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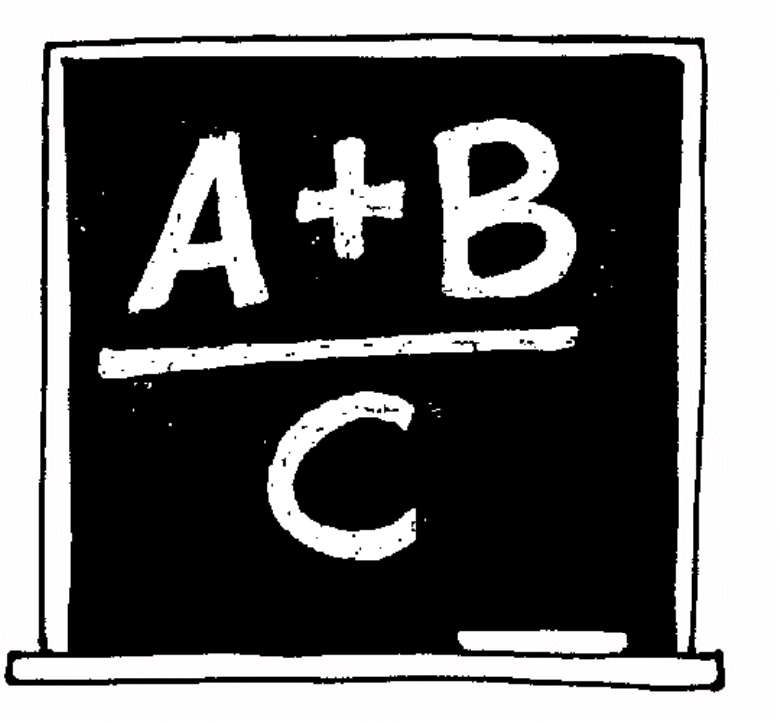

Math in the Middle Institute Partnership
Action Research Project Report

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Using Think-Aloud Strategies to Solve Word Problems

Abstract

In this action research study of my sixth grade mathematics class, I investigated how students' use of think-aloud strategies impacts their success in solving word problems. My research reveals that the use of think-aloud strategies can play an important role in the students' abilities to understand and solve word problems. Direct instruction and modeling of think-aloud strategies increased my students' confidence levels and the likelihood that they would use the strategies on their own. Providing students with a template to use as they solve a word problem helps students to better focus in on the think-aloud strategies I had been modeling for them.

I have been teaching since 1989, and sixth grade has been my assigned grade level for most of those years. Over that time I have experienced a number of frustrations. None, however, has been more frustrating than that of watching my students struggle over word problems in mathematics. Every year I vow to help them to become successful problem-solvers. And every year I end up disappointed in myself and in my students.

The students in my classroom for the 2006-07 school year have very few skills when it comes to solving word problems. When given a word problem, students will often try to pull the numbers out of the problem and perform some sort of operation on them (such as add, subtract, multiply, or divide) and come up with some kind of answer. They really do not seem interested in if the answer makes sense because they do not have the necessary skills to tackle the problem. It seems that students cannot, with any sort of sensible reasoning, decide which operation to use, mainly because they do not understand the word problem itself. Also, when students come up with an answer, they demonstrate difficulty deciding if an answer makes sense or not. I believe that students are not really understanding the “story” that is going on within the word problem.

Like so many teachers, my challenge has always been a matter of time. In order to stay on pace with our district mathematics objectives, I feel that I just did not have extra time to devote to teaching how to solve a word problem. It is as though I am limping along by helping my students solve word problems when they come up. I am taking responsibility for student learning. I am not expecting a whole lot of effort on their parts.

I used to blame the students. I told myself that they must have shortcomings on some developmental stage. Perhaps, I wondered, sixth graders just do not think abstractly enough to work successfully through word problems in mathematics. I also teach reading, and I know that their comprehension and reasoning skills are at the sixth grade level, so that cannot be the excuse in my mathematics class. Is it that sixth graders are lazy? I have to rule that out, too. I have had some fantastic students who worked hard day in and day out, and even they struggled with word problems.

I often think that educators just throw story problems at students without cultivating the skills necessary to solve story problems. It is important for students to be able to transfer the skills we have taught them in class to real-world applications. Using the right word problems can be a great way to bring those real-world applications into the classroom. However, before assessing whether students can use the mathematical skills they have learned by successfully solving a word problem, teachers had better make sure that they first understand *how* to solve one. It is unfair to judge students' mathematical skills by the answer they get to a story problem, if we have not yet taught them how to go about solving a story problem.

