INCREASING STUDENT MOTIVATION IN THE MIDDLE SCHOOL CLASSROOM

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Abstract

The purpose of this study was to investigate the effects of using problem-solving strategies in middle school mathematics classes. Participants were seventh grade Pre-algebra students from a school located in Maryland. Sixty-nine students participated in the study. Using math attitudinal surveys, exit tickets, observations and interviews as measuring tools, this study was designed to determine if motivation in students would increase if the students were taught problem-solving strategies in order to help them become more resilient. Students successfully completed exit tickets and demonstrated resiliency in attempting and successfully completing problems that appeared unsolvable to them. Also, based on the attitudinal surveys, after only a one-week period, 16% of the students no longer hated the challenge of math.

Introduction

I am a middle school mathematics teacher in a Maryland school in a very large school district. With the start of each new school year, I experience the same behaviors with my students. The majority of my Pre-algebra students enter my classroom with a very low self-confidence level in their mathematics abilities. Some lack willingness to participate for fear of failure, and they get discouraged very easily. In my classroom, before teaching problem-solving strategies, students who were unable to complete a math problem were likely to give up on it and skip it. Looking at this on a larger scale, I found students were not only giving up on or skipping problems in class, they were also demonstrating this behavior on statewide tests.

To start the year in a positive direction, I prepare several problem-solving lessons to teach to my students. I would give the Pre-algebra students an algebra problem that I knew they did not have the algebraic knowledge to solve, and I would tell them to find a way to solve it. For example, in one lesson I gave them a chicken and a cow problem that would be solved algebraically using a system of equations. They had to determine the number of chickens and the number of cows a farmer had, given only the number of heads and the number of legs. Since they did not have the knowledge to solve the problem algebraically, they had to use a problem-solving strategy like drawing a picture. I used the problem-solving lessons as a scaffold in order to help the students build their confidence level in their math abilities and take risks in math class. As a result of these lessons, I have observed significant increases in my students' willingness to solve problems they would not attempt before. Then, I heard that the curriculum I teach was being realigned to meet state testing guidelines. Not only was the curriculum I teach being realigned, but the problem-solving lessons that I feel are very beneficial in boosting the students' confidence levels were being omitted from the curriculum.

Imagine my dismay when I learned that because of our new statewide curriculum problem-solving strategies were omitted. I began to realize if I were to teach these outside of the given curriculum then I would need more solid evidence that these approaches really were effective. In an attempt to unravel the problem-solving mystery that had manifested in my life, I conducted a short study of seventh graders using multiple methods of problem-solving strategies.

Purpose Question

In an attempt to research the effects of problem-solving strategies on middle school students, I developed the following research question: Would students become more resilient in solving mathematics problems if they were taught problem-solving strategies? Resilience is defined in this study as the ability the students have to bounce back when they make a mistake. It involves

demonstrating the willingness to try a different way to solve problems when the first way is not successful. I studied sixty-seven seventh grade Pre-algebra students of which 28 were males and 39 were females. Resiliency was measured by observing the different strategies that the students utilized when they were confronted with challenging math problems.

Review of Related Literature

Middle school brings about many changes in a child's life. Children are transitioning from child-like behaviors to adult-like behaviors. Middle school aged students are in a limbo-like transition where they are still acting and feeling like children part of the time, but they want to demonstrate grown-up behaviors at other times. It is a time when they are not seen as children who are dependent, but they are seen as adolescents who now need to be given more responsibilities in order to prepare for their lives as adults.

One major change that occurs is that students now have to be more cognizant of their responsibilities in order to get tasks done independently. They are transitioning from someone else being responsible for all aspects of their lives to becoming capable of evaluating their own needs, their own performance, and their own academics (Wentzel, 1997). This transition that occurs is important because this is the time when children either develop an eagerness to learn or begin to devalue education and disengage from the learning process which influences their motivation and their academics (Wentzel, 1997). In order to encourage students to become eager to learn, teachers must incorporate motivational strategies into their lessons and help the students be successful. Middle school students are at a point in their lives where they are beginning to determine if they have the power to produce results they intend to achieve. If they are successful, they become more eager to learn. If they fail, they begin to disengage from the learning process. Therefore, teachers should provide students with many opportunities to develop a positive self-efficacy. Researchers have identified four key features of a positive self-efficacy: self-regulation, risk-taking, intrinsic motivation, and mastery goals.

