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Cooperative Learning in Relation to Problem Solving in the Mathematics Classroom

Abstract

In this action research study of my classroom of 5th grade mathematics, I investigated cooperative learning and how it is related to problem solving as well as written and oral communication. I discovered that cooperative learning has a positive impact on students' abilities in problem solving and their overall impression of mathematics and group work. I also found that my students' communication skills improved in oral explanations of their work. As a result of this research I plan to continue my implementation of cooperative learning in my classroom as a general method of teaching. I also plan to continue to use cooperative learning in working with my students to increase their achievement in problem solving and communication of mathematics.

Introduction

The focus of my research was on cooperative learning in relation to problem solving (habits of mind) and overall improvement in oral and written mathematics expression. Habits of Mind problems are problem solving types of problems which encourage the students to work together and challenge their mathematical skills. I implemented cooperative learning in the area of problem solving due to low scores in problem solving on national and local tests. This is an area of concern throughout my district as well as a personal concern of mine.

At the beginning of this project the students in my room were somewhat reluctant to work with habits of mind problems. They had a tendency to wait until a classmate near them solved the problem and try to copy their work or not solve the problem at all. When presenting a solution to a problem they often lacked the ability to properly articulate how they reached the solution or what the solution represented. This included not using proper terminology as well as displaying a lack of complete understanding as to what concepts were applied in reaching the solution.

I focused on three main areas in relation to problem solving; student confidence, written and oral communication of work. As noted above these three areas are something with which my students struggled on a frequent basis. My hope was that cooperative learning would create an atmosphere that would encourage students to think creatively when solving problems as well as increase their confidence when solving problems. I wanted to see my students assert themselves when working with problems instead of waiting for the solution to come to them. I wanted them to think creatively and view problems unique challenges instead of burdens placed upon them. I was hopeful that an increase in their confidence would in turn increase their ability to communicate their solutions and work. I believed that if a student is invested or motivated to do

their work they would also be more motivated to describe their work and their solutions. I believed their descriptions would become much more clear and precise not only to myself and their classmates, but ultimately to themselves. I believed that cooperative learning had the potential to show other teachers within my district that students working together and supporting each other in the learning process is a very powerful tool in the classroom.

Problem Statement

The students in my class struggle with representing their ideas and solutions in a clear and concise manner. They often reduce their solutions to simple computations such as repeated addition or subtraction. They struggle with the idea of using graphs, pictures, diagrams or more complex computations. A basic break down occurs within reading the problem and relating it to a solution method. Students cannot create a solution using manipulatives unless they are given explicit directions as to how to use them or how they can be used in solving a problem. Not only do these issues relate to representation of the problem or solution but also to manipulation, exploration and representation of numbers.

When working the students can correctly find solutions to basic problems (again as stated above through the use of simple concepts and computations) but struggle with understanding when to use higher order concepts such as multiplication or division. They cannot follow through with multi-step problems that require the use of more than one computation method much less correctly decipher which method should be used first. Finally, if the students find a solution to a problem be it correct or incorrect they cannot properly articulate or write how they found the solution or what the solution means. They struggle with understanding mathematical terms, their meanings, how to describe their thought processes and computations.

Due to these issues and concerns, I think this problem is worth knowing more about. It has the potential to affect my own school district's approach our own dilemma of low scores in problem solving. I am excited about discussing the results and techniques used with my students with fellow teachers. My goal is that it will encourage others to think outside of the box or revisit \techniques when working with students to find a way to improve their skills.

Literature Review

Prior to beginning my project I researched and read many articles on the method of cooperative learning. Many of the research articles that I have found which relate to my topic address student achievement not only mathematics but all subject areas. This seems to be the main problem that many researchers are trying to address. Other underlying themes are student involvement within groups, overall group work and dynamics as well as teacher use and understanding of cooperative learning. These are the main themes that I have focused on while finding research articles. I will be addressing all of these topics at some point in my own research.

Academic Achievement

Virtually every article I have read as part of my literature review has addressed issues with student achievement in relation to cooperative learning. It seems as though this is a common thread as more people look to find something to help them reach their low-achieving students and increase test scores at the same time. The literature I have found suggests that there are positive effects in student achievement when cooperative learning is introduced.

Although most of the authors have noticed a marked increase in student achievement virtually every author was reluctant to put a definitive reliance on cooperative learning as the reason for the increase. Though the authors strongly suggest the introduction of cooperative

learning as a turning point for students academically, they also note there are a variety of extenuating circumstances that could have a positive effect on achievement as well. As noted in the research review article by Davidson (1991), many researchers found it difficult to connect cooperative learning to mathematics achievement due to different and difficult circumstances in which to link achievement to teaching techniques. Davidson's review of cooperative learning research originally stemmed from articles published by NCTM (National Council of Teachers of Mathematics) in which cooperative learning was highlighted due to an increase of the method being used specifically in mathematics. Though many research articles that Davidson reviewed supported cooperative learning and acknowledged an increase in achievement scores many did not point to cooperative learning as the reason. This was due in part to not only student circumstances but teacher knowledge and implementation of methods as well. In short many researchers have found it too difficult to measure the success of cooperative learning and achievement.

