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ORGANIZATIONAL TACTICS IN MATHEMATICAL PROBLEM SOLVING

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ABSTRACT

Problem solving is at the core of mathematical understanding. It is the mathematical reasoning that is vital in life. Problem solving reflects the true understanding and application of mathematical content. It is necessary to instill mathematical understanding and reasoning. Some research has been done on tools to assist students in solving word problems, but more must be studied for students to achieve success in problem solving. This qualitative research study documents the observed and reported experiences of 14 low-achieving fifth grade middle school students and the students' ability and attitude in solving mathematical word problems with organizational tactics, such as concept mapping, checklists, reflection sheets, rewording for understanding, reciprocal teaching, and rubrics. Student work was collected along with student-teacher conferences and observations to analyze any difference. This study suggests that organizational techniques assist students to score higher in solving word problems. By the conclusion of the study, all students were performing proficiently in solving word problems. Student attitude was found to become more positive over the duration of the study.

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fuzzies I received. If it were not for my students, I would not be so determined, dedicated, or concerned. Thank you to all the boys and girls who make me so proud and put smiles on my face.

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RESEARCHER STANCE

I have found the most challenging task to initiate in mathematics to be problem solving. Many students and adults alike, including myself, often find problem solving a painful endeavor. I tend to believe that this is because unlike other mathematical content, it cannot be learned via rote memorization. When solving word problems, the participants are forced to make sense of abstract situations with confusing semantics. Further, there is a necessity for higher order thinking skills. How many children have developed higher order thinking skills in the elementary years?

My experience with problem solving, from elementary school until the present day, is less than rewarding. I had no idea how I succeeded in solving the occasional word problem, because it was always so confusing. I know I did above average in math, but had no idea how I derived an answer. I assume my teacher guided me very well. Now I have been shown steps, tactics, and means through my collegiate experience and can pass that on to my students. I can remember loving “fast facts,” because they were simple solutions with definite and memorized answers. If you were able to memorize, you were able to, what was then called, “learn.” Presently, education has developed to more than memorization and exact answers as learning. Now understanding is learning. I could not tell you why I regrouped in addition or subtraction, but I knew how to

do it expertly. This does not mean I was a mathematical genius. I just listened well and practiced. It was not until I was in college learning how to teach mathematics, that I learned why regrouping makes sense. It was not until my math professor, whom I highly regarded, taught me mathematical understanding and reasoning that even the lowest level executions clicked for me. Suddenly, I found myself truly understanding math for the first time. This is not to say I render any negativity toward all other teachers who had educated me in math. I know, all so well now, the anxiety of covering the curriculum and scarcity of time to do so. I also tend to believe pedagogy has been and will continue to better develop. I was always very fond of my teachers and wanted to please them. Yet, I had no awareness of why I was able to perform mathematical concepts or how to solve word problems. Hence, I had no attachment or desire to develop understanding in mathematical studies. I never even knew mathematical understanding existed.

When I teach my students, I recognize the need for their understanding because learning is not legitimate without having understanding to apply throughout life and other areas in education. I also realize the anxiety and frustration my students encounter when expected to solve these higher order thinking word problems. The anxiety and frustration was apparent every time I said, “take out your POD (Problem of the Day) notebooks.” Noticing their obvious discontent for word problems, I found myself omitting a few word problems from their textbooks so they would not be so negatively affected with

their work on facts. I was wondering if I was expecting too much and if all the experts in the field, who I hold in high regard, were wrong about the ability of elementary students' capabilities and developmental readiness to solve word problems. I was beginning to lose hope in my students' and my own abilities. After being a teacher of all disciplines, I recognized the need for further development of problem solving.

Earlier in my master's program, I had conducted a study for two weeks in my third grade classroom at my former school. I had my class use webs, checklists, rubrics, and reflections to solve word problems. Although I did not study them or collect data, other than work put into their portfolios, the class consensus was positive. My students appeared to be thinking more about their thinking and less fearful of solving such non-concrete word problems. They could explain their answers and steps in more detail than before.

Before I embarked on my research this year, I took a new position at a middle school housing grades five and six. This position consists of Pennsylvania System of School Assessment (PSSA) training for mathematics in the morning and teaching language arts in the afternoon, for fifth grade students. The students at this school are very low on their math PSSA scores. Hence, the district thought it necessary to have the students take an additional math class. The purpose of another math class is to give more time to teach concepts for understanding. The need to augment mathematical understanding became even stronger for me with

this career change. Dewey (1938/1997) reported the need to have comprehension and understanding of education to promote life-long learning. Now my goal is to also improve PSSA math scores lending to the pertinence of promoting mathematical thinkers.

Problem solving is an essential facet of curriculum standards. Because it is a necessary component to mathematical understanding, it was also a daily routine in my classroom across all mathematical concepts. I have modeled, taught strategies, developed rubrics, implemented cooperative grouping, used peer teaching, and have taught, reminded, and hung the problem solving steps in a visually accessible position in the classroom. I have tried to lessen my students' anxieties and guided them through the problem solving process. I have had them create their own word problems, and I rewarded creative thinking and various strategies. Still, they resisted and detested problem solving. I contemplated and attempted better techniques weekly. My students did not like problem solving and could not explain how they came up with answers. Even if my students could answer problems correctly, they could not show or explain the work. I was not sure I could ever get them accustomed to or comfortable with problem solving. Something different was necessary. I decided to research how others have found success in teaching problem solving.

Problem solving is at the core of mathematical understanding. It is the mathematical reasoning that is vital in life. Problem solving reflects the true

understanding and application of mathematical content. In order to perform mathematics successfully, students must be able to think mathematically (Mason, Burton, & Stacey, 1982). It is necessary to instill mathematical understanding and reasoning (National Council of Teachers of Mathematics, 2000). I am the type of teacher, much like my college professors, that wants my students to understand what they are learning and why. If they cannot be successful or comfortable with problem solving, how can they understand the importance of mathematical reasoning and understanding? This is the true purpose of math, not mere memorization of facts and equations. Problem solving must be taught effectively, and I recognize the pertinence of creating a "word problem friendly" environment.

After brainstorming, talking with my graduate professors, talking with peers and education professionals, as well as reading research, I decided to implement organizational techniques. Having my students own their learning and thinking for themselves would have to be guided by means of organization, like concept mapping, reciprocal teaching, rewording for understanding, steps with checklists, reflection, and rubrics. These guides should lead to effective problem solvers who own their mathematical understanding, not fear it. In order for students to think for themselves, they have to be connected to their thinking. I hoped to find my students better able with and more positive toward problem solving with this implementation. Since my new job is to bring PSSA test scores

up, I knew I had to bring problem solving to new levels of growth. I decided to ask the question, *What will be the observed and reported experiences of implementing organizational tactics in mathematical problem solving?*

LITERATURE REVIEW

Rationale

Problem solving is at the heart of mathematical understanding. Word problems call upon higher level thinking skills. Elementary teachers are required to teach often abstract, mathematical problem solving to still developing minds. Coy (2001) states, “Problem solving is not just about getting the right answer; the importance of problem solving is how that solution is reached” (p. 3). Problem solving is defined in the mathematical curriculum standards as well as the core of mathematical understanding (Thorson, 2001). Problem solving is mathematical understanding. Solving a word problem consists of understanding how to choose and perform an operation, or operations, to derive an answer. Yet, this necessary content is frustrating and difficult to many students. It is an inherent part of the mathematics curriculum. The students’ struggles and negative attitudes toward word problems must be addressed and alleviated.

Coy (1991) states, “Word problems combine the areas of reading, logic, and mathematical skills” (p. 24). To effectively solve a mathematical word problem, one must understand the problem and how to carry it out, and execute it. Organizing thoughts and processes, which often entail abstract and higher order thinking, can assist students in their learning concepts and the ability perform using those concepts. Organizational tactics can serve as a viable tool to develop productive mathematical problem solvers. Research suggests the improvement of

mathematical problem solvers using the following organizational, assessment, reflection, and rewording techniques for understanding. Further, authentic assessment and reflection can aid and empower students in their mathematical understanding (Coy, 1991).

Organization Of Skills And Knowledge

Application of knowledge is essential to solving word problems in mathematics. Students must understand the problem and synthesize knowledge with good modeling, in order to solve it (Fuchs, Fuchs, Prentice, & Burch, 2002). This means that if students can make sense of knowledge, the students can use this knowledge to perform tasks such as problem solving. Anderson, Olsen, and Wrobel (2001) have found that students need to use complex mathematical strategies to solve word problems, and organization aids students in solving mathematical word problems. Many students are not equipped with the higher level thinking skills necessary to effectively solve them. Student difficulty in problem solving is reflected through teacher observation and reflection. Students must be able to plan and self-monitor to correctly solve these word problems. Anderson, Olsen, and Wrobel (2001) found that instilling reflection and thinking strategies led to effective mathematical problem solvers. This suggests that incorporating organization through higher level thinking skills such as reflection, reciprocal teaching, concept mapping, and paraphrasing will promote self-efficacy

and more accurately solved word problems in mathematics (Anderson, Olsen, & Wrobel, 2001).

Reciprocal Teaching

Reciprocal teaching is essentially when students teach students (Palincsar, 1986). The benefits of reciprocal teaching are to bring deeper meaning to the students and facilitate a group effort between the teacher and students. Students who partook in reciprocal teaching in reading were able to function more independently of teachers and produce work of higher quality (Palincsar, 1986). Students working together can learn more and be more actively engaged in their applications. Reciprocal teaching and cooperative grouping are valuable functions in problem solving. Reciprocal teaching is when students and teacher exchange roles (Palincsar, 1986). Students model, summarize, generate questions, clarify, and predict for each other, as the teacher would normally do. When reciprocal teaching is implemented into problem solving, students learn more for themselves and through each other leading to self-efficient and empowered problem solvers. Students have been found to better attack word problems and further their mathematical understanding when practicing reciprocal teaching for word problem strategies and understanding (Kahre, McWethy, Robertson, & Waters, 1999). Cooperative grouping via reciprocal teaching was also found to promote students' understanding of mathematical word problems. Peer brainstorming and

working together promotes deeper understanding and more capable problem solvers (Kahre, McWethy, Robertson, & Waters, 1999).

