw a diagram

4. Look for a pattern
5. Use a table to organize information

Students were encouraged to use these strategies on a variety of problems throughout the unit.

We started the problem-solving unit with introduction and practice with the working backward strategy. We introduced the following problem:

Pat went bowling. First he spent half of his money to rent bowling shoes and pay for the games he bowled. Then he spent \$2.75 at the snack bar. He had \$3.15 left. How much money did Pat have at the start?

Students did find different methods to use to find the correct solution. We were then able to show the application of the work backward strategy in this particular situation. We were also able to pull out a similar problem and ask students to decide what information is given. If an ending quantity is given, then working backward is an appropriate method of solving the problem.

The students' response to the writing prompt in the first problem tended to focus more on their opinion rather than on the facts. We were hoping students would respond by recognizing they were given the ending total and so needed to work backward to find the amount of money Pat started with. Students were not sure how to justify why their solution method was a valid one to use. The writing prompt asked students to explain why working backward is a good strategy for solving this problem. Emily wrote, "Because it is easier and just better to work with."

We returned the problems to students after assigning a grade from the four-point rubric. We also tried to add comments to students' papers like, "why did you start with this" that would hopefully encourage students to expand on the thought process used to solve the problem. We

discussed the difference between opinion and fact when writing a solution. We found that most students on the second day were able to write a more coherent explanation of the tactic used to solve a problem. Some students still have a difficult time coming up with the words to use to describe a problem-solving process.

Even though this is a class in which letter grades are not used, students are graded on a commendable, satisfactory or needs improvement scale. The four-point rubric has been a great motivator for students to give a good effort on their written solutions. As students look back in their notebooks to see their previous score, we hear the chatter. "Look, I got a four" or "how come I only got a three on this?" The second question provides a springboard to offer very specific advice about what could be added to their explanation that would bump their score up to a four. Usually, the next write-up provided by that student was a bit better.

During the session on using a table to organize information, we gave the students the following problem:

Chris bought a newspaper for 25 cents. How many different coin combinations were possible to pay for the newspaper with exact change?

Tyler's write up to the question "Explain why it is important to keep your data organized when solving this problem" was given a three on our four-point rubric:

"It is important to keep your data organized by putting them in a chart like I did on the back of the paper because it makes it a whole lot easier than just writing them down."

Our comments to Tyler tried to steer Tyler away from opinion and into fact. We wrote: "Did it help you know that you didn't have the same solution twice? How can you tell if you found them all?"

For the same problem, Nicole received a four out of four when she wrote, "Because if you don't it gets harder to tell what matches what on your data table." Nicole was able to see the rationale for using the table to organize the information generated by the problem. If students view a method as efficient and accurate, they are more likely to be successful in solving the problem.

The effectiveness of the rubric surprised us both. During the post-unit interview, each of the three students could easily recall the four-point rubric and how it worked. Each student was motivated by the rubric to give their best effort on each problem. Nicole made the comment that when she got a 3 or a 2 "I could look at it and figure out what I did wrong from what I got." According to Tyler, "it gave confidence that tomorrow I could do this." We asked students during their interview to select a problem they were most proud of. Jerome flipped immediately to "the first one I got a 4 on."

Another strategy we introduced to Math Intervention was the guess and check method of problem solving. Students were very comfortable with this strategy as it had been discussed in previous coursework. However, many students wanted to use guess and check to solve a problem when a much more efficient strategy would be available.

One particular example for which the guess and check strategy is the most appropriate strategy to use is the following:

Last Saturday, George and his friend, Mike went to a big-league baseball game. After the game, they went to the locker room to collect autographs of their favorite players. Together they collected 18 autographs, but Mike collected 4 more than George. How many did George collect?

Most students could solve this problem, but seemed to have difficulty finding a way to organize their responses. Nicole received a four for her solution to this problem.

"I made a graph and guessed 12 for George and Mike has 4 more which =16 that doesn't =18. I knew I had to guess lower which I picked 8 then added 4 which =20 so I knew I had to pick lower so I guessed 6 then added 4 = 16 so I knew I had to guess higher so I guessed 7 then added 4 which = 18 that's how I found my answer."