Self-Regulation

Some students have self-regulation techniques. Students who possess self-regulation techniques have the ability to take responsibility for their own learning (Dembo & Eaton, 2002; Gordon-Rouse, 2001). They use strategies that they have developed in order to complete a task on their own, follow through on assignments, and place the responsibility of mastering the content on themselves. Students without self-regulation strategies depend on other people in order to learn.

In addition to seeking and avoiding tasks, there are also students who seek help and those who avoid seeking help. There will always be random times that students will have questions or require clarification of the content. Therefore, it is important that they seek help when they need it. Research has shown that students who were confident in their abilities, had mastery of the content, and had a positive self-worth were more likely to seek help. However, students who were not confident in their abilities and did not master the content were not likely to seek help for fear of appearing incapable in front of their peers (Turner, 2002; Ryan & Pintrich, 1997; Dembo & Eaton, 2000; Newman, 1990).

Waxman & Huang (1996) conducted a study about resilient students in comparison to non-resilient students in mathematics abilities. They used instruments that elicited individual responses to each student's role in the mathematics classroom. They found in their study that resilient students had the ability to bounce back easily when they experienced any sort of failure, and resilient students were more motivated than non-resilient students. When resilient students made an error or mistake, they were likely to reexamine the problem or issue and then find another way to solve it. However, when non-resilient students made an error or mistake, they were likely to give up and accept failure viewing it as their own incompetence. Teaching students problem-solving strategies will equip the students with more than one way to solve a math problem. In turn, problem-solving strategies will help the students be more successful in their math abilities and become more resilient when attempting math problems.

Risk-Takers

Teachers often encounter students who are willing to take risks and students who prefer not to take risks. There are several differences between the two types of students. Risk takers prefer difficult tasks. They have a tolerance for failure, and they have the ability to be flexible when they make errors (Turner, 2002; Newman, 1990). On the other hand, students who do not take risks fear failure. They want easy tasks so they can attain success, and when errors arise, they tend to just give up on the task.

It is very important for educators to understand the differences among students in regards to their willingness or non-willingness to learn and to complete tasks given to them. Although there is a continuum where students can be placed in different circumstances, such as they may be willing to learn on one day and not another, this study will focus on the two major ends of the continuum: those students who consistently seek challenges and those students who consistently avoid challenges. Students who seek challenges have a positive self-worth; whereas, students who avoid challenges have a low self-worth (Turner, 2002; Ryan, 1990). Students are more likely to seek challenges when they are confident in their abilities. They accept themselves for who they are and demonstrate a desire to be successful. On the other hand, challenge avoiders are more concerned with how others perceive them and avoid tasks for fear of failure. Wieschenberg & Arvai (1994) stated that people who are highly motivated and seek challenges achieve success because they take responsibility for their own successes and failures and attribute failure to lack of effort on their part; whereas, those who avoid challenges do not take credit for their successes, and they feel that their failure is due to their lack of ability. Problem-solving strategies may encourage risk-taking because the students will have alternate ways to be successful when encountering more difficult math problems. Problem-solving strategies will enable students to attempt challenging problems because they are equipped with strategies to help them attain success.

Intrinsic Motivation

Teachers encounter students who either have intrinsic motivation or extrinsic motivation. Students who develop intrinsic motivation want to learn for their own benefit. They have a sense of accomplishment based on their own effort and perform a task because it is going to be beneficial to them in some way. Students with extrinsic motivation have external reasons for performing a task. They receive some type of reward from someone, and the reason they perform the task is solely for that reward. They do not appear to care about the benefits the activities would have for them and their intelligence. It is much more important to develop activities and strategies that encourage intrinsic motivation in students so they can see the importance of a task and the benefits the task will hold for them in their everyday lives.

As students transition from elementary school to middle school there is a change in social roles and expectations. Middle school aged students form different relationships with students, teachers, and parents. Peer relationships become more important for students at this age as they become more independent of adults. Interpersonal relationships can potentially influence academic motivation and intrinsic motivation. There was a relationship between the way middle school students perceived support and caring from their parents, teachers, and peers and their motivation to succeed academically (Wentzel, 1998; Howard & Johnson, 2000; Read, 1999).