Slavin (1999), noted an increase in student achievement in both reading and math. However, the school used in this study (an urban school with 800 students) had dedicated many staff development hours for both teachers and administrators to learn about and adopt the cooperative learning method of teaching. The school under observation also had hired an on-site cooperative learning facilitator to assist and monitor student and teacher progress. Therefore the students, teachers, and leaders of the school were completely involved in cooperative learning which provides a strong framework for support and success. From Slavin's research, it is evident that cooperative learning does increase achievement in mathematics when the teaching staff is provided with numerous professional development opportunities.

There could be a possible explanation for an improvement in student achievement when looking at this specific school. In his article Slavin (1999) commented on the success of the students in the cooperative learning school he had studied noting

> They create a structure within which high-quality implementation of proven cooperative methods can be the norm, not a short lived innovation. Research on these programs shows that they can have a profound impact on student achievement, especially that of children who are at risk. (p. 78).

What this quotation means to me is that Slavin (1999) found that the implementation of cooperative learning methods provided structure, expectations and an atmosphere were even struggling students could excel.

Although Slavin (1999) and Davidson (1991) were reluctant to directly point to cooperative learning as the reason for student improvements academically, both seem to suggest that the amount of teacher knowledge in cooperative learning as well as the implementation itself seems to have a positive effect on the students achievement.

Teacher Experience

A common thread in every educational practice is teacher experience in the methods in which they are teaching. Talmage (1984) describes the amount of time spent in programs developing a method of learning produces teachers who have a much more positive attitude towards working with cooperative learning. Talmage chronicled classrooms over a three year span noting student response to teachers who had been exposed to a variety of in-service programs in relation to cooperative learning. Talmage's research followed three subgroups of teachers some participating in cooperative learning and some not. The teachers were observed, interviewed and given pre and post tests that measured attitudes and teaching practices. Talmage

states "Teachers participating in such programs not only appear to develop more positive attitudes toward cooperative classroom practices, but also tend to implement such practices more frequently in their own classroom" (p. 174). Not only did the study find that teachers were much more excited about implementing cooperative learning, but they also used these techniques on a much more frequent basis.

This same finding is also documented in the article written by Antil (1998). Antil followed six schools in two districts and surveyed teachers on their response to using cooperative learning in the classroom. The teachers were from four urban and two suburban elementary schools in the Pacific Northwest. The schools demographics ranged from upper middle income to low across many districts. As with the previous articles mentioned, Antil found a direct link between teacher exposure of cooperative learning and willingness to use these methods as well as their effectiveness had a direct correlation. Likewise, teachers who may have been new to the concept or new to the districts were less likely to implement cooperative learning techniques on a frequent basis or implement them in an effective process.

As both researchers suggest, the exposure to and support with cooperative learning techniques has a direct effect on its use within the classroom. This is also suggested in Slavin's (1999) article as discussed previously. It seems as though the more a teacher is educated in the cooperative learning method and the more support the school offers within this framework the more success the teachers and students experience.

Student Involvement/Interpersonal Skills

Many of the articles that I read discussed the concepts of low-achieving students and their involvement within a cooperative learning classroom. Leikin (1997) article discussed this concept at great length. In this research project four groups of ninth graders participating in a

cooperative learning math class were observed, given surveys, and were to write self-reports on their experiences group work. Leikin noted a behavior where "…low-achieving students are reluctant to ask for help when they have learning difficulties in mathematics." (p. 334). Students were avoiding asking questions in class for fear of being deemed "not smart" by their peers. This original statement led to the question of student involvement within groups. A main focus in Leikin's paper was that low-achieving students would be less likely to participate or excel in the cooperative learning environment. However, as found thorough surveys and discussions with students participating in the study many of these students actually found group work as a pleasurable experience, one that they could and did excel in.

The concept of low-achievers finding success in group work was also noted in the book written by Marzano (2001) which chronicles a variety of teaching techniques. Marzano wrote that one of the five defining elements of cooperative learning (Johnson & Johnson 1999) include interpersonal skills such as communication, trust, leadership, decision making and conflict resolution. This same paper also noted that low-achieving students tend to stay at a low level when homogenously grouped, it is better to group students heterogeneously especially with cooperative learning where students are challenged to compete not only against themselves but as groups against each other.

Though most articles focused on student interaction within a group few that I found pertained to student communication of work. Leikin (1997) only describes communication as some what of an after affect of group work. Included in the desegregation of the data the researchers compiled a list of student activities called "active activities". Part of this list included student explanations and help seeking. Basically, the author's idea of tackling the concept of communication was to write down if the observer noticed increased student behavior in asking

questions of peers or teachers and their willingness to answer questions. At no part in the article was the quality of communication discussed. Though there was a marked improvement in student willingness to actively participate within the group and class as a whole (when compared to a control group) there was no rubric or way to gauge the quality of the oral communications being made.