Problem Solving Steps

Incorporating problem-solving steps clarifies and instills the stages of problem solving. Polya (1948) was the first to identify problem-solving steps. Polya (1948) stated that students must understand the problem, devise a plan, carry out the problem, and lastly, look back to the problem. Student Steps are like foolproof instructions on how to accomplish a task. Giving students steps to follow can ensure word problems are thoroughly planned and executed. Many educators tend to believe students try to guess how to go about solving the word problem. The students attempt to solve the word problem a few times, but get frustrated and just give up (Mills & Stevens, 1998). Therefore, Mills and Stevens (1998) implemented problem solving checklists in their middle school classrooms, recognizing the necessity for a visual aid to promote the thinking process. This action research study resulted in the students knowing more about their thinking and the ability to perform with this thinking.

When students have explicit phases to follow, they can follow sequential steps to promote efficient problem solving. Steps accompanied with checklists can provide students with tangible means to perform optimally with word problems (Hohn & Frey, 2002). Students need a set of steps to aid in word problem solving. Fuchs, Fuchs, Prentice, and Burch (2002) found self-regulated

problem solving with structure enabled low-ability students to better solve mathematical word problems and apply their solving in other areas of instruction. It was found that students regulated their learning and, as a result, prospered in their abilities and understanding. Jackson (2000) conducted an action research study to increase critical thinking in problem solving. When following steps sheets, the sixth grade students were better able to verbalize their thought processes. Kjos and Long (1994) also conducted research emphasizing steps to solve word problems. The results showed students thinking more about their problem solving processes. Kjos and Long (1994) state:

> More students showed that they thought about the problem before solving it. An increased number of students checked their work step by step, and thought about the information needed before working the problem as compared to the pretest. (p. 57)

Thinking about procedures and having a model to do so is essential to solving word problems.

Confidence and self-esteem were also found to be the result of using step sheets for problem solving. Assessment and students' ability to think on word problems went up. With concrete steps, the student's problem solving process heightened efficacy and attitude. This research solidifies the need for step sheets as a tangible guide to higher order thinking processes, which promotes self-esteem and motivation.

Concept Maps

Concept maps can help students to order their own thinking and content. Bolte (1997) studied the effects of using concept maps and interpretative essays to promote mathematical thinking. Bolte's (1997) results show that mathematical understanding was greatened and modified through use of concept mapping. The implementation of concept maps and reflection also promoted creativity. McGowen and Tall (1999) also found that concept mapping leads to a better understanding of mathematical knowledge and application. The more successful the concept maps were created, the better the students performed on the content. McGowen and Tall (1999) found the links between concepts and applications from student created web concept maps, which promoted successful mathematical execution. Kahre, McWethy, Robertson, and Waters (1999) suggest a variety of concepts maps be incorporated. Webs along with K-W-L charts, Venn-Diagrams, and hierarchical maps should be modeled and chosen by the students to fit their learning styles. Baroody and Bartels (2000) have also found how the implementation of concept maps in mathematics show an illustrative means of the students' understanding and connection in middle school students. Students in the middle school level often struggle with understanding. Concept maps are visual and concrete means to reach and illustrate understanding, which could otherwise be overlooked. Coy (2001) found using charts and organizational lists in fifth grade daily word problems promote students working longer and harder in solving

the word problems. Practice, along with a gain in confidence, appear to be the motivational factors in this eight weeklong study.

Concept maps not only promote mathematical understanding for the students, but also lend great insight to their teachers. Teachers can easily view the cognitive processes at work within their students by assessing concept maps. This allows the teacher to focus on areas of efficacy, clarification, modeling, and emphasis (Williams, 1995). Wilcox and Sahloff (1998) discuss how concept maps can lead to better future instruction of mathematics. Concept mapping is a viable means to student centered learning and teacher assessment and direction. Wilcox and Sahloff (1998) reiterate how concept mapping aids the teacher in future planning of mathematical concepts at the middle school level. They have also found concept mapping to be a useful addition in student assessments and activities.

Paraphrase

Deciphering what is truly meant in word problems is often quite difficult. Learning to read stories well does not equate to proficient readers in mathematical contexts. The difficulty students have in solving word problems may have more to do with their word problem reading ability than their mathematical skills (Coy, 2001). It is imperative that students understand the semantics of a word problem in order to solve it. Understanding the language of a word problem is necessary to be able to work it out. When students can paraphrase the language in

mathematical word problems, they can better understand what is being asked and figure out how to solve them. When students can reword problems into “student friendly” language, their understanding is heightened (Bernardo, 1999). Understanding what a word problem means is essential to solving it. Students must understand what they need to find so they can work it out and come to the correct answer.

Rubrics

Rubrics are considered alternative assessments. Alternative assessments often help students achieve a level of ability that traditional assessments may lack. Rubrics have been found to aid students in understanding the idea behind the answer more than traditional test assessments (Belle, 1999). Well developed rubrics can lead students to better perform problem solving. Rubrics set the stage for and promote the problem solving process.

Students must be aware of the assessed components to problem solving in order to successfully plan and execute them. Rubrics also serve as a more tangible rationale for evaluation. They lead into further self-reflection, which is necessary in the mathematical problem solving process. Studies illustrate the need for procedural and reflective awareness to promote well-equipped problem solvers (Millard, Oakes, & Sanders, 2002). Rubrics serve as buffer for student stress. When students have a clear picture of what is expected and the components of assessment, students have the much-needed confidence they need to combat their

word problem anxieties. In order to lessen the inherent stress involved with mathematical word problem solving, rubrics are optimal for the process and assessment (Mills & Stevens, 1998).

Reflection

Reflection is writing down thoughts and knowledge. Kjos and Long (1994) state, on reflective writing, “writing is an ideal way to develop higher order thinking skills” (p. 37). Students need to give as much time to reflection as to application to gain contextual and procedural knowledge. They cannot truly obtain understanding unless they can reflect and re-conceptualize knowledge. Freire (1970/2005) states, “reflection - true reflection - leads to action” (p. 66). In this quote, Freire (1970/2005) means that reflection is essential to action. The action in this case is applied learning. Only when students have the ability to think about and review what they have done in a free manner, can their processes and abilities grow. Memorization of steps and strategies alone will not promote life-long learning (Star, 2002). Educators must instill reflective practices to ensure efficient mathematical knowledge and procedures. Students can gain procedural knowledge and application, as found by Fuchs, Fuchs, Prentice, and Burch (2002). Further, knowledge attained was augmented as well as ability through daily reflection. It was also discovered that students carried over their introspection into other academic endeavors.

Reflection is a valuable tool in understanding and serves multiple purposes. It enhances student metacognition as well as giving the teacher awareness of their students' thinking. Dewey (1938/1997) states, "To reflect is to look back over what has been done so as to extract the net meanings which are capital for the intelligent dealing with further experiences. It is the heart of intellectual organization and of the disciplined mind" (p. 87). It also allows students to represent more of their knowledge and make conclusions to aid in their future tasks (Mills & Stevens, 1998). In the present, education's emphasis is on thinking skills. Providing means for students to develop their thinking skills can be achieved through student self- reflections (Jackson, 2000). When students reflect on their processes, strengths, and weaknesses, Jackson (2000) discovered students' abilities rose, as well as their self-affirmations. Ability, understanding, and morale rose. Reflection is a necessary means to instill reasoning, thinking skills, and understanding of word problems. When students are able to have appropriate reflection and sharing time, they are better able and gain positive attitudes toward solving word problems (Palomares & Hernandez, 2002). Mills and Stevens (1998) have found two major areas of student progress when middle school student students use self-reflection in problem solving. The students had higher levels of success and lower levels of frustration. It was also found that 92% of the students felt they could represent more of what they know via reflections compared to the initial 52% before the reflection implementation.

Summary

Mathematical problem solving is mathematical understanding. To gain this understanding all components of it: reading, thinking, and executing must be addressed. This aspect is often abstract, especially for elementary students. Elementary students need tools to utilize higher order thinking skills. With a foundation of organizational thinking techniques like reflection, reciprocal teaching, cooperative grouping, checklists of steps, rubrics, concept mapping, and paraphrasing, students have been found to be more efficient and positive with problem solving. Each of these organizational components have been found to call upon the higher order thinking skills needed to effectively solve word problems and create a student-friendly learning environment. These components connect the students to their learning, provide a working framework, and provide evidence to allow the students and teachers to make adjustments. Further, students' levels of motivation and esteem become heightened. With this, their fear and frustration lessens. It is only then that students can succeed in problem solving and become life-long learners in mathematical understanding.

Although not all articles and action research studies combined every aspect of my study into theirs, it is clear the organizational techniques I intend to implement in my research are of utmost importance to the students. All promote success academically and personally for the students. Steps sheets, rubrics, concept maps, reciprocal teaching, and student-reflections all serve as beneficial

means to achieve higher-order thinking and life-long learning. I hope by including all of these educationally sound components into my action research study to find more conclusions, insights, new areas to examine, and educational benefits.

METHOD

Participants

Fifteen male and female fifth graders, with below basic, or low ability in math, were the participants in this 14 week long study. There were 10 males and 5 females. During the sixth week, a male student was removed from the class and put into a proficient, or average, class. In this school, 80% of the basic level participants are Hispanic and 10% of them are English Second Language (ESL) students. Approximately 9% are Caucasian, 10% are African American, and 1% Asian. I, the PSSA content math teacher, was the sole researcher in this study.

Setting

The school is an average socio-economic urban middle school in the northeast United States, housing grades five and six. Seventy-two percent of the entire population, are Caucasian, 16% are African American, 11% are Hispanic, and 2% are Asian. Three groups of students are above average, 3 groups are below average, and 13 groups are average students. Students change classes for each subject according to ability. There are 86 classroom teachers. There are 16 students to every 1 teacher in the school. Based on state testing percentages, approximately 26% of the fifth grade students are below basic, 21% are basic, 22% are proficient, and 23% are advanced.