Solving story problems is a skill. When students do practice exercises that go along with a skill they are learning, they simply follow the steps they learned in class. For instance, dividing fractions; students know that they need to change the sign to multiplication, and then find the reciprocal of the second fraction. However, when students are given a word problem, they have to first understand the "story" in the problem, and then students need to decide what to do with the information that is given. It is a lot of extra thinking, and requires some habits of mind such as putting the data

from the story problem into a table. Students get easily frustrated and are not willing to persevere long enough to see a problem through to its end. Because of this, I knew I needed to find a way to help my students be more confident and comfortable with word problems.

These ideas led me to start thinking about what I could do differently in my classroom to help my students be successful problem solvers. I knew that I needed to have a strategy for students to use if they were to be successful. I also knew that, regardless of time constraints, I would have to take the time needed to teach my students the strategy.

I had been reading about think-aloud strategies during the summer and fall of 2006, and wondered if they would work for my students. By paying close attention to what I did when I solved word problems, I began to make a connection. I was able to successfully solve word problems because I had a procedure that I followed each time. I found, too, that I would actually talk myself through the procedure. For example, I read the problem through twice to make sure I understand what it is asking. Next, I tell myself what facts I know from the problem. Then I ask myself what it is I want to know. Finally, I make a plan to get from the facts to the information I really want to find out.

Perhaps if students could talk themselves through the word problems, they would be less intimidated; especially if they had a model to follow and knew what to say to themselves. It is like trying to drive through an unfamiliar town without a map. You would just have to drive, hoping that with some serious thinking and perseverance you would stumble upon the place that you were looking for. However, if you were given a map to follow, you'd have much more confidence that you would arrive at your

destination successfully. All I had to do, I thought to myself, was give my students that "map" to follow, help them learn to read it, and they would be successful!

Problem of Practice

The goal of my action research is to better understand how I can equip students to solve word problems successfully. I want my students to know how to understand and analyze word problems without feeling frustrated. I would like them to be equipped with some sort of process they can work through whenever they are given a word problem to solve. With this process in place, they may gain a better understanding of what operation to use. Finally, students need to learn how to see if their answers truly make sense as an answer to the story problem.

I see two Problems of Practice going on here. The first is an issue of teaching. Students have not been taught a strategy that they can pull out and apply to a word problem. At this point I was thinking that the students needed a very teacher-directed intervention. They need to see and hear what I am doing and thinking when I solve a word problem. Students also need a visual aid, a resource that is readily available when they go to solve a word problem. For example, this visual aid might have steps for the students to follow, or even key things to think about as they decided how to solve the problem. Finally, students need time to work together in small groups to struggle through several problems as they learn to use what I will have taught them about solving word problems. These students need this extra support and strategy building in order to become successful problem solvers. However, they do not get the strategies they need inside the regular district-mandated objectives.

The second Problem of Practice has to do with learning. It seems to me that the whole point of learning mathematics is to be able to use it to solve problems in everyday

life. When a situation comes up in everyday life, students need to be able to pull out strategies that they have learned to deal with that problem. The same is true in the area of mathematics. When students face problems in their everyday lives that need to be solved using mathematics strategies, students should be able to pull the necessary strategies out of their repertoire of strategies in order to solve the problem. Even if the problem is not specifically related to mathematics, students should have some sort of thought process they use in order to solve the problem at hand. The ability to solve word problems demonstrates a conceptual understanding of learned skills. But to even be able to demonstrate their conceptual understanding, my students first need to feel comfortable with word problems.

These Problem of Practice tie in with the NTCM Process Standards. These standards include Problem Solving, Reasoning and Proof, Communications, Connections, and Representation. At this point I am particularly interested in the reasoning part of the standards. I would like to find ways to guide students to reasonable thinking. I would like them to be able to read a word problem and come to a reasonable conclusion about how to solve it. However, reasoning cannot stand alone. To successfully solve a word problem, students need to utilize each one of the standards listed above. I believe that think-aloud strategies will help with that.

This Problem of Practice is worth knowing for a couple of reasons. First of all, if teachers can teach students how to effectively solve problems, then the next generation of leaders will be able to solve problems, related to mathematics or not, in an organized systematic way so that the solutions to those problems will make sense. Even more locally, if I can teach my students successful problem solving skills and strategies, then

the teachers who have these kids next year and on into high school will be able to challenge their thinking even more. Students will progress more easily through their mathematics classes, and ideally, reach higher levels of mathematics than they could have otherwise.

As I think about this research project, three questions come to mind. First of all, what generalized process can I equip students with that will help them begin to solve any problem they may be given? Second, will teaching students to work through story problems through modeling better enable them to choose the appropriate mathematical operation for the problems they are given? And, finally, what kind of time can I devote to this process in my mathematics class? As students acquire and use think-aloud strategies, their ability to solve word problems will increase. As their ability increases, perhaps their confidence and willingness to be risk-takers will also increase.