The research which I reviewed again focused primarily on group dynamic within the language classroom. The findings written by Oxford (1997), is very similar to Leikin's (1997) in that it researched communication within the language learner classroom based on an increase in student willingness to participate with other group members as well with the teacher or class as a whole through questions and answers given or received. Though the article written by Oxford was informational on the background of cooperative learning as well as methodology, it failed to actually provide a first hand review of a research project. It seemed as though the author's main focus was to provide information on the foundations and implementations of cooperative learning, not interaction or communication though explicitly listed in the articles title. Oxford, similar to Slavin, stated that an increase in student involvement in the classroom was noted primarily through observations of the students. Though there was a marked increase in student dialogue with other students as well as an increase of student questioning the quality of the communication was not addressed.

Though many of these articles focused on group dynamics and ensuring a smooth transition into a group driven atmosphere few actually discussed the quality of oral or written communication within the group or by individuals when working problems. All of these articles seem to have stressed the importance of the group dynamic over that of individual communication. It seemed as though it was more important to the researchers involved to rate or

measure group dynamic through observations. As stated above a main focus of these observations was student interactions with other students as well as the increase of student questioning on problems. Though an increase in these behaviors was observed the quality of these observations was never measured. The primary focus was to document an increase in students asking questions of other students in their group and their teacher in the whole group setting.

Group Processing/Work

Effective grouping and group work is a theme found in the article written by Slavin (1984) as well as the book on cooperative learning written by Kagan (1999). Slavin's article looks at and compares 46 other studies done on cooperative learning primarily in the area of student motivation and student work. Both sources cite student grouping as a pivotal part in cooperative learning. According to these two sources, students can be grouped in a variety of ways. Yet grouping students with a variety of achievement levels is part of the success of cooperative learning. As Kagan (1999) notes "Heterogeneous teams maximize the potential for cross-ability tutoring, positive race relations, improved cross-sex relations, and student-assisted classroom management" (p. 6:1). Yet Kagan suggests that always grouping students heterogeneously is not recommended. Heterogeneous grouping of students allows for a group that includes students who are at a variety of educational levels, some low-achievers, average and high-achievers working together to complete a task. Exposing the students to homogenous grouping for some tasks does allow higher functioning students to receive further academic stimulation and lower achievers the chance to excel at leadership opportunities. Homogenous grouping of students places all students at a specific learning level together. An example would be low-achievers working together apart from high-achievers.

Another key is setting cooperative learning up in the classroom so that it is a success. Teaching students how to work in groups and work well in groups is part of the key as well. Both articles suggest teambuilding activities as well as clear group guidelines. Providing students time to review and discuss their work as well as problems is also a pivotal part of cooperative learning success.

Since group work is such a pivotal piece of cooperative learning it is important to establish expectations of the group itself. Clear expectations will help the members of the group function in a civil and organized manner. However, group dynamic cannot be established by rules and expectations alone. Kagan (1999) has devoted entire chapters of his book on cooperative learning specifically to grouping students as well as team building activities. Various teambuilding activities are to be used within the group to promote cohesive team that fosters creativity, understanding, and respect for its members. Likewise, Slavin (1984) also points to peer respect as a pivotal point to team success. In general, teams who have respect for their individual members ideas are more likely to do well.

Time to review group work is equally as important to team and student success. Antil (1998) notes in his article "…it is also essential to remind students to practice their collaborative skills by giving groups time to reflect on their processes and encouraging team members to give feedback to one another about the level and character of participation" (435). Antil goes on to state that roughly one-third of the participants of his research said they allocated time for the groups of students to evaluate their efforts as well as time to consider ways to maintain effective working arrangements. Time given to groups to review their work or attempts at work also gives the students a foundation of knowledge, dialogue, and a continuation of education in relation to the problem they are studying.

It seems as though a common theme of the research I found is that of devoting time to group work through teambuilding exercises and group discussion. Setting parameters for the group as well as allowing time for the group to grow is pivotal to the success of the team and their work. By including time for teambuilding the teacher allows time for the team to grow and work together before actually moving on to a graded task. Likewise, dialogue of what worked well or failed within group activities allows the group to reflect not only on the quality of their work but also the operations and team management as well. In short, team time is a large part of securing the success of cooperative learning.

Conclusion

Many of the articles addressed cooperative learning and achievement as well as the importance of group dynamics within the cooperative learning classroom. I was unable to find any articles that focused their studies on the improvement of problem solving skills in relation to oral and written expression. Problem solving was an area that was not discussed in any of the articles I found. In most cases the researchers and authors were concerned on the general atmosphere in the classroom as well as the way methods were being used. Also, the idea of communication either oral or written in reference to problem solving was not mentioned. Again, the researchers of the various articles discussed an increase in student participation when asking questions but none noted an increase or decrease in the student ability to communicate when working explicitly with problem solving. Though I have learned a great deal and have gained many more questions for my research it seems as though my topic could add to the existing research on cooperative learning. My research has the potential to provide information on a specific topic as it addresses oral and written expression not just general student achievement.