Procedure

Baseline Data

Prior to conducting research I submitted my research proposal to the Moravian College Human Subjects Internal Review Board (HSIRB) to ensure the protection of human subjects. Once I received permission to conduct my study, I was able to get permission from my principal. After my principal permitted my study, I had the parents of willing students sign consent forms. This reflective inquiry research project lasted for 14 weeks. The study began in September and concluded in December. Baseline data were collected through initial questionnaires (see Appendix A). Initial questionnaires were analyzed based on participant remarks and the data were converted into a table.

Step Sheets

Step sheets based on Hohn and Frey (2002) were used for every word problem solved during the study. Students used the checklists to ensure they followed all the steps of problem solving:

1) Read the problem twice
2) Find the question
3) Use the concept map to write the information
4) Plan to solve
5) Solve
6) Check to see the answer makes sense

7) Reflect

The class was first taught problem solving tasks by using the working step sheets (see Appendix B). The class reviewed the problem solving process and was instructed to check off each step as they were completed when solving a word problem. The class did the first three weeks of word problems together, stating the order the steps were completed. When a student from the class read aloud the completed step, the rest of the class checked it off as being finished. When in groups, the students were encouraged to complete the checklists together. The students were informed the word problem must be accompanied by the completed step sheet in order for it to be considered complete. By the fourth week the participants completed the step sheets independently.

Rewording the Problem

With the first word problem in the study, students were encouraged to suggest parallel ways to reword semantics of the word problem the students found difficult. Students and teacher gave examples during the first six weeks of the study. Students also shared ways to reword the problem in groups. By the tenth week of implementation, students were rewording independently.

Reflection Sheets

In the first week of the study, when steps were clear, students were familiarized with student reflection sheets (see Appendix C). The participants were informed that they must think about the problem after they do it to help them

understand better and remember what they accomplished. They were instructed during reflection and before to take time to think, be honest, and write what was thought and felt. The participants were also instructed to explain each answer. The students did not complete a reflection sheet on their own until the third week.

Rubrics

Students were shown and instructed on the word problem rubrics (see Appendix D) by the second week of this study. I gave examples of work in each domain. I emphasized a perfect score is dependent on completion of student work, step sheets, reflections, and a concept map. Students began using the rubrics the second week and continued throughout the duration of the research. Each student graded his or her own work, and I performed a second grading. After I scored the word problem and its components, I returned the work and rubrics back to the students for explanation of the score. If student scores and my score differed, the students and I assessed collectively.

Concept Maps

Students were told in the first week they would continue the curriculum, solving daily word problems with the addition of organizational techniques. These techniques include concept mapping via webs (see Appendix E), Venn Diagrams (see Appendix F), K-W-L charts (see Appendix G), and hierarchical maps (see Appendix H). For all concept maps, students were encouraged to reword the verbiage of the word problems so they could better understand the meaning.

Participants also worked together in reciprocal teaching groups to assist in mastering the organizational techniques.

The first 2 weeks the class focused on web maps (see Appendix E). I modeled once how to use it on the chalkboard, with a word problem in front of the class. The next two times of web implementation, the participants took turns of modeling its use. The third week the students were completing them independently.

Close to the 4th week of the study, Venn Diagrams (see Appendix F) were introduced. A student modeled the first time on the board with help from student volunteers. I played a student, but inconspicuously guided them through the process of completing the map. Students reviewed the second Venn diagram, after all participants had completed the Venn Diagrams independently. The Venn diagram was utilized until the students felt comfortable using it in the 5th week of research.

I introduced and had students help teach K-W-L charts (Appendix G) using the K-W-L chart for word problem solving purposes. The class and I, as facilitator, discussed its importance. The next week the students reciprocally taught each other in groups how to complete the K-W-L charts.

During the 11th and 12th weeks of this study, students were introduced and taught hierarchical maps (see Appendix H). Again, I modeled how to use the concept map to help solve the word problem. Then the students reciprocally

taught each other how to use hierarchical concept maps to solve word problems, after each participant independently attempted the map. Finally, the participants chose which concept map to utilize for the independent word problems during the last 2 weeks of implementation - weeks 13 through 14.

Data Collection

Reflexive classroom inquiry was utilized to qualitatively collect data (Hubbard & Power, 2003). During all 14 weeks of my study, I journaled my observations. As suggested by Connelly and Clandinin (1988), I used a T-chart, journaling my observations and reflections separated (see Appendix I). I also conducted student conferences (see Appendix J) once a week (Cole & Knowles, 2000). At the conclusion of the 14th week, the participants completed final questionnaires (see Appendix K).

Student work, weekly conferences, initial and final questionnaires, concept maps, reflection sheets, and working step sheets were collected. All student work was portrayed using pseudonyms to maintain confidentiality of the students. Student work was analyzed and triangulated (Hubbard & Power, 2003) with teacher journaling, questionnaires, student conferences, and reflection.

Trustworthiness Statement

As important as the research itself is the ethical guideline to be followed during my research (Arhar, Holly, & Kasten, 2001). I received approval to conduct my study through Moravian College Human Subject Internal Review Board. I introduced and explained my study to the students prior to research. I explained to my students that I would not use real names or name of the school. The participants were given parental consent forms and informed that although they will all participate in the class, they will not have to be included in the gathering of data. Further, the participants had the option to decide not to participate in the study at any time, with no consequence. All data I collected for my study were not seen by anyone but myself and were locked up for my use only. I also explained to the class if they were feeling uncomfortable in any way to see our principal, guidance counselor, or myself without prejudice. We had periodic class discussions on why this research is so important to them and my future students in aiding instruction. Feedback, questions, and concerns were encouraged.

In order to conduct accurate action research, I had to make a commitment to constantly and consistently reflect on my study and practices. I had to always stay open to changes, refute any biases that could potentially conceal or artificially create erroneous perceptions. My own misled educational history and present desire for knowledge could not be projected onto my class. I silenced my

opinion to hear my students' opinions. I remained objective and pulled data from multiple sources, such as my students, peer researchers, and professors, in conjunction with my own observations.

My main concern was to not lose sight of my purpose, which was my class. I had to be ever conscious of tendencies to become so involved with my research that could potentially take my focus away from my role as teacher. My priority was my students. I also explained this to my class and asked them to bring it to my attention if I should lose sight of that. I could not allow my research to override my responsibility as a teacher. I pride myself on being an easily approachable and open teacher who cares about each student, in his or her entirety. If my students felt they are not receiving all that they needed of me, I asked them to tell me. I also reflected daily upon whether I was the teacher I should be during my research. I discussed my experiences with my research group and advisor to ensure I did not allow any aspect of my students or career to slip through the cracks.

MY STORY

Off We Go

It was time for my study to begin. I had built a good rapport with my class and felt prepared to embark on my research. I explained to the class I was going to research if ways we organize solving problems help us to understand them, make word problems more enjoyable, or make them easier to do. I almost cringed when “word problems” came out of my mouth, being fearful of the class response. I tried to emphasize the easiness. To level the playing field, I explained that I, too, am a student, like them, and this is my project. I informed them that they would not have to participate in my collecting data on them, but they would all be doing the work. The class appeared excited and willing to be involved.

After handing out the consent forms, we embarked on our proactive participation in making problem solving fun and inviting. Only 3 students returned their consent forms promptly. I began to worry about the class’s responsibility. Slowly, I received the rest of the consent forms. I had to constantly remind the class to bring them in. I held a positive attitude and my students reciprocated. I passed out questionnaires for the participating students to complete and explained that word problems can be hard, but we are going to make them easier, and away we went. Most of my class did not have positive attitudes towards problem solving, at this time. “Aw” could be heard in the classroom from some students as their eyes dulled. The 5 students who reported

liking problem solving in the Initial Questionnaire reported that they like word problems because what we have done in class and prior experiences to date were easy. Many students had negative feelings about problems solving. The students with negativity toward problem solving found it boring, hard, or easy and hard.

Table 1

Problem Solving Initial Questionnaires

Students who like problem solving	5
Students who find problem solving easy	5
Students who find problem solving easy and hard	5
Students who find problem solving hard	4
Students who do not like problem solving	11
Students who find problem solving boring	3

Checklists

Once I received all consent forms, I started teaching and modeling word problem checklists. Since we began with the checklist and focused on the problem solving steps, I had my students omit the concept map and reflection components of the checklist. I explained that we would practice and learn about those components later. The class proceeded completing the checklists (see Appendix B) with ease, omitting the concept map and reflection components. I passed out the reflection sheets to my students for clarification of what reflection entails, but had the class write a few sentences on their checklists stating what they thought and felt about the word problem and organizational tactics used. I decided that before implementing another tactic before the checklists and concept maps were fully understood, a quick reflection would be best.

Webs

My students deemed the word problems easy, and they loved doing work in groups. Group work is a standard procedure in my class, especially with new content and tasks. Then I introduced the web concept map to help the students organize their thoughts. We took a week to model, explain, and practice the web with word problems. The students had a background of using webs in language classes. They appeared to be adjusting well. The class then could check off the concept map section on their checklist and write a brief reflection on it. I decided to have students write a brief reflection on the checklists to allow more success in

the present organizational techniques before introducing the detailed reflection sheet. The students were instructed to write 1 or 2 sentences on what they thought and felt about the word problems and figuring them out.

Rubrics

Next, I introduced the rubrics (see Appendix D) we would be using. We reviewed the criteria, and I guided the students in scoring their word problem with the rubric. The students struggled with scoring themselves in the work and concept map domain. I had assumed the rubric I created was objective and clear. The rubric also served as a tool to illustrate the completion and success aspect of problem solving for many students. A few students still did not feel confident in scoring themselves. They often wanted my input first. I told them to look at the work, word problem, and rubric to do their best. Since after each student or group was shown the correct answer on the board, the only aspects they needed to think about was work for the problem, the checklist, and the completed concept map. It dawned on me that this was a lot to evaluate. The students would state, “Which paper am I using for this?” I realized, along with the students, that practice in scoring word problems and my modeling would have to continue to achieve more benefits of utilizing this tool. I decided to push off the reflection sheets a week longer to concentrate on student understanding and application of the rubric. I realized how many new aspects were being included into the word problem solving process. The students continued to practice using the rubric twice more

and were showing progress. By the third rubric, students were starting to understand how to use the rubric to score their word problem. Once clearly understood, much of the students would call out, “I’m done!”