Students must be able to get along with and work in groups with other students. Therefore, peer relationships are very important both inside and outside of the classroom. The students' perceptions of their peers' support is a predictor of academic success or failure. If students feel a high level of peer acceptance, they are apt to be more successful academically; however, if they feel lower levels of acceptance, they are more prone to academic difficulties (Wentzel & Watkins, 2002; Ryan & Pintrich, 1997; Wentzel, 1998; Howard & Johnson, 2000; Gordon-Rouse, 2001). Peer relationships also affect help-seeking behaviors. Students who felt accepted were less likely to feel threatened by peers when asking for help. Therefore, those students would be more likely to ask for help when they needed it (Turner, 2002; Dembo & Eaton, 2000; Newman, 1990; Ryan & Pintrich, 1997). In addition, it is important for educators to realize that students viewed the use of extrinsic motivational strategies by teachers as more threatening to their peer relationships than using intrinsic motivational strategies. As a matter of fact, students who had low perceptions of their own cognitive ability were more likely to feel criticized by their peers when pursuing extrinsic motivation (Ryan & Pintrich, 1997).

Based on the literature review, it appears that self-efficacy mediates between math ability and math achievement (Randhawa, Beamer, & Lundberg, 1993). Without the willingness to take responsibility for their own learning and success, their resiliency, and their perceptions of how they are viewed and cared about socially, students may not achieve in math even though they may have the ability to do so. Learning problem-solving strategies would allow students to make mistakes in front of their peers, but then establish resiliency by using another strategy to be successful. Allowing students to see other students make mistakes, but then demonstrate resiliency by using a problem-solving strategy will stimulate encouragement for others who are having difficulty with the math problems while it reinforces intrinsic motivation in those resilient students because of their successes in correctly solving math problems.

Mastery Goals

Another way to look at students is in terms of their goals. Some students have mastery goals while other students have performance goals (Turner, 2002; Ryan & Pintrich, 1997; Wentzel, 1998). Mastery goals are goals in which students feel a sense of accomplishment from mastering the content they are learning. They are more interested in the process, the way something is done, instead of the product that they get at the end. They value their own learning and do not compete with others. Students who demonstrate performance goals are more interested with the product. They compete with other students to have the best project. Their learning is based on how others perceive their work. Problem-solving strategies will help the students value their learning because they are being successful, which would help the students become more resilient on other tasks. If students are able to make connections using problem-solving strategies to gain success in math, I believe they will use other problem-solving strategies that will help them be successful in their everyday lives.

Increasing student confidence levels in their mathematics abilities will not occur over night. It is a process that takes time. However, I feel increasing student confidence levels in their math abilities is an important topic in education, and I believe that problem-solving strategies help students develop a positive attitude towards mathematics. In a study conducted by Howard & Johnson (2000), teachers and students were interviewed about various resilience factors. Both teachers and students stated that problem-solving skills positively influenced student resiliency. In addition, another study about resiliency conducted by Read (1999) concurred with Howard & Johnson's study stating that problem-solving skills are necessary in order for students to be resilient. If students are successful with mathematics, develop an appreciation for the subject, and understand the importance of mathematics in their everyday lives, they will be motivated to learn it. If they are motivated, they will learn the content to a deeper level of understanding and will be able to better retain the information.

Purpose of the Study

Would students become more resilient in solving mathematics problems if they were taught problem-solving strategies? Here are the specific research questions for this research:

1. What are students' attitudes about math before and after instruction on problem-solving strategies?
2. To what extent did students demonstrate resiliency by voluntarily applying problem-solving strategies to specific math examples?
3. Did students report that problem-solving strategies were beneficial in helping them achieve success when they could not solve a math problem?

It is very important for educators to help students become responsible for their own learning. Providing students with problem-solving strategies will allow the students to see that there is more than one way to solve a problem, and it will give them a chance to be successful even when they are attempting a more challenging problem. It is also very important for students to have positive attitudes about learning so they will be motivated to learn. Since students learn and are motivated in many different ways and have many influences on their lives, it is important for educators to support the students with strategies that will help them gain success and confidence in their abilities while helping the students take responsibility for their own learning and achievement.