Purpose Statement

The purpose of my research was to implement cooperative learning as a method to increase my students' performance in problem solving and communication of mathematics. I wanted to know if cooperative learning or group work in general could help my students with their understanding of mathematical concepts as well as their expression of their work.

As part of my research I wanted to observe my students learning process in a group setting to better understand their interactions and struggles with problem solving and communication. I also wanted to learn new ways to reach my students through these observations. The foundation of my research was comprised by four main research questions:

*What will happen to my student's confidence in math when cooperative learning is used in my classroom?

*What will happen to my student's oral explanations of problem solving methods and solutions once cooperative learning is introduced into the classroom?

*What will happen to my student's written explanations of problem solving solutions when cooperative learning is introduced into the classroom?

*How will cooperative learning affect my own teaching methods or beliefs?

Method

Data was collected for this project in four forms, through a student survey, student group work, through small group interviews and a teacher journal. When the project initially began, students were given a pre-survey (Appendix A) which was also the same survey given at the conclusion of the project. At the beginning and ending of the project the surveys were collected and data was analyzed calculating the number of responses for each question on the survey.

After the survey, students were then randomly placed in five small groups with numbers per group totaling no more than five students. Groups were reassigned each month on a random basis. Roughly each week, the students were given a "challenge problem" (Appendices D-H) to work together in their groups. The challenge problem was adapted from word problems in the students' textbooks. I typed the problems on a separate sheet of paper for the students to work on; at no point in the research did I tell the students where the originated. Although students worked together in groups to solve each problem, individual answers were collected from each student for every problem. Some of the initial challenge problems were then presented in a group format in front of the entire class. These presentations were graded on a whole group rubric (Appendix B). Problems that were assigned for individual completion were also graded with a rubric (Appendix C). For both group and individual presentations students were allowed to view the rubric they would be graded on ahead of time.

Before starting work on problems the groups first collaborated to make a list of rules they thought should govern the classroom and individual groups. Individual rules from each group were put into a master list and voted on by the entire class. These rules (Appendix J) were then displayed for the entire class to see as a list of guidelines for group work/behaviors.

Each month when groups were reassigned, their first task was to create a name or identity. Their group name was to be agreed on by all members and representative of the individuals themselves. They would then create a team poster with their name on it; their posters were then used to keep track of team points earned through presentations and work. Points earned through the rubrics were then transferred to each group. At the end of every month, the group with the highest accumulation of points decided on a celebration for the class as a whole. This established a goal for each team, to work their hardest and gather the most points in the class. Posters were hung next to group rules so that everyone could track not only their team's progress but that of the other teams as well.

Two times throughout the project students were interviewed in small groups on their feelings towards group work and problem solving. Each time the students were asked the same list of questions (Appendix I) in an open forum students were encouraged to add their perspective to the conversation as it took place. If an interesting idea or topic was addressed in the conversation, it was explored freely. Since I had a fairly mobile class I chose to interview all of the students for both sets of interviews.

As my project progressed, I had my students journal or answer prompts after completing a challenge problem (Appendix J). Each time the students wrote about their work or solution they were encouraged to do so on their own, though sometimes they were allowed to collaborate with their group members.

During the semester there were two college students working with my math class, one was specifically a tutor geared to work with individual students on an as needed basis, the other a practicum student. Their presence created a challenge that I had to overcome while working on my research. During our first group project I noticed both college students assisting individual

students in the solution to the challenge problem. After this occurred both the college students and the students in my class were told they could not ask for help on their problem. I wanted to keep their experience authentic, I wanted the students to try and solve each challenge problem on their own, in their groups.

The students were generally given the last 15-20 minutes of a class period to begin their work on a problem. The entire class the following day devoted to finishing their solutions as well as working on and presenting final solutions to the entire class. Students were told they were not allowed to solicit outside help. Often, if a group believed they would need more time to work on their solution they met in my classroom together during their study time to further discuss the problem.

Throughout the semester I found that finding time to working on our challenge problems was a bit of an issue. Due to vacation breaks, missed school days for weather, and school activities we were not able to always work a challenge problem each week. However, each time a problem was presented to the class I made sure that the students had two days to work on the problem without interruption from a planned activity or weekend.

Findings

The class that was involved in this project was made up of 19 students, who were considered to be below or close to grade level in mathematics for grade 5. They were placed into my class after taking a placement test from their textbook and basic facts tests over multiplication, division, addition, and subtraction. There were a total of five leveled classrooms for fifth grade and this class was considered the second to lowest class. There were 15 boys and four girls who completed the entire project. Throughout the semester I did gain two students, one

boy and one girl. However, they were both only a part of my class for less than a quarter. Therefore, their data has been excluded from the project.

Since my students transitioned from their other classes in the morning we began a daily routine at the very beginning of the year that continued through our project. This routine was set to provide transition time for students and to avoid the possibility of students missing vital information because they were dismissed late from their previous class. Each day when they walked into the room they knew that there will be some sort of a warm up written on the board or overhead. They knew that they had a few minutes to work on the problems at their seat before we would go over their answers or the solutions as a class. Their daily warm-up consisted of a review from their textbook over material covered throughout the year. After this task was completed, homework would be collected, and the lesson for the day would begin. If it was apparent that the students struggled with the previous day's content, we would do a quick review or question and answer period over their assignment.