The Storm

By the third week, my students failed to listen to directions and took a long time to complete their work. I began to realize this implementation would take longer than I had previously conceived, and I realized it was not just them not listening. It was I not giving them enough guidance. The confusion and change in my class was inevitable. I never took into consideration how changing the methods used for solving problems would change the class dynamics. The class needed me more before they could become independent in their own thinking. When I was not offering enough guidance, the class was confused, off-task, and behavior was less than desirable.

Rough Seas Ahead

We were on the same voyage, captain and first mates, headed for the land of Mathematical Understanding. Each student appeared to hop into my boat without discretion. I, the captain, was as happy as could be with my loyal and willing skippers. We were sailing along until one day a dreadful storm was brewing across the horizon and mutiny was approaching. The skippers became able to rock the seemingly smooth boat.

All Aboard?

Week One-The Captain

Away we go, smooth sailing ahead
Problem solving not to dread
The waters once rough can be calm
Here we go- one and all.

Week Two- The First Mates

We don't cry, we don't fuss
We can solve them count on us
They can be fun, they make sense
We can put our fears to rest.

Week Three- The Captain

Aughhhh, they are out of control
As if not hearing any word was told
It should not take this long to do
If I can do it so can you.

Figure 1- Poem describing classroom dynamics.

Venn Diagrams

Since that I feared a class mutiny beginning in the second week of the study, I realized a change was necessary. When I introduced Venn-Diagram concept maps (see Appendix F), I decided to have a participating student, Tracy, teach how it should be done, with assistance from the class. The entire class was so excited and all attention was on the concept map and how to complete it. I "played" a student and assisted Tracy when the class as a whole needed guidance. I was so impressed how they worked together and were completely on task. The class appeared to enjoy using the Venn-Diagram chart when solving word problems, although they were also confused in completing the Venn-Diagram

sheets. I believe this is because the students were actively involved in developing the means of completing it, but did not have enough guidance from me. It was excellent having the student interest. Yet, the actual application of doing the Venn Diagram suffered. I decided not to stress over it. We were about to embark on other concept maps and my intent was for students to find the concept map that best worked for them. The class was engaged and excitement was evident. Student attitude toward problem solving, in my mind, is just as important as achievement.

Reflection

Feeling gained confidence in my students and myself, I had the students complete the reflection sheets (see Appendix C). At first, many students were confused by what the questions truly meant. I gave examples and the majority of students were deep in thought while proficiently writing down their reflections of the word problem. Much of the confusion came from the last section of the reflection sheet, “I shared my plan with others.” I explained that since we do many word problems and the tactics in groups, this was a way to make sense of what everyone learned and contributed in groups. It was a way to recognize what each student learned being in groups.

Two of my students, Barry and Harry, still did not believe they could answer the questions well. They both retorted “I don’t get it.” When my students say, “I don’t get it,” they mean that they do not have the concept in their

possession. I found that the two students doubted their capabilities to complete the sheet. I explained to Harry and Barry that they cannot make a mistake, and they were to answer what they thought and felt. I told them to take as much time as needed to think about it.

Dewey (1938/1997) states:

> The method of intelligence manifested in the experimental methods of demand keep track of ideas, activities, and observed consequences. Keeping track is a matter of reflective review and summarizing, in which there is both discrimination and record of the significant features of a developing experience. To reflect is to look back over what has been done so as to extract the net meanings which are capital for the intelligent dealing with further experiences. It is the heart of intellectual organization and of the disciplined mind. (p. 87)

By the second time students completed the reflection sheets, they had come up with great insights. Many students reflected profoundly on what needs to be addressed in work groups and what is further needed for success. I felt proud that the class came to these conclusions without my interference. Recognizing something from within is more powerful than being told. My students were having revelations and addressing them. The students were now in charge of their groups and how to better the group dynamic.

K-W-L Charts

Next we started the K-W-L charts. I played the role of teacher this time with help from my class. I introduced the K-W-L chart and had students explain what they thought they should put in each section for the word problem. In the beginning, about half the class was unsure how to do the K-W-L map sheet. By the end of the day, most students understood it well. Many students indicated through class discussions and interviews that the K-W-L charts were the most helpful and easiest concept map. I had started interviewing participating students in groups. When I asked students about each concept map taught to date, the students beamed when I asked about K-W-L charts. Rhonda would scream out, "Yes!" when I would tell the class they would be using the K-W-L map to solve the word problem. It seemed as though they had much confidence in using the K-W-L chart.

All Aboard!

By the seventh week of the study I noticed success in student work and positive attitudes. Through interviews, collected work, and observations, I noticed a greater class morale and student self-confidence. The rubrics were being scored more successfully. This entails correct answers and complete concept maps. Student interviews showed that morale and ability was greatened. This was the point in my study where the students and I recognized student success. For the first time, even the least motivated students had pride in themselves and their

work. “Yeah” was the common reaction to a perfect 3 or near perfect score on the word problem rubric. Positive opinions and correct applications of problem solving were greatened. The class had faith in themselves. Solving word problems with the organizational tactics became less cumbersome and more rewarding. My biggest sense of pride in my students was their abilities and awareness in reflections. It appeared as though we were all on the same ship again and heading toward the land of Self-Understanding.

Reflections

I like them - I like telling about myself
You can tell about yourself
You get to express what you like
I like you get to tell about your feelings
It helps you know what you are doing
You get to explain what you’re doing and help
It’s fun and helps to do the P.O.D.
Helps explain what you need- helps a lot
It helps telling the teacher what you like.

Figure 2. A Patai poem based on interviews from 12/2/06.

Hierarchical Concept Maps

I finally got to introduce hierarchical concept maps (see Appendix H) by the first week of December. At this time in my study, I was worried whether I

would get through the study for the students to choose the maps that they liked the best. I had originally thought the hierarchical maps would be more difficult for the class. From the first day of the hierarchical map implementation, the class did very well. The students almost instantly recognized their knowledge as they comprehended the question, what they needed to know, how to carry it out, and what they already knew as a result of the hierarchical concept map. I was very proud of my class and was feeling pride in my students' and study's success. I documented that all participating students were on task and only 2 were somewhat confused the first day.

The two students, Rod and Tracy, were often "confused" or reported to be confused. I find it no coincidence; they were often in a world of their own. I wrote down during class observations, "Tracy was staring into space." Rod and Tracy were so lost in being lost, that they could not recognize that being off-task was creating their confusion. I had talked to them numerous times as to how important it is to pay attention and how many important things and answers are missed if people do not listen for them. I related my "speech" to everyday life. I spoke of winning prizes, missing parties, and not knowing how to get fun places. I attempted to illustrate real life importance of listening in all arenas of life. The point of reflection in my study is for students to learn for themselves, but I could not help myself from interjecting this necessary fact.

The reflection sheets indicate that Rod and Tracy are aware of this and understand this problem. Both Rod and Tracy prefer being social rather than academic. Since my teaching and study incorporate group work and reciprocal teaching during lessons, I understand the benefits that can be gained in learning in this type of environment. Yet, if working in groups yields more distraction than learning, it is a hindrance to the learning process. A very effective reflection came out of Tracy, whose academic achievement is often inhibited by social disruptions. When reflecting on his problem, he wrote down and told me he would do better if he were working in a different group. Although reflection is a process, I noticed the classs's ability to reflect growing.

Tracy is quite conscious of his limitations and even suggested he sit closer to the front of the room, and not play with his friends during class time. Tracy is growing from his reflection. Reflection is helping Tracy. Rod is still unwilling to make his necessary changes. I do not believe Rod understands what is disabling his connection to the content. He wants nothing more than to goof around with his friends. Tracy has made tremendous strides in his accountability. Rod still remained lost above sea.

Ironic Voyages

We are all on a voyage. Some appear in the boat, while others appear lost in space. I'm sure outer space Is quite fun. There would be no authority figure, no one to tell you what you had to do. Yet, it could get lonely. Tracy enjoyed the freedom and fun of space but he realized all his friends were at sea. The voyage at sea was where all of his friends were. Tracy knew to be with his friends he needed to board the ship en route to the land of Mathematical Understanding. Rod seems to think the way to have fun and be with his friends is up above the atmosphere. He realizes his friends are way below at sea and that he should be with them. Yet for as much as he treasures his friends, he still resides in isolation looking far down at his friends, his mates.

Figure 3. A metaphoric vignette about Rod and Tracy.

When the next hierarchical map was constructed, all students were on task and showed understanding, but one. Rod, the solitary student off-task, was the only student confused. Rod appeared to be more focused on his drawing than his word problem. His reflection on work was still not promoting his learning. Although Rod often stated he needs more help and to work harder, he still coveted working in groups to socialize. Yet, he scored a perfect 3 on his rubric, by completing his checklist, concept map, and work with the correct answer. I decided to not berate the fact that he still has not taken charge of his learning. I supposed I allowed myself to step back from his insufficient self-control because

of his achievement in solving the problem and believing he must come to his own realization to alleviate his situation. All students received a perfect, or near perfect score on their P.O.D. The students' checklists, maps, and work were mostly perfect.

Harry, who often stated, "I don't get it," got a perfect score although he did not believe he understood what to do initially. Harry is a very hard worker and consistently wants to contribute to class. He wants nothing more than to excel in school. He wants to be the smartest student in the class. He has much potential. He has great ability, but not enough confidence in himself. Harry is the kid that always wants to please his teacher. He is also the student the teacher silently cheers for that he will answer correctly and feel pride in his answer with every response. Harry wants to succeed, but something holds him back.

Hey, I'M HARRY!

