Action Research Proposal

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The purpose of this action research is to improve the basic math skills of algebra I students at North Panola High School. One of the fundamental pieces of algebra is taking a word problem and translating it to an algebraic expression. In order to successfully complete this, students must be able to recognize and use basic mathematical terms (Maccini, 2000). In addition to writing algebraic expressions, students must be able to solve these problems. This requires knowledge of how to perform basic mathematical operations (Maccini, 2000). I have found that many of my students are lacking in the ability to perform basic mathematical operations. They struggle with simple multiplication facts, as well as working with positive and negative numbers. These are necessary skills to have in order to succeed in any higher level math class, including algebra I.

Beginning teachers, myself included, are faced with the struggle of teaching students with varying levels of ability all at the same time. The biggest challenge is helping those students of lower ability master grade level content knowledge when they continue to lack basic skills. To do this, teachers must fill in whatever gaps students have in their basic knowledge. The teacher must fill in those fundamental pieces of algebra that each student is lacking. Much research has been done on methods to improve, or compensate for, a lack of basic skills (Carroll, 1994; Maccini & Hughes, 2000; Mevarech & Kramarski, 2003; Sweller & Cooper, 1985; Sweller, et al, 2001; Ward & Sweller, 1990). These methods include using worked examples, (Carroll, 1994; Sweller & Cooper, 1985; Ward & Sweller, 1990; Sweller, et al, 2001) problem-solving strategies, (Maccini & Hughes, 2000; Mevarech & Kramarski, 2003; Sweller, et al, 2001) and peer tutoring (Allsopp, 1997). Finding a way to improve the basic skills of students will allow students to succeed in algebra specifically, as well as all math courses. While much research has been done, there is a lack of research in rural, high poverty areas. This study is relevant for stakeholders in my individual classroom, including students, parents, and myself, as well as other algebra teachers who are struggling with a lack of basic skills in their students.

The first study (Sweller & Cooper, 1985) investigated the use of worked examples as a way to develop mental schema which are required to categorize and more easily solve problems. The study used year 9 students at a Sydney high school. All students were given two worked example problems to study and were then allowed to ask questions. The students were divided into two groups, one group worked on conventional practice problems, while the second group was given the same worksheet with every other problem worked for them. The results showed that students in the worked example group spent less time in the acquisition phase and made fewer errors than the conventional group.

Carroll (1994) took Sweller and Cooper's (1985) findings and applied it to a Midwestern, United States city. Students were given a pretest to pair them based on ability and then were divided into a conventional practice group and a worked example group. After instruction and practice (either conventional or worked examples), a post test was given. The results found that the worked example group did significantly better on the post test compared to the conventional practice group.

These studies raised the question, how do you write a beneficial worked example? Sweller and Ward (1990) performed a study about what makes a worked example effective. In this study, two year 10 mathematics classes in Sydney were used. The students were taught two topics, one using conventional practice and the other using worked examples. The results showed that worked examples are most effective when students do not have to split their attention between and integrate two or more sources of information. Sweller and Ward (1990) found that worked examples can always be effective and that ineffective worked examples can be reformatted to be effective by making sure they use only one source of information. In other words, the worked examples need to allow students to focus on recognizing a pattern, not necessarily on the multiple steps required to solve the problem.

In 2001, Sweller, Kalyuga, Chandler, and Tuovinen performed a study comparing problem solving, or conventional practice, to worked examples. In this study, students in a first year trade course were instructed on a new topic. After initial instruction the students were divided into two groups, one group used conventional practice and the other used worked examples. The study found that as students gained experience the worked examples became redundant. Essentially, as students became more experienced they no longer needed worked examples, and instead needed to practice using the skills they learned through worked examples.

In contrast to the previous articles' support of worked examples, Mevarech and Kramarski (2003) suggested that metacognitive training is a more effective method to develop mathematical reasoning than worked examples. The metacognitive training used in this study was a series of problem-solving questions the students use to direct their thinking. This study used 122 eighth-grade Israeli students from 5 different classrooms. These same students were re-examined a year later to determine the long term effect of both instructional methods. All students were given basic instruction by their regular teachers. After the initial instruction period, the students were divided into two groups. One group was given worked examples paired with practice problems. The other group was given a series of metacognitive questions to use to direct their thinking toward finding a solution. The study found that students using the metacognitive questioning technique outperformed the worked examples students on both the immediate post test and the delayed post test. In addition, the metacognitive group was better able to verbally explain their mathematical reasoning.

In 2000, Maccini and Hughes, performed a study designed to see if students, specifically those with learning disabilities, could learn a self-instructional strategy to help them monitor their problem solving performance. The study looked specifically at writing and solving expressions based on word problems. Six students were chosen from a secondary school in Pennsylvania for this study. These six students received part time support in a resource classroom where they were taught the STAR problem-solving strategy; **S**earch the word problem, **T**ranslate the words into an equation in picture form, **A**nswer the problem, and **R**eview the solution. The study measured percentage correct on problem representation, percentage correct on problem solution and answer, and percentage of strategy-use. The study found that the students learned to represent and solve addition, subtraction, multiplication, and division problems successfully. They also found that the students increased their ability to correctly use STAR to help solve problems.