Once the daily warm-up was complete, there would be a short introduction and description of the content of the current day's lesson, students would then practice their skills trough a variety of ways. Towards the end of class, students would be assigned homework over the content presented and have time to work on their own or together. If it was a "group day" students would be divided into their assigned groups to work together throughout the class time. Two days were usually set aside each week to work on challenge problems. The students would receive the challenge or word problems the last few minutes of class on Thursday. They would then have the following day to work on their answers, presentations, posters, and finally give their presentations on the solution to the class. Though as the semester progressed and time became short our weekly problem sessions became more spaced out. Though days in which the

students worked on their word problems were set aside specifically for groups, I usually tried to present lessons in such a way that the students could be in their groups for at least 3 days a week. This way the students were not in their groups for the purpose solving a word problem only. They were able to work together on their assignments or class activities and begin to form somewhat of a group atmosphere. Each group had an assigned location throughout the room. After a short time of working in groups, it became clear that the students wanted to work in their groups on a daily basis as "Is it a group day?" became a question phrase upon entering the room each day.

Overall I believe that my project in cooperative learning was a success. I believe it was a success not only because I saw growth in my students but because I saw growth in myself. I believe the hardest aspect of teaching is challenging yourself or changing your methods. This project helped me push my limits so to speak and try something new. It opened me up to the idea of new adventures and methods in teaching my students math. Based on my findings I have changed my own ideas about teaching my students I consider this to have been a successful project. The success however, can be felt or seen on multiple levels with my students as well.

At the beginning of my project I wanted my students to have an increase in their confidence when working in math in general. I had hoped that with the use of cooperative learning as a teaching and the experience of group work their confidence would increase. I had also hoped that an increase in confidence would lead to better math performance and a more caring attitude towards their work. Having finished my research I can honestly state that I did find cooperative learning increased the level of confidence for a majority of my students. When looking at the students post surveys, for the question: "I feel confident working word problems on my own" 14 of the students answered that they agreed with this statement whereas only five

agreed prior to beginning the project. The survey also supported that students had an increase in their confidence when explaining a solution to a word problem. On their post survey, 12 students agreed that they "felt confident in explaining their solution" only three agreed to this statement on the pre-survey. This growth in numbers shows that the students had gained more confidence in themselves as problem solvers throughout the semester.

An increase in student confidence was also found as I walked through my room and listened to or watched my students work. One example I wrote about in my teacher journal describes how a typically quiet student had found strength in her voice when working in her small group

> Today when the kids were working in their groups, I was walking around listening to them. I have begun trying to be a silent observer and not really getting involved in their work with them. The kids have been working on long division for some time now. I just introduced dividing decimals to them and they were working on their homework assignment. Katherine, a somewhat quiet or timid student was looking over the shoulder of another and noticed they had done their work wrong. She grabbed his paper and said, "Listen here buddy, what did you do wrong here." She proceeded to go through each step in the problem until the error was found and the problem corrected. I am so glad I was with their group at that moment; all I could do was smile. Katherine would never say that in front of the entire class! (Teacher Journal, April 2008)

In another example at the end of the year the students were taking their annual AYP (Adequate Yearly Progress) exam. The exam had been met with groans in the past due to the fact that it was 24 problems that were all over problem solving. The students took this exam the last week of

school, after we had finished the semester working with cooperative learning and problem

solving. As I passed out the exam I noted:

> The kids are taking their math AYP today – again. They had taken it last week too but I
>
> was not aware that they were allowed to use calculators on the test, so, we are taking the
>
> whole thing again. The entire test is 24 word problems. I was really surprised when I
>
> handed out the test (both times) how many of my kids asked if I wanted them to write full
>
> sentences for their answers. I was even more surprised at how many of them did. Though
>
> the test does not require full sentence answers many of the students gave them, and most
>
> of them labeled their answers as well. It seems as if all of their hard work this semester
>
> has really made an impact. I also noticed that when I handed out the test and they realized
>
> it was over word problems there wasn't a single groan. It was if I had laid before them a
>
> basic type of assignment, there was no tension, just an attitude of "we can do this."
>
> (Teacher Journal, May 2008)

Another main concern at the beginning of this project was my students' ability to orally

explain how they had reached the solution to a word problem. I wanted to know their thoughts,

the strategies they chose to solve the problems, and the reasoning behind those strategies. As

they began working in their groups, I presented them with a rubric (Appendix B) which outlined

how they would be graded on their presentations of their solutions. As part of our discussion we

looked at each area of the rubric and listed qualities that made a "good presentation" such as

using clear strong voices, and making eye contact with the class and those that made a "bad

presentation." The students were some what nervous about having to present their solutions to

their problems in front of the class; this was something that we had rarely done before. They had

grown accustomed to solving problems on the overhead or whiteboard as part of their warm up, but never having to fully explain their solution.