My name's Harry. I look smart. Some people tell me my glasses make me look smart. But some kids say I look dumb in my glasses, so sometimes I don't wear them. I think being smart is important. I am smart. I don't like when I don't get it though. It upsets me. I know I'm smart! I don't know why I let myself get confused so much. My dad wants me to be smart too. My Dad does cool things. I get to do a lot of cool things with my dad, like fish and go to work with my dad. He helps me a lot. I think I'm a good kid! I ask my teachers if I am when they get upset. They are never talking to me. I don't realize it until they tell me though. I wonder why Miss D. and all of my teachers like me so much. Is it because I look like Harry Potter? Is it because I am so good? Is it because I am so smart? They have so much confidence in me. I don't have that much confidence in myself. I know I can, but in school I get nervous and that can stop me from showing what I can do. Sometimes I think and rethink until I get confused. I know the answers, but why do they feel so lost in my brain sometimes.

Figure 4. A vignette about Harry.

Choices

Two weeks later, in the middle of December, the students were able to choose any concept map they wanted to solve the P.O.D. It was great to see the excitement in the classroom as my students carefully picked which concept map they would choose to solve the word problem. I informed the class that for the rest of the word problems, they would be able to choose whichever map works best for them and work independently. The class loved being empowered, and I felt like I gave them a special treat for their hard work and determination.

The first time the class chose, 6 students chose K-W-L charts, 4 students chose Venn Diagrams, 2 choose hierarchical maps, and 1 student chose the web. Almost all students received perfect scores on the rubric. Only 1 student, Rhonda, performed above average on constructing the map. I was surprised she chose a web and not the K-W-L chart being that she would get so excited and spoke so highly about how the K-W-L Chart helps. Another student, Barry performed average on constructing a concept map. The rest of the class did proficiently on the word problem and organizational techniques. All students reworded the problem expertly. The students were consistently being successful.

Table 2

Concept Map Preferences 12/12/05

Concept Maps	Number of Students	Students who did perfectly	Students who did above average	Students who did average to below average
Web	1	0	1	0
Hierarchical	2	2	0	0
Venn	4	3	0	1
K-W-L	6	6	0	0

The next P.O.D. was received with students exclaiming, “We get to pick our own again!” This time 6 students chose the Web, 2 students chose Hierarchical, 2 chose Venn diagram, and 3 students chose the K-W-L. I was surprised that the K-W-L was not chosen more being that it had such rave reviews from my class observations and interviews. I believe so many students chose the web because it was the first web and we spent more time in practicing it, although they did not perform expertly in constructing it.

This time 4 students: Sam, Chenzo, Tracy, and Jim performed above average to my dismay. I thought they would be scoring higher than the previous

word problems. A possible cause could be that they were working independently, being this was the independent phase of my research. I recognize the need to have my below basic students have as much assistance as necessary, but to accurately gauge their progress, I needed to have them working independently. I also find it interesting that they chose the first map we learned and implemented, the web. Being that it was so long that it was used might have been a factor in the class's above average performance.

Table 3

Concept Map Preferences 12/14/05

Concept map	Number of students	Students who did perfectly	Students who did above average	Students who did average to below average
Web	6	2	4	0
Hierarchical	2	2	0	0
Venn	2	2	0	0
K-W-L	3	3	0	0

I conducted the 5th student interviews, in the third week of December, and found that all students found checklists helpful. Each student proficiently used the checklist to solve the word problems. All word problems were being solved proficiently. The students were having great success in solving word problems independently using checklists, chosen concept maps, and rubrics. I found it strange that I had to remind the class how excellently they were doing in their word problems. The students were getting perfect scores. I began to wonder if past experiences in problem solving were so negative, that they could not recognize their own success. I often reminded the class how high they were scoring on the word problems. They saw their grades for every word problem, but still did not appear as confident in themselves as I had believed each student should. I found myself conscious of praising my students to ignite self-recognition in each student of their immense progress. I wondered what happened to render my class, and students everywhere, so scared and unsure in mathematical problem solving.

I also discovered my students' attitudes toward reflections from interviewing. All, but one student, Chenzo, found reflections helpful. Chenzo said he could just write a few sentences on the bottom of the checklist like the class has done when they did not have to complete a full reflection worksheet. Chenzo believes the reflection sheet is redundant. I must admit he has a very valid point. Chenzo is not a student who is willing to contribute to many aspects of the class,

including mandatory schoolwork being that he does not seem interested in the least. Before the implementation of this study, Chenzo performed below average on problem solving. He would say, “This is boring.” His boredom is not a result of the content not being challenging enough. Chenzo has a low ability and even lower motivation. Yet, by tenth week of the study, Chenzo was scoring perfect or above average. Chenzo still has a negative attitude toward problem solving, but is now producing perfect to above average work.

I had introduced the word problem, “What are the chances that we will have a delay on Friday? ” I asked the class what the probable effect was for Friday morning, if there was a 70% chance of snow. Sam said, “It’ll get slippery.” “Yes, ” I replied. Dana added “A delay?” “Could be,” I affirmed. Rod called out, “We have off 17 days.” I asked Rod what that has to do with having a delay on Friday. He just looked up at me. I could see the stardust floating between his ears. Rod was still lingering in outer space. When checking his self-chosen web concept map, I noticed he wrote in the answer space “17 days off of school.” Apparently he did not take heed that he was on the wrong track. He did erase his answer and left the answer circle blank on his sheet. This P.O.D. was different from the others because the class did not have to do a mathematical operation to find the answer. The answer is logical with use of correct terminology. The rest of the students simply put in the answer that was obvious to them, “a good chance”, “highly likely”, or “likely.” Rod had nothing but an erased answer of “17 days

off school." Rod remained disconnected from the class. Again, he was the only student not with the rest of the class, but this time his concept map was only average. Rod was still not connected to the content. I specifically implemented that P.O.D. to connect students. I had hoped they would get excited because it directly affects them, especially Rod, who would rather be doing anything other than being in class. It still did not reach him.

Dewey (1938/1997) states:

> They become concrete only in the consequence, which result in their application. Just because the principles set forth are so fundamental and far-reaching, everything depends upon the interpretation given them as they are put into practice in the school and home. (p. 20)

Dewey means that students must connect to their learning. Students cannot be taught skills in isolation without identifying the purpose and necessity to apply it. Students must be taught the purpose and the true reason for their educational practices. I have noticed time and again the lack of connection students have in solving word problems. When students are guided and feel more connected to word problems, they are better able to solve them. When my class feels more able and a sense of understanding, they can partake in the problems solving process with less fear and more certainty. It is the role of the educator, myself, to bring these concepts and applications to the students. In my participant

observation journal, interviews, student reflection sheets, and work samples, I have noticed the ease students have in solving word problems when they are connected to the problem and see its purpose. My class often enjoys solving word problems when the problems pertain to the class personally. The students see the point. I have noticed the most student connectivity when student opinion is used to collect data. I also have found in my documentation of interviews that students enjoy solving word problems when they understand why and how they are solving them. Yet, Rod is still not connected.

Rod's Thoughts
I just want to be with my friends.
I get my work done quick so I can draw.
I like to draw.
Why does Miss D. and all my teachers make me stop, I finished my work.
I don't care if it's right. I just don't want to do work.
I know I get into trouble.
I don't want to get into trouble with my teachers.
I know they are going to make me do my work again over.
Sometimes I can sneak past them. I usually try to.
Sometimes my work is perfect, then, they can't make me redo it.
But if it's perfect and my teacher can't read it, I have to do it over neatly.
I'd rather be drawing.

Figure 5. A vignette taken from observations, reflections, and interviews.

The Finale

At the end of the 14th week, I had the participating students complete final questionnaires. I was surprised that only 7 students, half of the participants, reported liking problem solving and 8 reported that word problems are easier. Six

students wrote they still do not like problem solving and 5 believe problem solving is too hard. One student finds problems boring. Three students reported that word problems were fun, and 2 wrote problems were easy and hard.

Table 4

Problem Solving Final Questionnaires

Students who like problem solving	7
Students who find problem solving fun	3
Students who find problem solving easy	8
Students who find problem solving easy and hard	5
Students who find problem solving hard	2
Students who do not like problem solving	6
Students who find problem solving boring	1

I must admit I thought with the success students had in solving word problems, their attitudes would be higher and would find solving problems easier than reported. I witnessed students' spirits lifted and the surprise with success. I

had hoped there would be more improvement in attitude. I assumed attitude would correspond with successful scores. Students stated they do find problems easier, and more students like solving problems, but 6 students out of 14 still do not like solving word problems. Vygotsky (1978) states, “Any learning a child encounters in school always has a previous history” (p. 84). Vygotsky means that all children learn since birth. Children are learning before new concepts are introduced. Students make sense of their world beginning before schooling develops learning further. Once in school, attitudes and learning is further developed.

I consider myself to be the educator who tries to expand upon prior knowledge. The learning experience of my students was present before they reached fifth grade and before they attended school. There are times when student learning experiences are tainted. For example, bad learning experiences, such as in problem solving, taint my class’s view on solving word problems. Most students have come to fear word problems most likely because of the challenge of solving them. I must constantly remember the students’ dislike for problem solving stems from years of negative experiences in hopes to alleviate the impending frustration and negative attitudes toward word problems. I have records of students’ negative experiences with mathematical problem solving. Out of 15 students surveyed before the study, 10 students wrote they did not like problem solving. Of the 10 students who dislike word problems, 7 think they are

too hard and 4 wrote word problems were boring to solve. One student found word problems easy and hard, but still reported not liking them. The first time I started the problem solving techniques of using a concept map and checklist so we can solve word problems better a student named Rhonda called out, ” Aw.” She was not excited to embark on problem solving. Her past experience with solving word problems tainted her willingness. She learned to not like word problems. By the 14th week of the study “Aw” never came out of Rhonda’s mouth. She would exclaim, “Yes” like the other students when she would see her score. I believe I alleviated her negative attitude toward word problems. Yet, if she had no experience, she would struggle much more. I am glad she has solved word problems before like the rest of the class and has been successful in this study, but I want to my students to really comprehend how much they have accomplished and can accomplish even more. Just as it took time to foster negative attitudes toward problem solving, I think it will take that same amount of time to undo the negative experiences. From initial to final questionnaires, positive attitude has increased. Yet, it should not be forgotten that prior experiences have much influence on the present.