Methodology

Design of the Study

This project was an action research project that was conducted in a Title I middle school. The study incorporated mixed methods of both qualitative and quantitative sources. Qualitative sources were used in order to gain a deeper level of understanding of the students' resilience about using problem-solving strategies; quantitative sources were used to ensure that the students understood the process of using problem-solving strategies. The study consisted of a math pre- and post-attitudinal survey, five lessons, and six interviews.

Participants

The sample for this study was selected from the 7th grade population of 223 students. The school had a satisfactory attendance rate of 94.2%. Total student population at the school was 621. Of that population there were 358 white students, 231 African American students, and 32 students of other descents. The students who attended this school were considered of low economic status. A median family income was $46,035 a year, and 6.6% of the families were considered below the poverty line.

One hundred twenty-two students were selected based on their level of mathematics. The Pre-algebra classes were specifically chosen because I considered them the average group of the 7th grade; Passport Mathematics is a lower level course and Algebra I is a higher-level course. Passport Mathematics students and Algebra I students were excluded from the study due to their math ability levels. As the researcher, I was more interested in the average group because I thought they were more likely to benefit from learning the problem-solving strategies.

Instruments

A math attitude survey was used that was developed by TERC, a not-for-profit education research and development organization based in Cambridge, Massachusetts. The survey was found at http://www.terc.edu/mathequity/cg/html/survey.html. It was based on a survey developed by Elizabeth Fennema for high school students, but I judged it to be appropriate for middle school students. I slightly altered it for two reasons: to allow for additional questions and to have more discrete differences in point values to demonstrate higher or lower attitude levels. The survey measured math attitudes. It included questions about liking/disliking math, boys' vs. girls' abilities in math, their own perception of their math ability level, and the importance of math in school and in everyday life. It was used as a pre-assessment and post-assessment instrument to measure students' attitudes and feelings about mathematics. It was anonymous with the exception of the students identifying their age and gender.

Another instrument used was exit tickets. Exit tickets were administered at the end of each lesson in order to assess whether students would be able to understand the benefits of the problem-solving strategies and/or use the appropriate problem-solving strategy to solve a problem that required mathematical knowledge with symbols that they have not previously learned. For example, students may not have known how to solve an algebraic problem, but they could draw a picture to solve it.

In addition to the attitudinal surveys and exit tickets, six interviews were conducted at the end of the study in order to gain a deeper level of understanding as to whether problem-solving strategies were beneficial in increasing students' confidence levels in their math abilities and promoting resiliency when completing more challenging math problems.

Procedure

The study was explained to all 7th grade Prealgebra students. They were told that they were invited to participate in a study to determine if learning problem-solving strategies and how to use them effectively would help them solve problems that they did not think they could solve.

The study began with the administration of an anonymous attitudinal survey about mathematics. The purpose of the survey was to determine if students had a positive or negative view towards the subject of mathematics. The highest possible score was 36 points. The higher the score, the more positive students were about their feelings towards mathematics.

After the surveys were administered, the students participated in a problem-solving unit. The unit was five days in length and consisted of five lessons. The first lesson was an introduction to problem-

solving strategies and why those strategies are important. The following three lessons consisted of the students learning three problem-solving strategies: drawing a picture, making a table, and establishing a pattern. The fifth lesson combined all three problem-solving strategies. The purpose of the 5th lesson was to help the students understand when to use a problem-solving strategy and to determine which strategy would be most beneficial for them to use. Each lesson ended with an exit ticket. The exit tickets ranged from solving problems using the strategy they learned for that day to answering journal questions.

After the problem-solving unit was taught, students had a class discussion as to the advantages and/or disadvantages of the lessons in which they participated in order for the students to hear the views of their peers. After the discussion, the students were given the same math attitudinal survey that they were given at the beginning of the study to determine whether their attitudes about mathematics changed.

Finally, six students participated in interviews that helped me better understand if the students thought that problem-solving strategies were beneficial. The interviews also helped me determine if the students would use problem-solving strategies on their own and when they would choose to use them. The interview consisted of three parts: a math problem, questions about state testing, and questions about problem-solving strategies (See Appendix A).