She also included this chart:

G	M	
12	16	
8	12	
6	10	=16
7	11	=18

Although Nicole used one long, long sentence to explain the process she used and left out some key words, like she found the sum of 12 and 16 then compared the total to 18; she clearly demonstrates an understanding of the process used to solve the problem

Interpretation

Overall, the direct teaching of problem-solving strategies to Math Intervention students was mostly positive. Some students did not demonstrate any improvement in their selection of strategies or in their written responses. Other students were able to apply strategies and write complete solutions in other situations outside of Math Intervention.

The four-point rubric and problem-solving binders were very effective in helping the Math Intervention students organize and evaluate the quality of their solutions. We will continue to use the notebooks in Math Intervention but we will expand the use of the four-point rubric to include all Math 8 students.

The direct teaching of problem-solving strategies will be continued and expanded on next year. At the beginning of the school year, we will introduce specific techniques for solving problems and continue to apply this to Habits of Mind problems throughout the year.

We will continue to examine student self-perceptions of their ability through surveys and teacher observation. We hope to gain insights of how we might better motivate students to be more successful in future math classes.

Although the start of this journey was a difficult one due to circumstances beyond the control of anyone connected with this project, the process has allowed for us to examine, on a formal basis, the effect of a curriculum decision on individual students.

"The real voyage of discovery lies not in seeking new landscapes but in having new eyes."

--Marcel Proust

Through the experience of working together on this project, we gained another set of eyes to evaluate student progress through the new curriculum. The gift of each other in the classroom allowed us to give the students the gift of expanded facility with difficult math concepts and, hopefully, joy in the process of problem solving.

References

- Bottge, B. A. (2001). Reconceptualizing mathematics problem solving for low-achieving students. *Remedial and Special Education, 22*(2), 102-112.
- Cuoco, A., Goldenberg, E. P. & Mark, J. (1996). Habits of mind: An organizing principle for mathematics curricula. *Journal of Mathematical Behavior, 15*, 375-402.
- Fraivillig, J. L., Murphy, L. A. & Fuson, K. C. (1999). Advancing children's mathematical thinking in everyday mathematics classrooms. *Journal for Research in Mathematics Education, 30*(2), 148-170.
- Gersten, R. & Chard, D. (1999). Number sense: Rethinking arithmetic instruction for students with mathematical disabilities. *The Journal of Special Education, 33*(1), 18-28.
- Jitendra, A. K., Griffin, C. C., McGoey, K., Gardill, M. C., Bhar, P. & Riley, T. (1998). Effects of mathematical word problem solving by students at risk or with mild disabilities. *The Journal of Educational Research, 91*(6), 345-355.
- National Council of Teachers of Mathematics. (2000). *Principles and Standards for School Mathematics*. Reston, VA:
- Pape, S. J. (2004) . Middle school children's problem solving behavior: A cognitive analysis from a reading comprehension perspective. *Journal for Research in Mathematics Education, 35*(3), 187-219.
- Reynolds, A. J. & Walberg, H.J. (1992). A process model of mathematics achievement and attitude. *Journal for Research in Mathematics Education, 23*(4), 306-328.
- Schullo, S. A. & Alperson, B. L. (April, 1998). Low SES algebra1 students and their teachers: Individual and a bi-directional investigation of their relationship and implicit beliefs of ability with final grades. Paper presented at Annual Meeting of the American Educational Research Association, San Diego, CA.
- Woodward, J. & Montague, M. (2002). Meeting the challenge of mathematics reform for students with LD. *The Journal of Special Education, 36*(2), 89-101.

Appendix A

Rubric to assess problem solving problems

- 4 **WOW!!** Work is accurate, answer is correct, explanations are complete
- 3 **OKAY!!** Work may have 2 or 3 minor errors but understanding is evident
- 2 **Hmmm** Many errors, little understanding is evident
- 1 **Yucky** No evidence of minimal understanding or effort

Appendix B

Student Interview Questions

Johnson/Schmidt
April 7, 2006

We will have student problem-solving notebooks and the hexamino work.

Direct Teaching of Problem Solving Strategies

1. In Math Intervention class, we introduced different problem solving strategies. Do you remember any?

Were any of these helpful to you?