DATA ANAYLSIS

Data were analyzed and triangulated (Hubbard & Power, 2003) with teacher journaling, questionnaires, student work, and reflection. I quantified data from interviews and questionnaires by creating tables, which grouped and showed student responses. I tallied up response codes and compared the data in tables. Observational checklists were also used to quantify student response, understanding, and word problem scores. Initial and concluding questionnaires were analyzed, along with student work. I also examined new variables in response from initial to final questionnaires, interviews, and student work.

Teacher journaling (see Appendix I) consisted of reflection and participant observation (Connelly & Clandinin, 1988). One side consisted of space to write observations. The other side had my reflections and thoughts of what I had observed. Each page and line on the page was numbered for quick reference. I coded the qualitative journal and found reoccurring themes to be put into thematic bins (Arhar, Holly, & Kasten, 2001). Student questionnaires, interviews, and work were also coded. The 1 to 2 word codes were written or typed on the data collected. The codes reflected important topics or relevant findings. The codes were then referenced in an index. When themes within observations and work were found, I wrote thematic codes on the data. The thematic codes were

organized into thematic bins for an overview and analysis of results (see Figure 6). I then created a graphic organizer to represent my themes.

Figure 6. Graphic organizer of data collected.

When all data were gathered and reflected upon, results were summarized based on my theme statements. I interpreted the findings with dramatic representations in the form of layered stories, poems, and vignettes (Ely, Vinz, Downing, & Anzul, 1997). These dramatic representations were based on observations, student work, interviews, and reflection sheets. I asked for student reactions to my poetic representations of observations and findings. The students read my poetic portrayals of themselves. The students agreed with and confirmed my representations based on observations, interviews, questionnaires, and student work.

Students were given pseudonyms for data collection. I listed each participating student and the pseudonyms I chose next to the student's real name. Names on student work, observations, and questionnaires were changed. Once results were found and reported, the data and name list were destroyed for the protection of the participants.

FINDINGS

My study set out to ask the whether mathematical word problem scores are affected by organizational techniques. Further, I wanted to find if student attitude would be affected by implementation of organizational techniques. I have found organizational techniques to better word problem scores, student ability, and attitude toward mathematical word problem solving.

From initial questionnaires (see Table 1) to final questionnaires (see Table 4), 8 students, 3 more students than in initial questionnaires, found word problems easier by the end of the study, and 4 less students reported word problems to be difficult. In the final questionnaire, 5 students still found problem solving difficult. Two students found word problems to be sometimes hard and sometimes easy in the final questionnaire, as opposed to 5 students in initial questionnaires. No student found word problems fun in initial questionnaires and 3 students wrote word problems are fun in final questionnaires. Three students initially reported that word problems are boring. Only 1 student reported word problems to be boring by the end of the study.

P.O.D. Scores

Problem of the Day (P.O.D) scores are affected by organizational techniques. Students' scores, on rubrics, range from below average to perfect.

Most scores are above average to perfect. Scores are rated with organizational techniques. Scores reflect solving the word problems and completing graphic organizers, checklists, and reflection. The better the students performed on the organizational techniques, the better they scored on the P.O.D. By the end of my study, almost all students were scoring perfect 3s. Occasionally, a student would score an above average, 2 ½.

Graphic Organizers

I wanted to find if graphic organizers, or concept maps, helped students organize their thoughts to perform better and understand word problems. Wilcox and Sahloff (1998) state, "The maps give a panorama, a sense of the whole, as perceived by students" (p. 468). I found graphic organizers assist students in organizing their thoughts to solve word problems. McGowen and Tall (1999) suggest that the more success students have in creating concept maps, the more mathematical knowledge is obtained. Williams (1995) believes concept maps are optimal because they better involve students and illustrate the students' perceived relationships. When reading the students' concept maps, I felt as if I could visualize their otherwise undetectable thought processes. Concept maps served as a viable tool to the inner processes of each student, when solving a word problem.

Students have reported that webs, Venn-Diagrams, K-W-L charts, and hierarchical concept maps help to organize their thoughts. The students' understanding of how to solve the P.O.D. is heightened. The more practice the

students had in doing the graphic organizers, the better they performed on P.O.D.s. The easier students find graphic organizers, the better they solve P.O.D.s.

Many students prefer the K-W-L chart and the web map. The Venn diagram was the class's least favorite concept map, and the hierarchical concept map was the class's second least favorite. Although students reported their favorite concept maps, they did not always choose the map they prefer when given the choice (see Tables 2 and 3).

Procedural Tactics

I also wanted to find if checklists helped students to solve and understand word problems. I discovered checklists assist students in solving word problems. All students reported that checklists help them to solve the word problems. The steps in the checklists help students to answer the word problem correctly and make the problem easier. Anderson, Olsen, and Wrobel (2001) explain providing students with structure to solve word problems will heighten student success. Students with checklists as guides have more success in solving word problems.

Grouping

When in groups or whole class, I sought to uncover whether students reciprocally teaching concept maps and steps enable students to better solve and understand word problems. The students can learn from each other and share multiple perspectives, which fosters deeper understanding. Palinscar (1986) found

student independence from their teacher when reciprocal teaching was implemented. The students also enjoy learning with classmates. Coy (2001) believes that, when in groups, students feel safe to express and discuss their ideas. Students found more understanding when being taught reciprocally by a classmate after being taught by the teacher. When in groups, students took responsibility, offered suggestions, helped each other to reword the problem, and recognized the group needs. Students were also very aware of group dynamics and most knew how to adjust to those dynamics for success. One student showed he recognized his weakness in group work, yet would not alter his behavior for success.

Understanding

This study analyzed whether reflection can help students to improve upon and better understand word problems. When students were connected to their learning and had free expression, they learned more about themselves and their ability to understand what is expected to solve word problems. Students understood their abilities and what they needed help with when doing reflection sheets. Jackson (2000) found that reflection increased higher order thinking skills and organization in problem solving. They also enjoyed the expression of their thoughts and feelings. When able to reword semantics in word problems, students found the word problems much easier to solve. These factors of comprehension connected the students to the content of the word problems and the problem solving process.

I also discovered that student feedback and expression could help communication between teacher and students. Student reflection sheets presented great insights to student perspectives and processes. I, the teacher researcher, could understand what students are obtaining from instruction, content, and student processes. Student expression, through reflections and rewording, also gave me more detail as how to adapt my instruction or reword my instructions to fit the semantics of the students. When students and teachers understand how each other connects to the content, effective communication and instruction can occur.

Bernardo (1999) explains that understanding the word problems is vital to solving them successfully. Rewording the problem also assisted students in creating concept maps and solving the problem. With observational checklists, I found students rewording the problem helped in creating the concept map and answering the problem correctly. Initially, students needed my guidance and modeling to reword the problems. Then the students worked well rewording the problems in groups. By the conclusion of the study, students were able to reword problems independently.

My study also sought to find whether rubrics help students to effectively solve word problems. It was found that rubrics assisted students in solving word problems. Practice of using rubrics made problem solving easier. Rubrics helped students to recognize what is expected of them to solve the word problem

perfectly. Further, students scoring themselves, using rubrics, helped the students assess and modify their work.

Positive Student Attitude

The effect of organizational techniques on student attitude about word problems was also observed. Positive students attitudes fostered greater ability to solve word problems. When students attitudes were positive, the word problems were much more enjoyable, easier to do, and the students scored better on the word problems. The students were more motivated and able to tackle word problems when they felt self-efficacy and excitement. Attitude and ability appear intertwined. Mills and Stevens (1998) found student confidence and ability to grow with the implementation of strategies. Positive attitudes instill ability and ability instills attitude.

Negative Student Attitude

I found that negative attitude is connected to low ability to solve word problems. When students were bored, they found the word problems too difficult, or find word problems are too much work; their ability to solve word problems lessened. Students feeling negatively become distracted, unaware, and unmotivated. When negative attitude was present, the class was in disorder. Still, 6 students reported not liking word problems in the final questionnaire. All students' ability was greatened through this study. Through interviews and

reflections, students reported that they like problem solving more. Yet the final questionnaire some students answered “no” to liking word problems.

Teacher Obstacles

While conducted this study, I discovered a teacher obstacle in implementing techniques to assist students in problem solving. Time management needed improvement. Lack of time, as a direct result of my time management, caused anxiety. I, the teacher researcher, encountered frustration with lack of time. Lack of time caused confusion with my students and frustration within myself. I needed to allow more time for students to take in all the new techniques that they were learning. Careful planning and time management alleviated my anxiety and frustration.

Student Information

In order to alleviate anxiety with what I am calling time management, I needed to find a means to communicate instructions more effectively. Student feedback in the form of questionnaires and conferences helped me to communicate with my students and understand my students’ needs better. I found student conferences especially valuable in communicating and understanding my students’ thoughts and needs.

I have found reflection sheets to be the optimal way to achieve this. Interviews were helpful, but very time consuming. Questionnaires also served as a valuable tool to collect information. Yet, questionnaires may lack deeper

understanding of the students, which I have encountered. An authentic reflection sheet can be done in a few minutes, and I found the reflection sheets to be helpful for students and the teacher.

NEXT STEPS

Summary of Results

Overall, I have found that organizational tactics assist students in mathematical problem solving. Checklists prove to be very helpful for the students in taking the steps to solve a word problem. Concept maps assist the students in figuring out how to solve the word problem. Rubrics help students to understand what they must do to obtain a high score of which they can be proud. Reflection sheets assist the students and teacher in understanding what is necessary for each student from themselves and their teacher.

Time Constraints

It was not until I heard various comments from my students that I realized how much work was added to problem solving. I had originally planned on 1 word problem a day. With all the new dynamics of checklists, concept maps, and rubrics, problem solving took longer. I often spread the problems of the day (P.O.D.) to 2 days. For optimal understanding, I believe students need to comprehend, execute, solve, and assess their word problem the same day. A one-day lesson is especially important when students, like mine, have the class every other day. When the bell was about to ring and we did not complete the P.O.D, I would wince. My students would look knowingly and sympathetically at me, as if to say, “Out of time.”