Data Analysis

The data that was collected included the responses to the surveys, the responses to the exit tickets, and the responses to the interviews. The responses for the attitudinal survey were scored, and points for all the statements were tallied to get one total score that determined the students' attitudes towards mathematics. Students who received a higher score demonstrated a higher confidence level in their math abilities. In addition to total scores, each question was analyzed for specific data that supported resilient behavior characteristics.

Each exit ticket and/or journal entry was scored on a four-point rubric, four being the highest score and zero being the lowest score, in order to determine the students' understanding of the problem-solving strategy as well as the problem-solving process or importance, and the extent to which they could successfully apply the problem-solving strategies that they learned.

Responses to interviews were analyzed to determine whether the students understood the problem-solving strategies, the importance of using them, whether they perceived problem-solving strategies to be beneficial, and whether they would use problem-solving strategies on their own, and when they would choose to use them. After analyzing exit tickets and interviews, I went back to the attitude surveys as a source of further explanation for my findings.

Results

Based on the exit tickets and interviews, it appears that many students were able to effectively use problem-solving strategies. The majority of the students received either 3 or 4 points on each of the exit tickets which demonstrated their ability to use each problem-solving strategy. The students were required to use the problem-solving strategy in their exit ticket in order to prove that they understood how to use it even if they were capable of solving it algebraically.

Problem-solving strategies definitely need to be learned. The majority of the students did not instinctively use a problem-solving strategy when they were having difficulty with a math problem prior to learning the strategies. However, I believe after the students learned the problem-solving strategies and the importance of using problem-solving strategies, the students developed a positive attitude about using them. For example, during the interviews the students were given a problem about ducks to solve, and every student who did not know how to solve the duck problem used a problem-solving strategy. All six students who were interviewed successfully solved the problem, five of whom used a problem-solving strategy to solve it. It is important to note that the students were given the Duck problem several days after the problem-solving unit had been completed and were asked to solve the problem. They were given no other directions besides, "Can you please take a couple of minutes to solve this problem?" The five students who did not know how to solve it algebraically used a problem-solving strategy. The problem-solving strategies used by the students in

the interview were drawing a picture, making a table, establishing a pattern, and guess and check. In addition, I believe the students developed an appreciation for and a positive attitude towards problem-solving strategies because when completing the exit tickets, every student was on task attempting to solve the problems, and during the interviews, not one student said he/she could not complete the duck problem. All the students worked to try to solve the Duck problem without persuasion.

The students demonstrated resiliency by voluntarily applying problem-solving strategies to specific math examples. They independently completed each exit ticket. When analyzing each specific problem-solving strategy, the results were as follows: 90% of the students were successful when drawing a picture, 84% of the students were successful when making a table, and 71% of the students were successful in establishing a pattern. I defined success as earning a 3 or a 4 on the exit tickets which demonstrated an overall or very good understanding of the problem-solving strategy process. In addition, in the final lesson, the students were given the opportunity to use any problem-solving strategy at each station. The problems at each station were designed so that at least one of the strategies of drawing a picture, making a table, and establishing a pattern could be used. However, I did not limit the students to these strategies. The students actively attempted each problem with a partner. They utilized their newly learned strategies and asked for only a minimal amount of help from me with the problems. As a walked around the room and observed the students, the students appeared to be using problem-solving strategies that they had just learned to achieve success in solving the problems that they otherwise were not equipped to solve algebraically. Even though I gave them math problems that were at an Algebra I level, they were demonstrating resiliency by not only attempting the problems, but also by solving the problems successfully.

Students reported that problem-solving strategies were beneficial in helping them achieve success when they could not solve a math problem. In addition to solving problems in the final lesson, the students had to answer three questions. The questions focused on the students' willingness to use problem-solving strategies and which strategies they preferred. When asked if they would use problem-solving strategies in math class, fifty-eight students out of sixty stated, "yes". Several of the students answered the question further by stating problem-solving strategies "helped me understand the problems better" and "made them easier to solve."

Responses towards question two, which focused on when the students would choose to use a problem-solving strategy also made it appear that problem-solving strategies were beneficial for the students. Many students responded with answers such as, "when I can't find a better way of doing it, when I get stuck on a problem, when I need help solving a problem, and/or when I have a problem visualizing it." The third question focused on the students' favorite problem-solving strategy. Keep in mind that the students were introduced to more than just the three problem-solving strategies in the first lesson of the unit. Several problem-solving strategies were chosen; however, the majority of the student responses indicated that they would use one of the three problem-solving strategies that I taught. This may be because the students better understand how to use those three strategies after learning specifically about them.