Written Communication

2. Do you remember the 4-point rubric used to grade your solutions to the problems in the problem solving notebook?

How did the rubric help you write up good solutions to your problem?

Which solution from your notebook are you most proud of? Why?

Persistence

3. Let's look at the hexamino problem. Do you remember how many solutions there were? How many solutions did you find? Did it take a long time? How did you know if you found all the solutions? How did you organize your work?

Was this problem hard for you?

Appendix C

Mathematics Survey

Date _____

Please place an X in the column that you feel is most accurate. Use the code below for each category.

SD-Strongly Disagree, D-Disagree, U-Unsure, A-Agree, SA-Strongly Agree

Statement	SD	D	U	A	SA
1. I enjoy trying to solve new problems in mathematics.					
2. Mathematics makes me uneasy and confused.					
3. Mathematics helps develop a person's mind and teaches them to think.					
4. Mathematics is not important in everyday lives.					
5. I am confident in my ability to solve new problems.					
6. There is nothing creative about mathematics, it's just memorizing formulas and facts.					
7. When I get stuck solving a problem I stop working.					
8. I know and can use a variety of problem solving strategies.					
9. I like to solve challenging math problems.					
10. I keep working at a problem even when I feel frustrated.					

Please place an X in the column that you feel is most accurate. Use the code below for each category.

N- Never used, S-Seldom used, F-Frequently used

In the past few weeks, how often have you used each of the following problem-solving strategies?

Strategy:			
11. look for a pattern			
12. organize information in a table			
13. use a graph			
14. work the problem backwards			
15. write and solve a math problem			
16. draw a diagram			
17. use manipulatives or objects (such as algebra tiles)			
18. begin with a simpler problem			

Appendix D

Math 8
Chapter 7 Quiz 2

Name _____
Period _____

For questions #1-4, set up a proportion or equation, then solve, showing all work.

1) 11 is what percent of 55? (1) _____

2) What number is 42% of 125? (2) _____

3) 15 is 25% of what number? (3) _____

4) 28 is what percent of 84? (4) _____

5) (a) Tell whether the change is an increase or decrease.
(b) Find the percent of change. Show work!

Original amount : 25
New amount: 40

(5a) increase or decrease
(Circle One)

(5b) percent of change = _____

Solve the following problem. Show all work.

6) A new \$300 jacket is on sale for 30% off. The sales tax is 6%.
How much will the jacket cost (including tax) if you buy it on sale?

7) **Explain in writing** how you find the number of people who liked the color red. You gave a survey and 25% of the responses said their favorite color was red and there were 200 people who took the survey.

Appendix E

The Locker Problem

Name _____

QuickTime™ and a TIFF (LZW) decompressor are needed to see this picture.

QuickTime™ and a TIFF (LZW) decompressor are needed to see this picture.

There are 20 lockers in one hallway of King School. In preparation for the beginning of school, the janitors closed all of the lockers and put a new coat of paint on the doors, which are numbered 1 to 20.

When the 20 students in the school returned to school, they came up with a plan to burn off some energy.

The first student ran down the row of lockers and opened every door.
 The second student ran down the row of lockers and changed the state of every 2nd door.
 The third student ran down the row of lockers and changed the state of every 3rd door.
 The fourth student ran down the row of lockers and changed the state of every 4th door, and so on, until all 20 students had passed by the lockers.

- 1) Explain any patterns you see for which doors are open (or closed).
- 2) Which of the lockers are still open after the twentieth student is finished? Explain **why** those lockers are still open.
- 3) Which lockers changed the most? Explain **why** those lockers changed the most.

- 4) Suppose there are 200 lockers.
Which lockers are open after the 200th student finished?
Explain **why** those lockers are still open.

Appendix F

An example of problem solving in Math Intervention.

What is the greatest number of coins you can use to make 35 cents? What is the smallest number of coins you can use? In how many ways can you make 35 cents?

Appendix G

Problem Math Intervention students struggled with from the end of quarter packet.

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Appendix H

Sample problems from Math Intervention problem-solving curriculum

Sample 1.

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Sample 2

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Sample 3

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Sample 4

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Sample 6

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.