I introduced, tried to teach, and had students successfully implement checklists, reflections, and 4 concept maps in 14 weeks. I think I was pressured for time, along with my students. Although ability rose, I think more time and practice is needed to take a positive hold on attitude. I think in the future I will allow a few weeks for each concept map with prior word problems to instill successful creation, understanding, and utilization.

Reflection sheets were insightful and beneficial, but time consuming. I had to have my students do quick reflections on their checklists to save time. Although quick reflective thoughts were less detailed than the worksheets, again, I often found myself lacking for time.

Choice of Concept Maps

I believe further research should be conducted to find the most beneficial concept maps for problem solving. Although students reported preferring the K-W-L chart and web, they did not automatically choose their preferred map when given the choice. This should be studied. I will need more time to have students fully encompass what their choices entail.

Student Attitude

I have discovered organizational tactics to assist students in solving word problems, as well as making them somewhat more enjoyable for the students. Yet final questionnaires show 6 students still not liking them, even with their impressive success. I wonder what happened to render my class, and students

everywhere, so scared and unsure in mathematical problem solving. The students' confidence and success may not affect their attitude. I believe the final questionnaire was too open ended. Students may never enjoy doing word problems even if they find success and pride in solving them. For future studies, the questionnaires should be more structured and ask specific versus open-ended questions.

I found that negative attitude is connected to low ability to solve word problems. Further, careful planning and time management can alleviate the anxiety and frustration of the teacher and students alike. These results illustrate the continuing need to assist students by implementing tools to solve word problems.

Problem Solving Instruction

I believe instruction should be adapted to counteract the anxieties both students and teachers face in problem solving. I have encountered both sides. In being an elementary student, I did not want to attempt difficult word problems. As an educator, I have dreaded the reactions of my students when expected to solve word problems. Educators must find ways to make the abstract process of solving mathematical word problems more tangible. Dewey (1938/1997) implicates the teacher's role by stating:

> It thus becomes the office of the educator to select those things within range of existing experience that have the promise and potentiality of

> presenting new problems which by stimulating new ways of observation and judgment will expand the area of further experience. (p. 75)

This quote means educators must create a developmentally student-friendly environment in which students can prosper in their learning experience. Educators are responsible for making the connections and scaffolding student awareness in their learning. Students must be taught awareness. Further it must be cultivated. I believe this is the goal of educators. We must deliver content in a way that the students are connected, and instill valuable tools to ensure success. Problem solving is often difficult. Educators have the ability and role of having their students connect and succeed. If students understand the process, they can expand upon it.

In researching previous studies to my own, I was disheartened by the lack of articles implementing new and various tools to assist students in problem solving. Much more research is needed if we as educators can lend the way to student understanding. Problem solving is the essential facet in mathematical understanding. Is it our own mathematical experiences that inhibit our instruction? Is it a feeling of learned helplessness that we project onto our students? Do all educators need a catalyst, like myself, to further their instruction? I must admit problem solving is difficult for me, as well. Yet, I recognize the importance, only because of my undergraduate and graduate professors' impact on my awareness of true understanding. I was once naive and

could erroneously hide behind the fact that the content was too difficult and the students just are not developmentally ready. Although that mindset was easier, it was my own projection. Now I am the wiser. I believe in understanding and have seen the growth in my students. There is no going back. I will continue along this path.

My Continuation

I want my students to have understanding of the pertinence in solving word problems. The seed has been planted in me and it is my role to perpetuate that for my students. Purcell-Gates (2002) states, "This achievement would not have happened without this teacher and her absolute belief that, yes, life was hard for these kids, but they were learners, they would learn, and it was her job to see that they did, in ways that worked for them" (p. 137). This quote sums up the conviction of a teacher to not allow her students to fail regardless of life circumstances. It means that no matter how difficult her students' home lives were, she was not going to excuse them from learning. There needs to be high expectations for all students regardless of extraneous circumstances. It is important to reach all students from all backgrounds by every means possible. Many of my students are underprivileged economically, socially, and academically. I feel compassion and pity for my class daily. Yet, I do not allow them to fail. No matter who they are, have been, or may become, I expect nothing but my students' best. I will help those who need it, so that they can succeed, but

will never dismiss poor quality work. I will not accept work that was done below expectations. I believe this will help my student excel and believe in themselves despite any deemed “dispositions.” My class also recognizes that they can learn no matter what academic dispositions they may have. Beth said that problem solving is hard, but practice will help her. Beth recognizes, like myself, that no matter her affective or academic disposition, she can succeed. Harry also stated that word problems are hard for him, but doing more will help him and make him find word problems less difficult. Rod is another student who finds word problems difficult, but believes with my help he can succeed in doing them better. Ronda, Dana, and Tracy stated that practice is making the P.O.D s easier to do. My students gained ability and pride by the end of this study. My class knows they cannot quit, and I will not quit on them. My students’ courage and progress ignites my determination. Hence, my research has and will continue until I can foster students who can undergo the problem solving process with lack of fear or failure.

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Appendixes

Appendix A

Name _____ Date_____

Initial Questionnaire

1.Do you like solving word problems in math?

____Why?_____

_____

_____

2.Are they easy or hard? _____ Why? _____

_____

_____

3.Can you think of a way to make them better to do?_____Explain._____

_____

Appendix B

Name_____ Date_____

Word Problem Checklist[1]

_____1. I read the problem at least twice and understand what it says.

_____2. I discovered the question.

_____ 3. I created a concept map to organize my thoughts in my own words.

_____4. I made a plan to solve my word problem.

_____5. I answered my word problem, showing work.

_____6. I checked my word problem to see if it makes sense.

_____7. I did my reflection sheet.

---

[1] Adapted from Hohn and Frey (2002).

Appendix C

Name_____Date_____

REFLECTION SHEET

Now I think _____

_____

_____

The best thing I did was _____

_____

_____

The hardest thing was _____

_____

_____

For next time I _____

_____

_____

I shared my plan with others. YES or NO

Others think _____

_____

_____

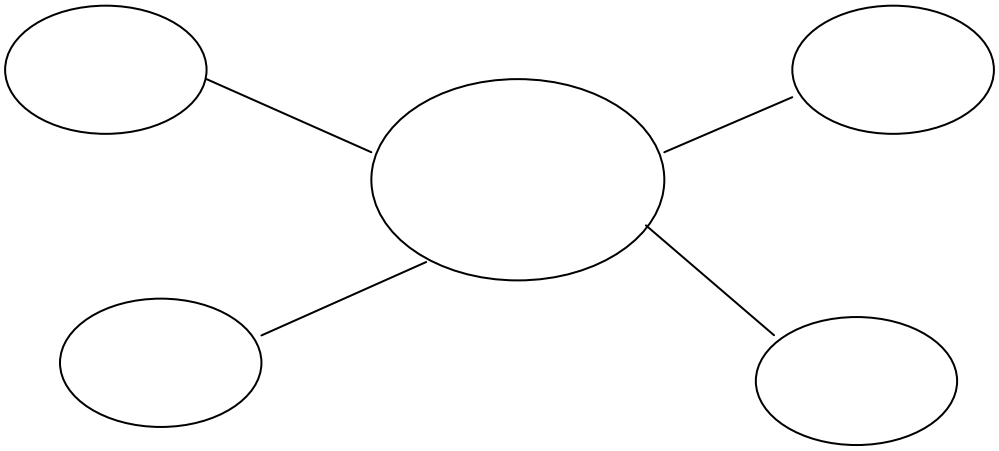
Appendix D

Name_____ Date_____

	3	2	1	0
Check List	**Complete**	**Mostly Complete**	**Incomplete**	**No Checklist**
Work	**Complete Work**	**Mostly Complete Work**	**Incomplete Work**	**No Work**
Answer	**Correct Answer**	**Incomplete Answer**	**Incorrect Answer**	**No Answer**
Concept Map	**Complete Map**	**Mostly Complete Map**	**Incomplete Map**	**No Map**