The interviews conducted also made it appear as if problem-solving strategies helped the students gain success in solving math problems. When asked about the statewide testing and its difficulty level, the students responded that when they got stuck on a problem, they used a problem-solving strategy to help them get the correct answer. This also demonstrated the students' resiliency not to give up or skip questions that appeared foreign or unsolvable on a very important test. I also felt it was important to ask the students if they thought I should teach the problem-solving strategy unit next year to the new students who would be entering my classroom. All six students responded, "Yes, because problem-solving strategies help students understand problems better."

There is an overwhelming consistency to the students' responses about learning problem-solving strategies. Ninety-seven percent of the students in this study responded that they would use problem-solving strategies to help them be successful in math. In addition, they felt problem-solving strategies were beneficial for them to learn. Understanding how to use problem-solving strategies and the importance of using them has left a positive impact on the students involved in this study. They demonstrated resiliency in solving problems that were very challenging because they did not have the algebraic knowledge or ability to solve the problems otherwise. In addition, I feel the students had a

more positive attitude towards their math abilities because they truly understood that every problem has more than one way that it can be solved.

There was little change between attitudinal surveys. Most students expressed positive attitudes toward math independent of learning problem-solving strategies. There was one exception. The results of the statement, "I hate the challenge of math," demonstrated that 16% of the students who initially agreed with the statement that they hated the challenge of math when they completed the pre-attitudinal survey changed their opinion to disagree in the post-attitudinal survey, which demonstrated that after learning problem-solving strategies they no longer hated the challenge of math. After a one-week unit on problem-solving strategies these eleven students no longer hated the challenge of math.

Limitations of the Study

There were two limitations to this study. The first limitation was that I only taught three problem-solving strategies when many more exist. This was a limitation because there are many problem-solving strategies that students can utilize to help them solve problems, and students may have preferred a problem-solving strategy that I did not teach in the problem-solving unit, which would not have indicated whether the students applied good problem-solving skills. The second limitation was that the students knew they were receiving a grade for the exit tickets; therefore, they may have conformed to my expectations to receive a good grade. In addition, the students may have thought that I wanted them to demonstrate a positive attitude towards using problem-solving strategies when all I really wanted was to investigate the effects of problem-solving strategies on the students' resiliency in their math performance.

Discussion

Previous research has indicated that students who are equipped with problem-solving skills are more resilient and that students who are successful take responsibility for their own learning. In conducting research on problem-solving strategies, my findings were congruent with previous research. First, ninety-seven percent of the students in this research study responded that they would use problem-solving strategies when they encountered a problem that they did not understand or had difficulty solving. In observing the students, I found that fewer students asked for help when attempting to solve a more challenging problem. Therefore, the students were taking responsibility for their own learning.

Second, in interviewing students, they stated that they used problem-solving strategies on the statewide test, which demonstrated their ability to be resilient. They used the resources that were available to them. If I had not taught problem-solving strategies, the students would have had two choices other than attempting the problem. They could have guessed the answer, or they could have completely skipped it and not answered it at all. I truly believe that statewide test scores may increase due to students learning problem-solving strategies because the students in my study were intrinsically motivated to attempt to correctly solve the problems using a problem-solving strategy. I feel if the students are using the strategies, they may be using them because they feel they are truly helping them achieve success, not just because I taught them.

In order for students to be motivated, it is important for them to have strategies to use when they are presented with a situation that they feel is beyond their understanding or ability. Problem-solving strategies are a source of motivation for students. They can use problem-solving strategies to take math problems that appear foreign to them and make sense out of those problems by drawing pictures, making tables, establishing patterns, etc. so they can successfully solve the problem. Problem-solving strategies help the students visualize or organize a concept so it appears easier to solve. They help students break concepts into smaller pieces so the problems seem more manageable. Therefore, students may feel like they are taking control of the problem instead of the problem taking control of them, and control has always appeared to be a motivational factor in life.