Literature Review

As I read the literature about the problem of helping kids be successful at solving word problems, two thoughts strike me. First, I see that most of the authors discuss the role of perseverance and attitude on the part of the students as a variable considered in their studies. I know that a lack of perseverance has kept my students from successful problem solving. Second, all of the authors discussed a variety of variables that affect students when it comes to solving word problems. This tells me that there is no easy answer when it comes to helping students become successful problem solvers.

Higgins (1997) relates that the amount of instruction students receive on how to solve story problems is directly related to how much effort they are will to put forth. In fact, Higgins states “the students who had received problem-solving instruction displayed greater perseverance in solving problems, and more positive attitudes” (p.

16). This suggests that there may be a correlation between the amount in instruction and the attitude of students concerning their ability to solve word problems.

Leader and Middleton (2004) talk about a gap that exists between student ability and student behavior. Even though students may have the ability to solve story problems, they are not persevering enough to get the job done. Could this be because they need more direct teacher instruction? Leader and Middleton go on to discuss how students may recognize that understanding a piece of literature may be a critical thinking moment in literature class.

However, those same students may not see solving a story problem in mathematics class as a critical thinking moment. Therefore, they are, in their minds, not willing to expend as much energy on the problem-solving task. Are we teaching our reading students critical thinking skills, but not expecting it of our mathematics students? This is the question asked by Leader and Middleton. Montague and Applegate (1993) state, “researchers agree that effective mathematical problem solving requires coordinated application of a complex system of cognitive and meta-cognitive processes and strategies” (p. 2). They go on to say that the cognitive processes necessary for mathematical problem solving include reading comprehension, ability to paraphrase, visualization, estimation, and computation. Along those same lines, Koedinger (1991) says that there are two phases that students go through when solving a story problem; “the comprehension phase and the solution phase” (p. 5). He goes on about the reading skills needed to process story problems. This idea of the importance of reading skills goes right along with the ideas that Montague and Applegate considered in their research.

Comprehension skills were also highlighted in several of the other articles I read. For example, Koedinger and Nathan (2005) talk about there being two phases of problem solving. The first phase is that of comprehension. Students must read, process, and understand the problem before moving in to the second phase; finding the solution. So, without comprehending the story problem itself, students will not be able to move on into the solution phase. Students actually go back and forth between the phases. The comprehension part of the problem solving process is interwoven between the two phases. Even as students are into the solution phase, they are still required to call upon their comprehension skills to solve the problem.

The primary focus of the Rickard's work (2005) is the role of the teacher. He writes about how the teacher needs to understand the difference between problem solving and just doing exercises. On the one hand, doing exercises refers to having students practice a particular algorithm on a worksheet or on a page from a textbook. On the other hand, problem solving is being able to apply the algorithm in a given circumstance described in a story problem or real-life situation. Rickard went on to discuss his study of one teacher's teaching strategies. Because the teacher being studied was trying to change his classroom emphasis to more of a problem solving approach, he made many changes in his own thinking. For example, the teacher used to believe that students should not use calculators when solving story problems. He believed that the use of calculators would not help students hone in on their basic facts. However, during the course of the study he changed his mind because he realized the real emphasis was on understanding and solving story problems, not perfecting the students' basic fact skills.

Leader and Middleton (2004) also explore the role of the teacher. They learned through their study that by doing appropriate activities, the dispositions of students to *not* think critically can be changed. It is their position that students can be taught to detect occasions for critical thinking “as a natural habit of mind”. It is the teacher’s job, they believe, to teach this to students. Leader says that teachers need to provide “authentic activities…similar to that available to people participating in craft apprenticeships” (p. 6).

Although Schommer-Aikins, Duell, and Hutter (2005) do not directly talk about the role of the teacher in their study, they so address how students’ attitudes about what they could and could not do, play a significant role in their ability to be successful problem solvers. They hypothesized that “the less students believed in quick-fixed learning, … the more likely they would be to believe that mathematical problem solving requires effort, confidence, and understanding mathematics” (p.4). When I, as a teacher, read that statement, I see it, at least in part, as a teacher’s role to communicate that idea to students. However, the authors’ primary focus was on the perseverance and attitudes of students.

Pajares (1996) also claims that perseverance and attitude are a major factor when it comes to the problem solving abilities of students. In his study, Pajares examines the role of self-efficacy in terms of mathematical problem solving in both gifted and average-ability students. The gifted students report higher mathematics self-efficacy and self-regulated learning. They also report less mathematics anxiety that the average-ability students. Consequently, the gifted students have higher performance scores in the area of mathematical problem solving.

Several authors, including Higgins (1997), Leader and Middleton (2004), Montegue and Applegate (1993), Rickard (2005), and Ridlon (2004) indicate that teaching the steps of problem solving to students is important. They vary in the way they described the steps, but overall they seemed to say that students should be taught to read and understand the problem, come up with a plan, solve the problem, and then check their answer against the fact in the story problem. Each of the authors thought that this is a variable that cannot be left out. Students who were taught this strategy and given time to practice in class, were overall better problem solvers than students who had not received this instruction.