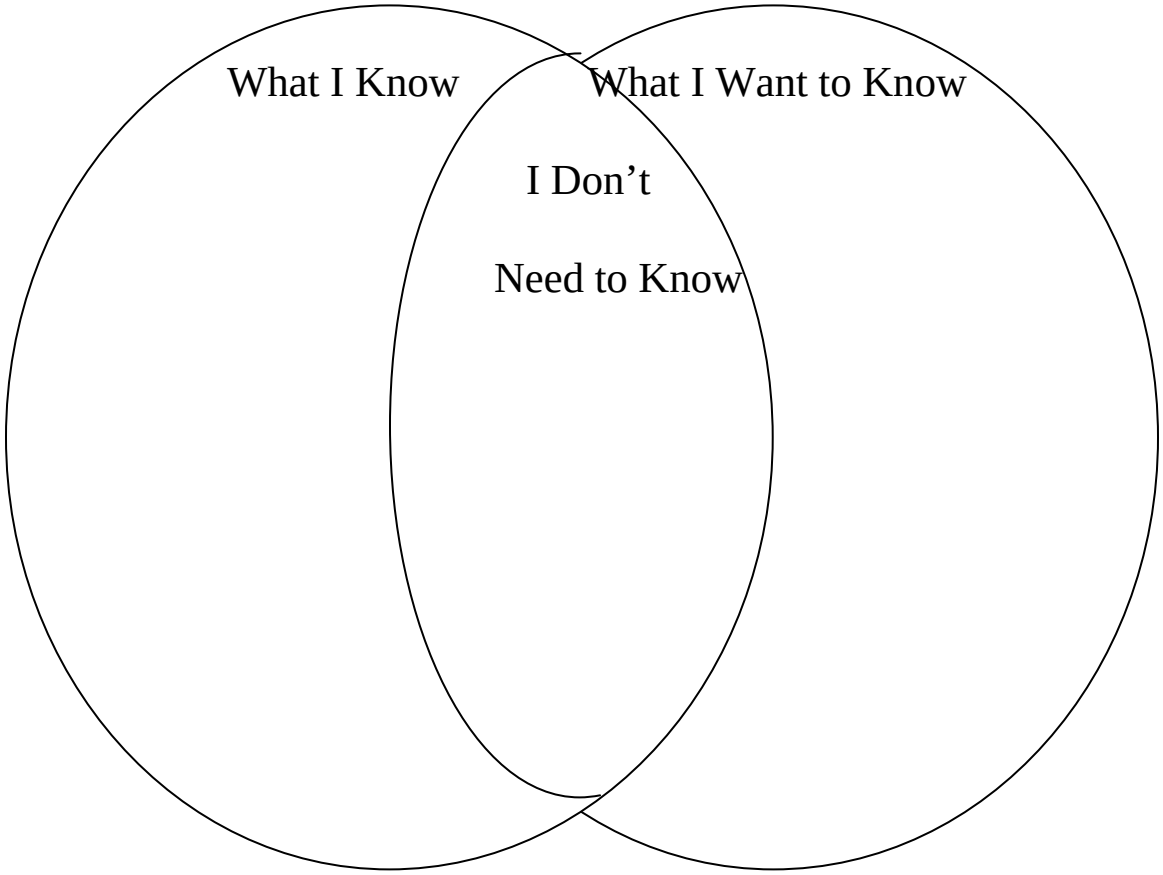
Appendix E

Name_____Date_____



Appendix F

Name_____Date_____



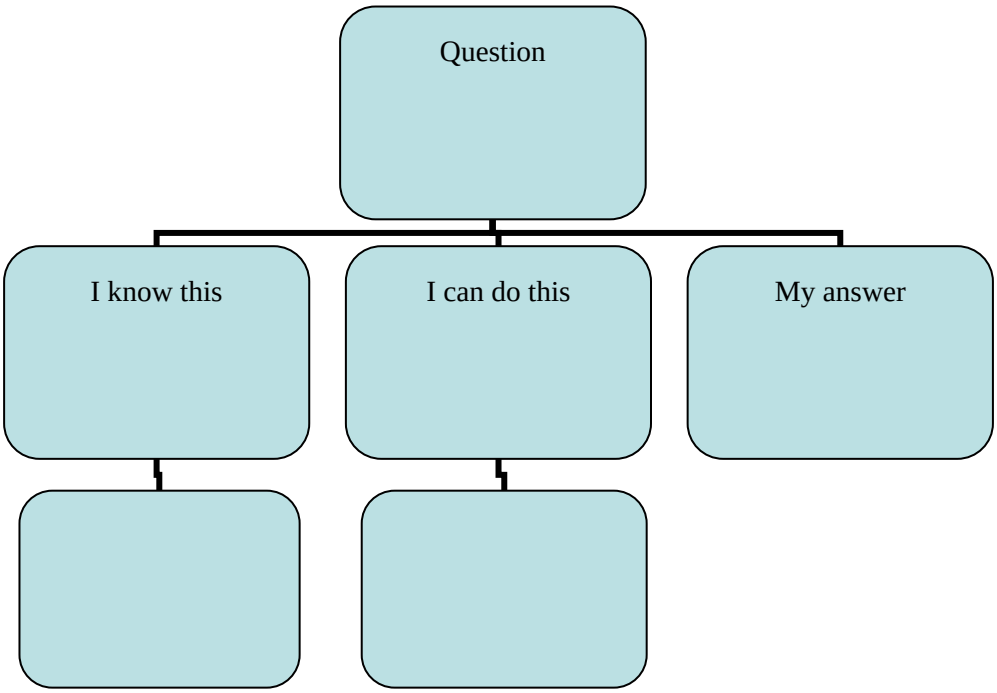
Appendix G

Name _____ Date_____

K What I know or have experience in doing	**W** What I need to know	**L** What I have learned or figured out

Appendix H

Name_____Date_____



Appendix I

Title_____ Date_____

Time_____

Observation	**Reflection**

Appendix J

Name_____Date_____

1. Hi. How are you?

2. What do you think about math and word problems?

3. Why?

4. What is the best thing about word problems?

5. What is the worst thing about word problems?

6. What can I do to help you be the best you can be?

Comments:

Appendix K

Name _____ Date_____

Final Questionnaire

1.Do you like solving word problems in math?

_____Why?_____

_____

_____

2.Are they easy or hard? _____ Why ? _____

_____

_____

3.What has changed about problem solving for

you?_____

Explain._____

_____

_____

Appendix L

MORAVIAN COLLEGE

August 22, 2005

Tiffani D'Angelo
1406 Stones Crossing Road
Easton, PA 18045

Dear Tiffani D'Angelo:

The Moravian College Human Subjects Internal Review Board has approved your proposal: Organizational Techniques to Assist in Third Grade Mathematical Problem Solving Given the materials submitted, your proposal received an expedited review. A copy of your proposal will remain with the HSIRB Chair.

The HSIRB committee, however, requests that you make further revisions to you Informed Consent Forms. The phases "There will be no consequences," and "without penalty," must be further explained. It is necessary for those who read the form to understand that grades will not be affected by agreement or refusal to participate in your research.

Please note that if you intend on venturing into other topics than the ones indicated in your proposal, you must inform the HSIRB about what those topics will be.

Should any other aspect of your research change or extend past one year of the date of this letter, you must file those changes or extensions with the HSIRB before implementation.

A hard copy of this letter will be sent to you through U.S. mail shortly. If you do not receive the letter by the time you need to begin gathering data, please do not hesitate to contact me. Also, please retain at least one copy of the appeoval letter for your files. Good luck with the rest of your research.

Debra Wetcher-Hendricks
Chair, Human Subjects Internal Review Board
Moravian College
610-861-1415 (voice)
medwh02@moravian.edu

Appendix M

CONSENT FORM

Dear Parents/Guardians,

I am completing a Master's of Education degree at Moravian College. My courses have enabled me to learn about the most effective teaching methods. One of the requirements of the program is that I conduct a systematic study of my own teaching practices. This semester I am focusing on mathematical problem solving. The title of my research is *What will be the reported and observed effects of implementing organizational techniques on mathematical problem solving?* The research will begin in September 2005 and conclude in December 2005.

Students often struggle with problem solving, which is at the heart of mathematical understanding. Making sense of word problems and being better equipped to solve them is necessary academically and pertinent to real life situations. I plan to use organizational concept maps, checklists, rubrics, reflection, and students teaching students tactics to simplify problem solving and generate more accurate answers.

All children in the classroom will partake in these problem solving math lessons, being that it is part of the curriculum. However, students may choose to not participate in the study. Students may withdraw from the research collection at any time, without any penalty. All information will be kept confidential, locked securely, and names will be changed to pseudonyms for data collection. Further, the school name will not be mentioned in this study.

Each child's participation in this research is voluntary. I welcome questions at any time. You can contact me, Tiffani D'Angelo, at school, at (610) [redacted], or via e-mail [redacted] or our principal [redacted] should you have any concerns. My Moravian College faculty advisor, Dr. Charlotte Zales, can be reached at (610) 625-7958 or e-mail [redacted]

Please sign, check and return the bottom portion of this letter and return it to me at school. Thank you very much for your time and support.

Sincerely,

Tiffani D'Angelo

_____

I attest that I am the student's parent/guardian and have fully read and understand this consent form. I give permission for my child to participate in this research.

Student's name_____Date_____

Parent/guardian signature_____Date_____

Appendix N

PRINCIPAL INFORMED CONSENT

Dear [redacted],

I am completing a Master's of Education degree at Moravian College. My courses have enabled me to learn about the most effective teaching methods. One of the requirements of the program is that I conduct a systematic study of my own teaching practices. This semester I am focusing on mathematical problem solving. The title of my research is *What will be the reported and observed effects of implementing organizational techniques on mathematical problem solving?* The research will begin in September 2005 and conclude in December 2005.

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Each child's participation in this research is voluntary. I welcome questions at any time. You can contact me, Tiffani D'Angelo, at school, at ([redacted], or via e-mail [redacted] should you have any concerns. My Moravian College faculty advisor, Dr. Charlotte Zales, can be reached at (610) 625-7958 or e-mail crzales@moravian.edu.

Sincerely,

Tiffani D'Angelo

I attest I am the principal of the teacher participating in this research study, that I read and understand this consent from, and received a copy. Tiffani S. D'Angelo has my permission to conduct research at [redacted].

Principal's signature[redacted]Date[redacted]

Appendix O

STUDENT CONSENT

Dear Class,

As you know Miss D goes to school to be a better teacher for you. I have a research project to do for my class at Moravian College. I am going to make a few changes in the way we solve mathematical word problems. We are going to teach each other, think about what we do, reword the problems, use rubrics and checklists, make webs, Venn-Diagrams, KWL charts, and branching maps to make problem solving easier for us. We all will do this, but may choose to not participate in my research study. This means we all do the same thing in math, but you don't have to participate in what I am studying. If you do want to participate, I still cannot use your real name or the name of our school because this is confidential. If at any time you decide you don't want to participate in my research information, please tell me. There will be no consequences. If for any reason you feel you want to talk about what is going on you may talk to Mr. Steckel, Mr. Vigilanti, or me. Just let me know. Thank you students!

From,

Miss D'Angelo

Appendix P

Word Problems

Unit Graphing

Week One: *How do the birthdays of the boys and girls in this classroom compare?*

Week Two: *How do the boys' and girls' favorite sports compare?*

Weeks Three- Five: *What are our favorite vacations? How has our amount of homework changed since we began school?*

Week Six: *Create a class pizza party showing our favorite toppings.*

Week Seven: *What is the average age of the class?*

Unit- Probability and Statistics

Week Eight: W*hat are the mean, mode, range, and median of the hours we watch TV in a week?*

Week Nine: *What are the statistics of the turkey feathers in your hands?*

Weeks Ten-Eleven: *Make a stem and leaf plot with Miss D's grades.*

Week Twelve: *What are the chances that Miss D. will pick a red M& M?*

Week Thirteen: *How many boy and girl pairs can we make in the classroom?*

Week Fourteen: *How many different outcomes of sundaes are there if your ice-cream is chocolate and vanilla and toppings are fudge, caramel, peanut butter, and strawberry?*