Although the pre- and post-attitudinal survey showed very little differences in scores, it demonstrated one very important aspect of student learning. Both surveys were given within a one-week period. I believe that it takes teenage students more than just a one-week time period to change their overall

attitudes towards math. They have already formed opinions and attitudes about their math abilities, and they have experienced math and the struggles of math for many years at this point in their lives. However, surprisingly, in a one-week period eleven students changed their feelings towards the challenge of math. Based on the exit tickets and surveys, it appears that many students are able to use problem-solving strategies. These findings may help to explain the reason why eleven fewer students agreed with the statement, "I hate the challenge of math," on the post survey. If students were taught problem-solving strategies in the beginning of the year, and those strategies were reinforced throughout the year, I believe that the number of students who hate the challenge of math may decrease even more. Learning problem-solving strategies and when to use them should be a regular part of student learning. It is possible that learning problem-solving strategies helped the students see math not as a challenge to be detested, but as a challenge to be embraced.

There are definite school curricula implications that need to be considered. As previously mentioned, the school district I work for omitted problem-solving strategies from the curriculum I teach when they realigned the curriculum to meet state-testing goals. After teaching the problem-solving strategies and interviewing students, I found that when students were unable to solve problems on the statewide test, they used problem-solving strategies. Keep in mind that in my classroom, before I taught problem-solving strategies if students were unable to complete a math problem, they were likely to give up on it and skip it. In life, there are many problems that the students will face. If they are conditioned to use problem-solving strategies in their schoolwork, I believe it will overflow into their everyday life. The students may become better problem-solvers in everything they do because they will know that they have different options. In this study, the students have shown that when they are aware of different options that they use those options to gain success. However, if teachers do not equip the students with several options, they may think that they only have one choice in everything they do in school as well as in life.

Although this study was conducted in a Title I middle school, I feel that problem-solving strategies would be beneficial for students at all schools and grade levels to learn. It would make the students accountable for their own learning, and it would help the students develop self-regulation techniques that help students become more resilient. Also, it would allow the students to develop intrinsic motivation. The students may begin to develop more of an appreciation for their learning since they are achieving success using their own abilities and knowledge. In addition, the students may begin to master higher levels of math because their confidence level in their math abilities will increase due to their successes, and as all of these components merge together, students may be more willing to take more risks. They will be confident, have a tolerance for failure, and follow through when errors arise.

Unfortunately, many teachers only have time to teach the curriculum that they are given, and sometimes are unable to teach everything they are required to teach. How then should teachers expect to fit problem-solving strategies into the time frame they are given? I believe the focus should not only be the content that teachers teach, but also other life skills that will help the students gain success. I observed that the students in my research study appeared less successful in their overall math abilities before learning problem-solving strategies. I also observed significant willingness of students to attempt a task given to them even after the problem-solving unit has ended. In one of the problem-solving lessons, I showed the students that there was no way for them to algebraically solve the problem I was giving them because they would not learn the process until Algebra I. I showed them exactly how to solve it algebraically using symbols, which meant absolutely nothing to them because it was beyond their comprehension. Then I told them to find a way to solve it.

I believe this lesson may have caused a turning point in the students' believing that there is always more than one way to solve a problem because it became real to them. They watched as I solved it algebraically. Then, they solved the same difficult problem using a problem-solving strategy, and they were successful. Their answer exactly matched my answer. Some of the alternate ways of solving problems can seem easier than the algebraic solution. The students may have understood the problem to a deeper level by using a problem solving strategy instead of solving it algebraically because they were drawing pictures that they used as representations; whereas, in the algebraic solution the students had to know what each variable represented. Unfortunately, I cannot solve the time issue for teaching curricula; however, I have seen the impact of students learning problem-solving strategies first hand, and I can say that learning problem-solving strategies has positively influenced the students' attitudes towards solving more challenging problems in my classroom.

For teachers who may not have enough time to teach problem-solving strategies, I have the following suggestions. Problem-solving strategies could be used as drills. This would require creativity. Problem-solving strategies could be taught in an abridged format in the beginning of the year while rules and procedures are being taught and then, be reinforced throughout the year through drills or extension problems so the students become more proficient in applying them. Finally, our schools have comeback math. Comeback math is where the students have one period of math every day and two periods of math every other day. I strongly recommend that problem-solving strategies are taught and continually reinforced in the extra math period.