Additionally, I noticed that seven of the nine authors I studied discuss, in some form, the importance of the think-aloud strategy. The think-aloud strategy refers to having students verbalize what they are thinking and doing throughout the problem solving session. Students who verbalized seemed to gain a better understanding of their own thinking. Therefore, these students were prepared to ask appropriate questions to enhance their understanding of the problem-solving process. They also seemed better able to trouble-shoot their own problems, and in many cases solve those problems on their own.

Most of the articles I gathered are recent, from 2003-2005. Only a couple of the articles are from the 1990's. However, after a lot of thought I was unable to come up with any big differences that would show some sort of trend from the 90's to the 2000's. I think these authors shared many ideas and beliefs. If I were to read more articles from the 90's, I may be able to detect a trend, but at this point, that is not the case.

After reflecting on these readings, I have come to the conclusion that I will focus on two main variables during my own research project. The first of these is teaching the problem-solving process to my students. This will include, not only the steps themselves, but also the knowledge that a story-problem is not always a thing that can be solved in a minute or less. Students often give up when they cannot find a solution immediately. I hope to instill in them that's it is OK to struggle and stew over a problem for while. After all, perseverance is the key to success.

The second variable I focus on is that of thinking aloud. For this study, I teach students specific statements that they should go through as they work out a word problem. My role is to model extensively for the class, then have students work in small groups to verbalize together about a given problem using the same language, so to speak. Students can even externalize their thinking by writing in a journal. My goal here is to "see" how students think and process that thinking. Perhaps, then, I can better pinpoint the direction I need to go to help students become better problem solvers, and to boost their confidence levels. This research will fill a niche that has not yet been filled. That is, teaching students what to say while processing through a word problem.

Purpose Statement

The purpose of my action research is to determine if teaching "think-aloud" strategies to my students can help them become more successful at solving word problems. This study attempts to answer the following research question:

Do think-aloud strategies help students to improve their word problem solving skills?

Methods

My data collection lasted from mid-February to the end of April in my sixth grade mathematics class. The research encompassed the end of the third quarter and the beginning of fourth quarter of the 2006-2007 school year. The class had a heterogeneous mix of 23 students. Four of these students were also in a mathematics intervention class. Of the 23 students in the class, 13 participated in the research; eight males and five females.

I have noticed that when I give students are given a story problem, they panic and give up easily. Students seem to feel intimidated by story problems and do not even want to face them, so the first thing I did was take some notes via my teacher journal about how students respond to story problems. My observations were during our "Problem of the Day" on February 24, 2007, The “Problem of the Day” is a part of the daily warm-up. I noticed, that overall, students don't really read for understanding. They have learned to find the numbers, pull them out of the problem, and apply some operation to them in order to reach a "solution". Since they did not really read the problem in the first place, they have no idea if their solution really makes sense. In fact, many students were unable to verbalize to me what the story problem was all about. It seems that they know how to read for comprehension in reading class, but do not transfer that skill to the area of mathematics.

All of our homework worksheets have a set of practice problems on the top and two to three story problems on the bottom. My rule for homework is that students at least have to try every problem. However, after taking some baseline data from students' homework sheets for one week, I realized that 86% of the students in my mathematics class did not even attempt the story problems. A shared attitude among

the students is that the word problems are too hard, so they wait until class time when I take the time to lead them through the word problems myself.

I asked students to write me a letter in their mathematics notebooks explaining why they do not even attempt to solve those problems. For example, Allison, who has a great deal of difficulty, but tries hard, wrote the following, “When I read a word problem, it's just a bunch of words with numbers and I get really confused." In this data the majority of the students mentioned being confused when reading a story problem and they don't even know what to do next. One boy wrote, for example, "There are too many words and numbers mixed together."

By looking at and studying the evidence just presented, I came up with the following working hypothesis: If I offer students a step by step process to follow for solving a story problems, that includes some think-aloud strategies, they will feel less intimidated and will be more likely to attempt solving word problems. My job then was to check out the hypothesis. I needed to present and model my think-aloud strategy to students. I also asked students to read each problem twice before attempting to solve it. To solve the Problem of the Day, read it aloud twice. The first time is to introduction to the problem, and a second time is for understanding. Then I begin to say these following phrases each time we work a word problem, "Now, we know that..." while I restate the facts from the problem. Next, I'll say, "We need to find out..." and then restate the question in the story problem. Next, I make a statement that starts with, "Maybe I can..." to begin thinking out loud about what operations might be appropriate for the data given. I am hoping that students will begin to follow my lead and use the language I used.

I continue to monitor story problems that appear on the homework assignments, to see if there was an improvement in the number of students who, at least, attempted to solve them. I was not concerned so much that students were arriving at the correct answer, I just wanted to see a thought process going on.