Bottge, in 1999, performed a study that looked at how problem solving skills were applied to word problems as compared to contextualized problems. Sixty-six students were used from a middle school in the rural Midwest. The students were assigned to either the word problem group of the contextualized problem group based on pretest scores. Both groups were given a multi-step problem-solving strategy to use. The contextualized problem group applied their strategy to solve contextualized video problems, while the word problem group had typical word problems to solve. As a final test, both groups were given the same problem to solve. The word problem group solved the problem more quickly, mostly due to the contextualized groups' quarreling. Interestingly, the study also found that although all students were able to solve the problem, none of them showed improvement in basic computational skills.

Another method to improve basic skills that has been researched is peer tutoring. In 1997, Allsopp performed a study comparing class wide peer tutoring to traditional independent student practice. The study used 262 students from 14 different general mathematics classes in three middle schools in the southeastern United States. The study was divided into four phases. In the first phase, teachers were trained on the curriculum and on class wide peer tutoring. In the second phase, students were trained to use class wide peer tutoring. The third phase consisted of direct instruction for one group and class wide peer tutoring for the second group. The fourth phase tested retention of knowledge by giving a post test. The study found that both treatment groups benefited from problem-solving strategies, but there was no difference between the independent practice group and the peer tutoring group.

The research has shown that there are many methods that can be used to improve the basic skills of students. Worked examples can be used to familiarize students with specific kinds of problems, allowing them to develop a mental schema (Carroll, 1994; Sweller & Cooper, 1985). Problem solving strategies can be used to develop how students approach problems, and how they think about those problems (Bottge, 1999;Maccini & Hughes, 2000). Peer tutoring is a useful alternative for independent practice as shown in Allsopp's 1997 study. Teachers need to use any and all resources and methods available to help improve the achievement of our students. This research demonstrates that there are methods out there that can and will help. Even more importantly, the methods given can be adapted to the classroom with little trouble. Also, as these studies show, finding instructional methods to help bring students up to grade level is on-going, and that different methods may be more appropriate at different times.

In this study, I am trying to discover how to improve the basic math skills of algebra I students at North Panola High School. To do this, I will look specifically for what basic skills are required for students to be successful. I will also investigate what basic skills the students think they lack, or find difficult and how they have compensated for these perceived deficiencies. Lastly, I am interested in finding out what has been done, previously, to help students improve their basic math skills.

In order to investigate these questions, I will be using interviews and student work samples. The interviews will be with students and, hopefully, former algebra I teachers at North Panola High School. The interviews will be conducted at school in the conference room. All interviews will take place in the morning, before school, unless otherwise scheduled on request of the interviewee. The interviews with students will be used to determine what basic skills the students struggle with, and how they have dealt with this lack of knowledge. I will also use this interview to discover the students' opinions of what has been done to help them succeed in algebra. Interviews will be open-ended and video taped to preserve their integrity. All students who wish to participate will be given a consent form that must be signed by both them and their parents. Students who return the signed form will be eligible to participate. The following questions will be used in the student interviews, though more may be asked based on their responses,

- What do you like about math? Why?
- What do you not like about math? Why?

- Does not liking ________________ make math harder?
- What have teachers done in the past that have helped you learn math better?
- What else could teachers do to help?

I will also interview previous algebra I teachers to determine what has been done to help improve the basic math skills of students in the past. Teachers will also be questioned about what basic skills they think are required for algebra I and, in general, which of those basic skills have they found students to be most deficient in. These interviews will also be open-ended and video taped for integrity. Teachers will be asked to sign a consent form before the interview begins. The following are specific questions that will be asked, more questions may be asked based on their responses,

- What are the prerequisite math skills needed for a student to succeed in algebra?
- Do most students possess these skills when they enter algebra I?
- How have you tried to improve the basic skills of algebra I students?
- What other methods would you suggest trying to another algebra I teacher?

In addition to interviews, I will also be collecting student work samples. Student worksheets will be collected and studied to determine what errors, if any, that student is making. The errors will be classified as concept errors, or computational errors. Computational errors will be sub-classified according to type of error (addition, subtraction, negative, etc.). These documents will be used to help answer the question; what basic skills students are lacking, and which skills need to be improved. If, for example, the student work shows that students understand the concept and are setting problems up correctly, but continue to make addition errors, then I, as their teacher, would need to go over addition.

The central question of my action research proposal is, how can I improve the basic math skills of my algebra I students? This question will be answered by interviewing students to discover what skills they lack, and what helps them learn best. To support the central question, I will also use interviews with students to discover what they have done themselves to compensate for their perceived deficiencies. Also through interviews, with both students and teachers, I hope to answer the question of what has been done in the past to help students, and how effective those efforts were. Because students don't always know what skills they lack, or how to describe those skills, I will also be collecting and analyzing student work to determine where their mistakes come from. The student work may also be used during the interview to determine the students thought process in solving a particular problem.

Hopefully, this research will provide me with options for how to improve the basic math skills of my students. First, by knowing exactly what skills the students struggle with and/or lack, and secondly by bringing to my attention how the students learn best. They might need more examples, more time to practice, or more one-on-one help. Through this research, I hope to find the best way to help my students learn the basic material they need to know in order to succeed.

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