At the end of their first presentation, I gave each group a point total or grade on their presentation. The students struggled with their first presentation with groups earning an average of nine points out of 16 on their presentations. However, by the end of the project the groups were averaging 12 points. The students overall growth in their presentations was something that I had noticed in my journaling as well.

The students presented their 5th problem today. It has been quite interesting to watch the students give their presentations. They have certainly become much more thorough in how they present. Even their posters have become more neat, and organized! On their posters they are writing full sentences giving descriptions of every step in their process. I am really impressed with how far they have come.

I have noticed the past few times when they give their presentations they generally tend to restate the problem in its entirety. This has become a starting point for them. Then they go through each step of their solution, explaining their work, the reasoning behind it and finally their solution and what it means. At the end of their presentations they usually read a fully written complete sentence on the solution. They have also begun almost "reading" me as they present. Their eyes are focused and they have become very critical of my reaction to their presentation or even their partners'. It is almost as if they are all following the presentation, if a member of their group forgets their part or does not fully explain something, the other members are quick to jump in and fill in the missing details. I am really impressed! (Teacher Journal, April 2008)

Throughout the course of the project, the students had successfully grown in their ability to orally explain the methods used in solving a problem as well as the relevance their final solution had. In the small group interviews, seven students agreed that it was important to be able to explain or describe their solution to a math problem. One student eloquently said:

> If you don't explain (your answer), they'll (your group) will be like, how did you get this? If you don't explain it and you just write down an answer then you don't know the process that you used to check to see if it's right or not.

However, not every student in the class agreed that being able to explain your work orally was important; some still believed that writing about their work was easier than verbally telling about a solution.

> [It's easier] to write about it, if you have a mistake you can fix it, it doesn't give you as much pressure as when you are in front of the whole class.

> The students began journaling part of the way through this project. I thought was better to

take small steps with them rather than overloading them with a large amount of change in my expectations and their routines. After the students had grown accustomed to the group atmosphere they began to not only work on problem solving in their groups but also journaling about their experience. Writing explanations was again something we had discussed before the students had started. I began by providing them with a problem in the same format as the group problems and asking them to solve the problem together but write their own solution. I wanted to have a "baseline" for their growth. As I looked over their solutions I was amazed at what I had found. The students were doing quite well on their presentations but were lacking in their writing skills. I began to wonder if the ability grouping of my class had a part to play in this problem.

This month has been really different. I have really tried to focus more on their writing than their group work since it seems that their group work is really starting to come together and their writing is still lacking. I have to remind myself though that I do have a variety of writing/reading levels in my class. Most of the kiddos are in something called Corrective Reading – which means that they are reading at least two grade levels behind the average fifth grader. (Teacher Journal, March 2008)

After their initial work, we went over the rubric that I would be using to grade their individual solutions (Appendix C). Similarly to what we had done when we looked at group presentations, we discussed what a "good" and "bad" solution would look like. We even took time to write out a good solution together as a class. At the end of this session I handed their original papers back to them and asked them to evaluate their solutions, then to re-write them. The second time around some of the students improved.

I went over how a written problem should look with the kids today. They seemed to do ok. We looked at what a "poor" example would be and created a good example together. I also had the kids look at the rubric I will be using and "grade" the two pieces I had presented to them. Then they were to look at their work from last week and see how they would have graded themselves. I am having them rework their answers as most really only wrote "I divided" and what their answer was. I hope this works! Ok, I have had a chance to view their work – yikes. Some really improved (well all actually improved) but most are still missing the mark. I hope more practice is going to help them. (Teacher Journal, March 2008)

As the project progressed, it became clearer to me that the students were excelling in their confidence and presentations but still were lacking in their ability write complete sentences.

Though when working in their groups and writing sentences to present, it seemed as though the

student who was most capable always wrote for the group. However, when I interviewed the

students in their small groups, four of the students mentioned that they thought it was easier to

write about a solution rather than talk about it. Their main reason for this was that they felt "less

pressure, if you have a mistake you can fix it; it doesn't give you as much pressure as when you

are in front of the whole class." It seemed as if my project was not focusing enough on the

writing aspect of problem solving so much as the confidence and verbal explanations.

When the semester came to a close and the project ended I began the daunting task of

reviewing all of the data I had collected. I knew that I had three main goals for my students and

one for myself. As the project had progressed I had never really put my own goal or question at

the forefront of my mind. I found that I was always focused on my students and how they would

react to every challenge or change in our classroom. It was only at the end of the project when I

realized how much my own teaching had changed as well. Looking back through my teacher

journal, I found examples of my progression throughout the semester. At the beginning of the

project I found that I was unsure of myself and how cooperative learning would fit into the

dynamic of my classroom.