After reading the letters that I had students write to me about I made an organizational worksheet for students to use while solving word problems (See Appendix A). I first model the worksheet for students during whole-group instruction. Students, then use the worksheet on their own during homework time.

Findings

I found that when I give students the structure of the think-aloud strategy to use when solving a story problem, they are more successful, both during class and at home. This structure allowed students to organize their thinking. This organized thinking also led to greater perseverance. The completion of story problems on the homework assignments increased. I notice that when students work in groups, they did not give up as easily as before we had a structure in place. In turn, the think-aloud statements made sense to everyone else in their group, making communication within the group more effective. This “common language” for word problems is a concept that does not occur within our regular curriculum, but is well worth the time it takes to teach.

The first week I had students use the worksheets on their own with their homework, I was pleased with the response of the students. Everyone who brought their homework back to school had attempted the story problem on the homework! 23% of the students did not come up with the correct answer, but they had at least attempted it. Of those who got the correct answer, 100% of them used the worksheet correctly! However, I also told students that if they used the organizational worksheet with the

word problems on the homework assignment, they would receive an extra stamp on their “Matho” card (See Appendix B). These were cards I used to motivate students to bring homework back each day. They were like Bingo cards. When students got five stamps in a row, they earned a Matho, and could choose a prize from my prize bag. Having this extrinsic motivator attached to the assignment could be part of the reason students were so willing to use the organizational worksheet at home.

By now it was the third week of March, and my next step was to continuing working with the organizational worksheet, while, at the same time, providing students with more challenging word problems. Up to this point, I had chosen problems that are at an upper fifth grade/lower sixth grade level. I wanted to challenge my students more now that they were familiar with the process. Additionally, I want to “step back” from helping them through the process and see how the table groups work together to think-aloud through various word problems. I really wanted to focus on listening to the conversations and thinking patterns of each group.

My ultimate goal was to have students feel comfortable enough with the think-aloud strategy that they would not need the worksheet. For now, though, this worksheet seemed to be just what they needed. When students use think-aloud strategies, they are more successful. However, they still would not use think aloud strategies on their own. If I was not there to coach them, students reverted to their “old ways” of simply ignoring story problems, or assuming they’re too difficult. They had not yet taken ownership of the think-aloud strategies. And, I believe, they still thought that solving word problems took too much time.

For example, I gave a homework assignment with two story problems on the

bottom. The two problems are as follows:

1. *Jack decreased his best time in the 400-meter race by 1 3/10 seconds. His new best time is 52 3/5 seconds. What was Jack's old time in the 400-meter race?*

2. *Lori used 2 5/8 ounces of shampoo to wash her dog. When she was finished, the bottle contained 13 3/8 ounces of shampoo. How many ounces of shampoo were in the bottle before Lori washed her dog?*

While going over that assignment with students I discovered that fewer than half of them had even attempted to solve the story problems at the bottom of the page. I interviewed three of my students about this. Each one of them started with the statement, "I didn't get it." During the interview process I dove deeper into this by asking them what they were thinking when they doing their homework and got to the point of solving the story problems. Two of the students I interviewed, Alexus[1] and Augustine, talked about how they problems just "looked hard". Augustine said, "Where there are a lot of words, I just know it's going to be hard." They said that using the think-aloud strategies work well when I am leading them through the steps, but when they try it on their own, they felt confused. Alexus stated, "it makes sense when you help us with it, but then when I try it on my own, it is really hard and confusing." The third student, Austin, noted that he tried the think-aloud strategy, but it "took too long and I didn't want to spend hours on my homework assignment."

I sat down with Austin, Alexus, and Augustine to help them work through the story problems. Two concerns surfaced right away. The first was a language issue. Both Austin and Augustine were unfamiliar with the term *decreased* so they were not finding meaning in the problem. All three students were confused by the use of fractions do

[1] All names are pseudonyms.

describe a distance. They indicated that they usually see distances with decimal points and the fractions were confusing. I had the students focus on our think-aloud strategy by using the worksheet I created. With some guidance, these students were able to solve both problems successfully.

Because I had wanted to find out how more of my students were feeling about the think-aloud strategies, I had the class write in their mathematics notebooks about it after the first week of the data collection period. Their assignment was to write me a letter about how they use the think-aloud strategies when they're doing their homework. I reminded my students to be very honest about their efforts. What I found is that all but two of my students do not use think-aloud strategies at home. Many students complained of not remember the steps of this strategy. Words like "confusing" and "forgot" were very prevalent in the students' writing. One very honest student wrote, "When I get home I just want to get my work done so I can go outside. So I usually skip the story problems. You go over them with us anyway."

When I had students using the think-aloud problem-solving sheet that I had designed to help them be more successful, I was seeing progress. After two weeks of using the sheet, I decided that students could use the think-aloud strategy without the sheet, but after three more days I realized that I was wrong. My students were not yet competent enough to work without it. I decided to reinstate the use of the problem-solving help sheet.