Future research should be conducted in order to gain a deeper level of understanding on the impact learning problem-solving strategies has on student achievement and resiliency. Research has shown that resilient behaviors lead to intrinsic motivation, self-regulation, mastery goals, and risk-taking in students. However, more studies need to be conducted in order to focus on when or how students initially develop resiliency and what factors, in addition to problem-solving strategies, cause resilient behaviors. Studies should also be conducted in order to determine how students sustain resilient behaviors. This may provide educators with a greater understanding of strategies and processes they should be incorporating in their classroom on a daily basis to promote student achievement and success.

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Appendix A - Interview

1. Give the duck problem.
   Three ducks and two ducklings weigh 32kg. Four ducks and three ducklings weigh 44kg. All ducks weigh the same and all ducklings weigh the same. What is the weight of two ducks and one duckling?
   a. Explain how you solved this problem

2. Inquire about the state-wide test
   a. What did you think about the state-wide test? Was it easy or difficult?
   b. Did you get stuck on any problems?
   c. What did you do when you got stuck?
   d. Did you use any problem-solving strategies on the state-wide test?

3. Inquire about problem-solving strategies
   a. Do you think the problem-solving unit was beneficial for you? Why or why not?
   b. Which problem-solving strategies do you prefer?
   c. Do you think I should teach problem-solving strategies next year? Why or why not?
   d. Do you think I chose good problem-solving strategies to teach or should I choose different ones next year?
   e. When you cannot solve a math problem, would you think to use a problem-solving strategy?

Appendix B - Exit Ticket Scoring Rubric

4 Point Answer:	Characteristics:
This response offers clear and convincing evidence of a deep knowledge of the mathematics related to this task. The solution shows a deep understanding of the problem including the ability to identify	• All answers are correct and are accompanied by appropriate methods. • There is a clear, effective explanation detailing how the problem is solved. All of the steps are included so that the reader does not need to infer how and why decisions were made. • Mathematical representation is actively used as a means of communicating ideas related to the solution of the problem.

the appropriate mathematical concepts and the information necessary for its solution. The solution addresses all of the components presented in the task.	• There is precise and appropriate use of mathematical terminology and notation.
3 Point Answer: This response offers evidence of substantial knowledge of the mathematics related to this task. The solution addresses all of the components presented in the task.	Characteristics: • All answers are correct but the method is missing or incorrect in one part of the problem. Minor computational errors are allowable. • There is a clear explanation. • There is appropriate use of accurate mathematical representation. • There is effective use of mathematical terminology and notation.
2 Point Answer: The solution shows that the student has a broad understanding of the problem and the major concepts necessary for its solution. The solution addresses most of the components presented in the task.	Characteristics: • Uses a strategy that leads to a solution of the problem. • Uses effective mathematical reasoning. • Mathematical procedures used. • A partially correct answer is achieved. • There is an incomplete explanation. It may not be clearly presented. • There is some use of appropriate mathematical representation. • There is some use of mathematical terminology. and notation appropriate of the problem.
1 Point Answer: This response offers little evidence of knowledge of the mathematics related to this task. The solution is partially addressed.	Characteristics: • The solution is not complete indicating that parts of the problem are not understood. • The solution addresses some, but not all of the mathematical components presented in the task. • There is no explanation of the solution, the explanation cannot be understood or it is unrelated to the problem. • There is no use or inappropriate use of mathematical representations (e.g. figures, diagrams, graphs, tables, etc.). • There is no use, or mostly inappropriate use, of mathematical terminology and notation.
0 Point Answer:	Characteristics: • There is no solution, or the solution has no relationship to

This response offers no evidence of knowledge of the mathematics related to this task. The solution is not addressed.	the task. • Inappropriate concepts are applied and/or procedures are used. • The solution addresses none of the mathematical components presented in the task.

Biographical Note:

Mary Lou Shears has been working as a middle school math teacher for the past four years in Baltimore, Maryland. Presently, she has been assigned a 7th grade Pre-algebra and 7th grade general math class. Interested in any research that will help increase her students' motivation and achievement in math, she continues to conduct ongoing action research studies that include alternative problem-solving strategies (something she feels is lacking in the present curriculum). She earned her Master's degree in Education in August 2005, and can be reached at mshear2@tiger.towson.edu.