> Today we really started working in groups. I think the kids were pretty excited I wasn't
> sure though if they were excited to be working together or if they thought it would be
> easier to cheat on their homework.
>   As they broke up into their groups they made a poster to signify their new group
> as a whole. Then began working on their assignment for the day. Their assignment was
> over order of operations which is something we had been covering for the last few days.
> I knew there were some kiddos who were still struggling with the aspect of operations.
> As they began working together I did remind them about positive group talk and to
> "help" each other to an answer, that copying was simply not allowed. (again one of my
> deepest fears). As I moved around the groups I was very apprehensive. I had
> relinquished control to the kids – this felt very foreign. However, as the time progressed I
> saw the kids actually change. They were working together. (Teacher Journal, February
> 2008)

By the middle of the semester I had begun to grow accustomed to letting the students work in groups and found it rather enjoying watching the students take a more active role in their own education. I found, just like the students had, group work was beneficial not only for the students but for me as well. I could observe my students in their own element, learning, interacting, and growing in math.

> The kids began working on their next group problem today. It has been a while since they have done a group problem and presentation. I am excited to see how well they will do in their new groups. (Teacher Journal, March 2008)

I found as the semester progressed that I enjoyed group work days just as much as the students had. Prior to implementing cooperative learning I had grown accustomed to a traditional style of teaching where my students rarely interacted with one another. By the end of the project, I was just as the students were, looking forward to their challenge problem days. I enjoyed watching their interactions, seeing them grow, challenge each other, and most of all, I enjoyed listening to their questions.

Overall, I would have to say that my project achieved three of the four main goals that I had set in the beginning. The students' confidence in problem solving and their oral communication skills improved. The only area that really saw no marked or major improvement was in their writing. This though as I have stated above could be due to outside factors. The students worked well throughout this process and enjoyed each new challenge as it was presented to them. Because of this I am very pleased with the ending results of this project and also very proud of their hard work.

Conclusions

Though the students showed an increase in their confidence in solving word problems, I do not know if I can specifically relate cooperative learning as the reason why. I think as a

teacher I must also look at the fact that the increase of exposure to word problems and an in-depth look at these problems might also have something to do with their increase in confidence.

When looking back at the research articles that I had found and read on cooperative learning, I am reminded that most of the articles claimed to have noted an increase in student achievement once cooperative learning was introduced (Davidson, 1991l Slavin, 1999). I also noticed an increase in achievement but I have to wonder if it is simply because students are experiencing a boost in their confidence (similar to that noted above) or if it is the group dynamic that increases their abilities. If the students are allowed to work together on assignments, similar to what had taken place during my project; it would follow that most would experience a boost in academic achievement. The students being able to work together creates an environment where no student is allowed to fail, they compare answers, correct, and achieve at a higher standard in a group than working alone. It is because of this that I am reluctant to agree that cooperative learning is the sole reason for academic achievement. I do believe that it encourages academic achievement, but only due to the unique group dynamic and group reliance that is formed.

I also noted that many researchers before me had found that low-achievers seemed to excel in the cooperative learning classroom (Leikin, 1997; Slavin, 1999). I did find this to be true as well. However, my definition of a low-achiever might make me drastically different than those of the other researchers (which were never defined). Considering that my class was full of "low-achievers" in the fact that every student in my class was below grade level to begin with. I took "low-achievers" to mean students who were less likely to participate in a whole group setting. As I have already mentioned, I did find that students who were less likely to speak in the

whole group setting experienced a more level playing field when placed in small groups. They were more apt to compare, ask questions, and help their peers than before.

Finally, I also agree with the previous research articles that teacher experience and support in cooperative learning relates directly to the success in the classroom (Talmage 1984, Slavin 1999). This project was my first experience with cooperative learning. I must admit that during this process I was extremely concerned about staying true to the cooperative learning methods I had researched and read about. I believe that I could have greatly benefited from formal training or assistance with the application of cooperative learning. However, I am hopeful that I will be able to do more with cooperative learning and I am interested in taking formal classes on this teaching style in the future.

Implications

Using cooperative learning in my classroom has greatly changed the way I view my own teaching of mathematics. This project has instilled in me a drive to find new ways to introduce and teach not only problem solving but all mathematical concepts to my students. Though I may not completely immerse my classroom in cooperative learning, it will be a method that I will rely on quite frequently. I am looking forward to building a strong mathematical community in my classroom through group work, understanding, and communication of ideas and techniques.

My project also showed me the importance of group discussion for my students. I believe that group interaction has allowed my students to feel more empowered. They have a strong connection to their class, group, and education. They also learn to look at math problems through other's perspectives. This teaches them to view math as a subject not formed by procedures and formulas but a subject where trial and error, creativity, and hard work prevail.

As a new school year or semester begins I am also looking forward to increasing time spent discussing and writing about mathematics. I have learned how to encourage my students to become more detailed in their descriptions of their solutions. This in turn helps them to better understand the concepts they are working with or learning about. I am also looking forward to having my students' journal about their mathematical experiences. Through this journaling I will be better able to understand individual students' successes and struggles with mathematics.

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Appendix A

Student Survey (Pre/Post Study)

Date: _____

Please answer the following questions honestly. Your response to these questions will not affect your grade but will help me better understand different ways to teach you in the classroom!