I knew what was happening with my students. When I am taking my own mathematics classes there are many times that I feel like I understand the concept that is being taught. However, by the time I sit down to do my homework, my thoughts are

not as clear anymore. I really have to re-read my notes carefully several times to remind myself of what we learned in class. The same is true of my students. I hope that if we continue to use the problem-solving help sheet with homework assignments, students will remember how we solved problems in class and begin to take ownership of the think-aloud strategy.

Therefore, my next step was to continue to practice the strategy in class, and then provide students with the help sheet so they could be more successful with homework. During the class time I tried to choose word problems that were authentic. For example, I used our school-wide reading incentive program as the basis for several of my in-class word problems. I hoped that this would show students that word problems really are a part of daily life. Additionally, I read the story problems on the homework aloud with students and asked some rhetorical questions to get them thinking. That way, when students are at home, they can think back to the questions I asked in class and have an easier time of problem solving. Within my five-week data collection period I used several forms of data collection to track progress.

One form of data collection that I used was student journals. Students had mathematics notebooks that were used for warm-ups and for journaling. The journaling in the mathematics notebooks were actually letters to me about what was going on in mathematics class. These letters included insights and feelings about the topics we were learning. I had students write letters to me once a week during the data collection period. Each of these letters focused on our word problem work. If the journals were my only form of data collection, I would have to say that the think-aloud strategies were not working. Overall, the statements from students did not change over the course of the

data collection period. At the beginning, students used words like “confusing”, “too hard”, “don’t get it”, and “takes too long”. When I read the journals from the last week of the data collection period, I read the same phrases. Only two students indicated that they felt more successful at solving word problems. Austin wrote, “I know what to do when I see a word problem. I don’t always get it right, but now I always try.” Ashton had similar sentiments. She stated, “Word problems are hard and sometimes confusing, but it is a little easier now.”

A second form at data collection was that of my teacher journal. I took many notes about what I was seeing as far as student behavior when it came to solving word problems. I watched as my students worked in small groups, and listened to the things they were saying to one another. When students were up in front of the class sharing a solution to a problem, I focused what they were saying to see if they were using think-aloud strategies. Students were greatly improving in how they communicated about and attempted to solve word problems. In early March I wrote about how one of the students, Noah, was at the overhead projector to show the other students how he had worked through a particular word problem. I am “thrilled that Noah used the same exact language with the class that I had been using with them all along!” I went on to explain, “Noah’s language at the board mimicked the phrases I had been using with students. Students giggled at Noah, which tells me that they, too, recognize that he is using the language I use. The time I take to model for students has paid off!”

I consider this a positive outcome and it is noticeable during group work. I made notes as students worked through word problems with each other while using the worksheet that I had designed for them. What I noticed was students using the

language I had modeled for them, and students answering the questions on the worksheet as they read through the assigned word problems. I wrote about how pleased I was with the verbal communication going on within the groups. The groups were on task, and speaking reflectively about the word problems. I noted in my journal that one of the groups spent a great deal of time discussing what the problem was asking. There were two different points of view. The group was finally able to come to a consensus.

Student work further reveals that more students completed the word problems on homework assignments than before using the think-aloud strategies. I kept the assignments so that I could watch students' progress over the data collection period to see what improvements, if any, I could notice. In particular, I wanted to find out if students were actually attempting the word problems, and, if so, were they using strategies that made sense. What I noticed was that although students showed a great improvement in the classroom, their efforts to solve word problems on homework assignments did not change overall. When I first had students use the help worksheet at home I would reward them with an extra stamp on their Matho card if they used it. This reward system caused some improvement in effort on the part of the students. However, when I took away that extrinsic reward, many students went back to not attempting the word problems on the homework. Or, if they did attempt them, they simply used the old method of choosing some sort of operation to do to the numbers they saw in the problem. It was obvious that most students were not using think-aloud strategies on their own. They had not taken complete ownership of these strategies yet.

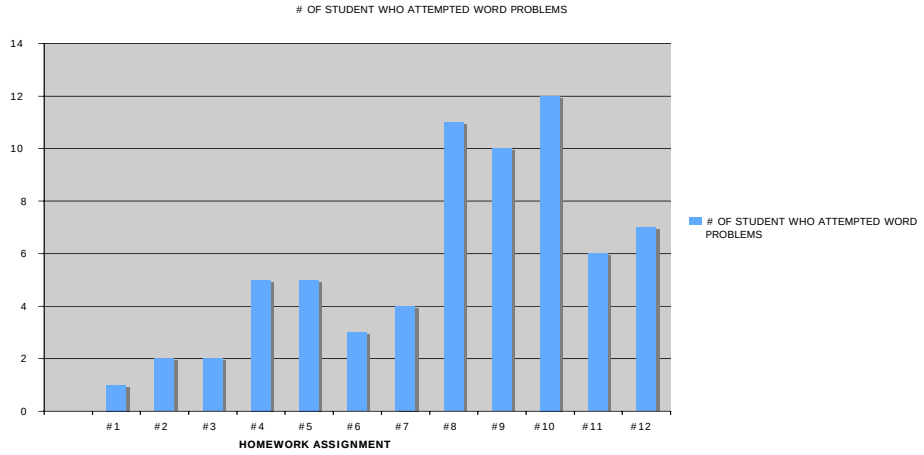
Analysis

This action research is certainly enlightening for me as a teacher. The first journal assignment I gave my class in mid-February as I started the data collection period was to write about how they feel when they see a word problem on their homework assignment. As I read through students' first journal entries in mid-February, I saw that two main themes that kept recurring. First of all, students complained that word problems were too hard. One student, in particular stated that, "When I see word problem on my assignment, I want to run away from it." Another student said, "Like mathematics is not hard enough you have to make us do word problems too." And still another asserted, "Word problems stink, they don't make sense and they are confusing." These statements were not surprising to me at all. I could tell that my students were not keen on solving word problems just by the attitudes they showed in class.

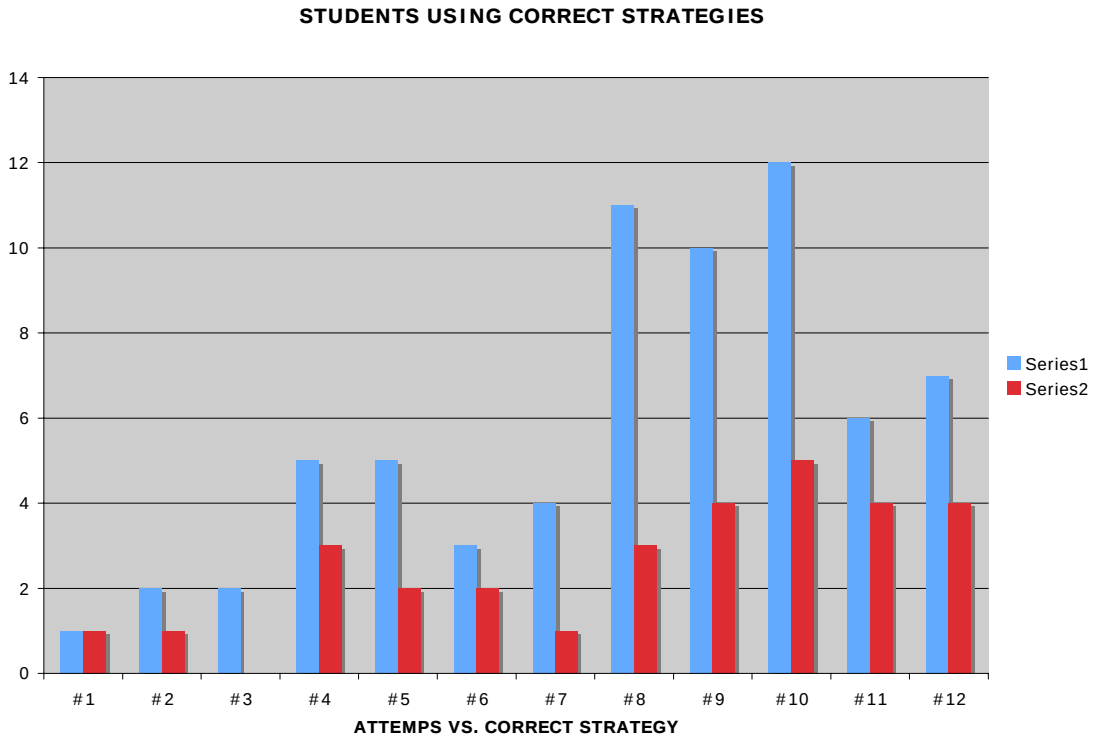
The second theme is stated clearly in Edgar's journal, "Word problems waste time, they take too long." Many others felt the same. Emily stated, "The word problems make the assignment way too long." And Noah's opinion was, "When there's a word problem they're always at the end and I just don't do it because I've already spent too much time on homework."

When analyzing the data on student work, the best mode of representation for me is a graph. First, I wanted to know if more students were attempting the word problems as time went on. So, my first graph simply displays the number of students who actually attempted word problems on homework assignments throughout my month and a half of data collection. As one can see, the number did increase. The highest increases on assignments 8, 9, and 10 were due bonus points I was giving on Matho

cards at that point in the semester. However, there was a rise in the number of students who were attempting word problems even without the Matho incentives. This rise seems clearly related to the think-aloud strategies I had been teaching in class.



Second, I wanted to know how many students were using reasonable strategies to solve the word problems. In other words, are students using strategies, or methods, that could lead them to the right conclusions? I was not as concerned about a right answer as I was about a correct strategy. The second graph shows, out of the students attempting the word problems, the number of students who were using correct strategies. The graph shows us that less than half of those students were using correct strategies. While this is not an outstanding improvement, it is an improvement, nonetheless. With additional time, I am sure there would have been even more improvement.



Conclusions

My data collection spanned a five-week period. During this time I did notice a positive change in student behavior when it came to solving word problems. Students were using the think-aloud strategies I had taught them and modeled for them. They used the help worksheet I had designed to help them organize their thinking. And within the confines of my classroom, things looked good.

However, students did not transfer this learning to times when they were on their own as I had hoped. This was obvious when looking at their homework assignments. There were slight improvements, but the only time word-problem success improved significantly was on homework assignments was when there was an extrinsic reward linked to it, like extra stamps on their Matho cards. I think that if I had had a longer period of time to work with, students would have used the organizer worksheet more effectively on homework. Students need more practice in order to get to the point where

they feel comfortable solving a word problem on their own using the think-aloud strategies. I need to give students that time, and encourage them as they continue to practice the skill.

Implications

The research did show me that there is a direct link between using think-aloud strategies and problem solving success. What I plan to do during the next school year is start working on think-aloud strategies right away. I will begin modeling the think-aloud strategy as soon as I can. The use of the help worksheets will be required; at least through first semester. And I will continue to have students write letters to me in their mathematics notebooks, so that I can keep track of what is going on in their minds. I hope that with the longer time period, good word problem solving habits will form by the end of next year. I also want to get to the point with my students that they feel comfortable coming up in front of the class to explain how to solve a particular word problem. When they do, I want to hear from them the same language I modeled while instructing them.

Through these methods, and my own enthusiasm, I hope to instill a love of word problems in my students. I hope that instead of feeling dread and frustration upon being given a word problem, students would feel confidence and excitement to show what they can do. And, having an entire year worth of practice would certainly have a more powerful effect. With a useful strategy on hand for students to draw upon when needed, they can’t help but to feel more empowered to tackle the dreaded word problems!

Even beyond my own classroom, though, I want to pass the information I have learned on to my colleagues. I know that the teachers I work with feel the same frustrations I did before beginning this action research project. There are three ideas

that I need my colleagues to understand. First of all, it is important for students to journal about their mathematics experiences. It was though those journals that I really began to have a sense of what my students were thinking and feeling about mathematics. The journaling really made students think about their own thinking as well.

Secondly, I want to stress to my colleagues that solving story problems is a skill that must be taught. They need to understand that just because a student has a good grasp of a mathematical algorithm, it is no guarantee that the student can apply that algorithm to a story problem successfully. There is a procedure to solving a word problem, just as there is a procedure for changing a fraction to a decimal.

Finally, I need other teachers to know that providing time for students to struggle through word problems is a powerful teaching tool. The time used for teaching and practicing the solving of word problems will be well worth it in the end when we have a generation of students whose knowledge base includes a deep understanding of mathematical processes, and how to use them in real-life situations. When other teachers start to buy into this idea of providing time for problem solving, perhaps we can start to convince our school districts to include this time on the pacing charts. It will certainly be time well spent!

References

Higgins, K. M. (1997). The effect of year-long instruction in mathematical problem solving on middle-school students' attitudes, beliefs, and abilities. *Journal of Experimental Education, 66*(1), 5-29.

Koedinger, K. R. & Nathan, M. J. (2004). The real story behind story problems. effects of representations on quantitative reasoning. *The Journal of the Learning Sciences, 2*(13), 129-164.

Leader, L. F. & Middleton, J. A. (2004). Promoting critical-thinking dispositions by using problem solving in middle school mathematics. *Research in Middle Level Education, 28*(1), 55-71.

Montegue, M. & Applegate, B. (1993). Middle school students' mathematical problem solving: an analysis of think-aloud protocols. *Learning Disability Quarterly*, 19-32. Retrieved November 30, 2006, from Council for Learning Disabilities http://links.jstor.ofg/sici?sici=0731-9487%28199324%2916%3A1%%3B2-9.

Pajares, F. (1996). Self-efficacy beliefs and mathematical problem-solving of gifted students. *Contemporary Educational Psychology, 21*, 325-344.

Rickard, A. (2005). Evolution of a teacher's problem solving instruction: a case study of aligning teaching practice with reform in middle school mathematics [Electronic version]. *Research in Middle Level Education Online, 29*(1), 10848959.

Ridlon, C. L. (2004). The effect of a problem centered approach on low achieving sixth graders. *Focus on Learning Problems in Mathematics, 28*(4), 6-29.

Schommer-Aikins, M., Duell, O. K., & Hutter, R. (2005). Epistemological beliefs, mathematical problem-solving beliefs, and academic performance of middle school students. *The Elementary School Journal, 103*(3), 289-303.