	5 Strongly Agree	4 Agree	3 Undecided	2 Disagree	1 Strongly Disagree
I feel confident working word problems on my own.					
It is easy for me to find a solution to a word problem.					
I use graphs or drawings to help me find my solutions.					
I feel comfortable explaining my solution to a word problem.					
I think being able to explain my work is an important part of learning about math.					
I can write a good solution to a math problem that explains how I solved it.					
Math is a subject that I am good at.					
Working in groups helps me better understand math.					
I feel like I can help my group solve a math problem.					
If I am struggling with a math problem it sometimes helps to have a classmate explain it to me.					
I feel like my opinions and ideas are used in my group.					
I think working in groups could help me understand math better.					

Please answer the following questions honestly.

Something I would like to change about group work is:

Something I like about group work is:

In math I feel confident working on:

In math sometimes I struggle with:

Appendix B

Student Oral/Group Presentation

Date: _____
Group Members: _____
Problem: _____

	4	3	2	1
Group Work	Student engaged, working well with partners, listening to suggestions and working cooperatively throughout the lesson.	Student engaged, had some difficulty working with others/working cooperatively.	Student cooperated with others but needed assistance staying on task.	Student did not work effectively with others.
Explanation of Problem	Explanation of solution/ work on problem is detailed and clear.	Explanation of solution/work is clear.	Explanation of solution is difficult to understand.	Explanation is difficult to understand or follow.
Work (solution)	Work is clear, neatly organized, easy to follow and adds to understanding of oral explanation	Work is clear, neatly organized, and easy to follow.	Work is somewhat clear.	Work is difficult to understand, does not add to understanding of oral explanation.
Mathematical Concepts	Oral explanation shows understanding of concepts used to solve the problem.	Oral explanation shows basic understanding of concepts used to solve the problem.	Oral explanation shows some understanding of concepts used.	Oral explanation shows little to no understanding of concepts used.

Appendix C

Student Personal Work

Date: _____

Student: _____

Problem: _____

	4	3	2	1
Explanation of Problem	Explanation of solution/ work on problem is detailed and clear.	Explanation of solution/work is clear.	Explanation of solution is difficult to understand.	Explanation is difficult to understand or follow.
Work (solution)	Work is clear, neatly organized, easy to follow and adds to understanding of oral explanation	Work is clear, neatly organized, and easy to follow.	Work is somewhat clear.	Work is difficult to understand, does not add to understanding of oral explanation.
Mathematical Concepts	Explanation shows understanding of concepts used to solve the problem.	Explanation shows basic understanding of concepts used to solve the problem.	Explanation shows some understanding of concepts used.	Explanation shows little to no understanding of concepts used.
Strategies Used	Student used an effective strategy to solve the problem and reached the correct solution.	Student used a strategy to solve the problem.	Student showed some use of strategies in their solution but is unclear on how to solve the problem.	Strategies were not used.

Appendix D

Problem #1 High-Speed Trains

Name: _____

Group Members:

_____

TGV's are high-speed trains used in France that can travel at speeds around 320 mph (miles per hour). A typical TGV has 3 first-class cars, 6 second-class cars, 1 dining car, and 8 motors. Suppose 354 of 450 total passengers were traveling second class. If passengers traveling first class or second class were distributed equally among the available cars, how many passengers were on each second-class car? On each first-class car? Show your work and the solution to the problem on the space below.

Appendix E

Problem #2 – Fast Movers

Name: _____

Group Members:

_____

Dolphins can swim about eight miles per hour faster than a leatherback turtle. This turtle can swim four and four tenths times faster than an Olympic swimmer. If the top speed of a swimmer is about five miles per hour, how fast can a dolphin swim?

Appendix F

Problem #3 – Baby Boomers

Name: _____

Group Members:

_____

In 1999, the world's population reached 6 billion and continues to increase. Some believe that by 2100 the population will reach 8-11 billion. During 2002 four children were born every second. Half of all the children born were in one of these countries: India, China, Pakistan, Nigeria, Bangladesh, and Indonesia. Given this information many children would be born in one day? How many of these babies would belong to one of the countries listed above?

Appendix G

Problem #4 Expensive Trips

Name: _____

Group Members:

_____

One of the most famous cruise ships, the Queen Mary, was 1,019. 5 feet long and had four 35-ton propellers. The ship traveled only 15 feet for every gallon of fuel it burned. If there are 5,280 feet per mile, how many gallons of fuel did the Queen Mary burn every mile? If the Queen Mary were to travel from the northern tip of South America to Florida it would travel roughly 1,050 miles, how many gallons of fuel would it burn on this trip?

Appendix H

Problem #5 Lotsa' Pizza'

Name: _____

Group Members:

_____

The 5th grade math club is having a Pizza Party Practice to prepare for the State Math Contest. The pizza delivery person presents a bill for $64. 36. The team coach volunteers to contribute $10 to help pay for the cost of the pizza. If twelve students are at the practice and decide to split the remaining cost equally, how much must each pay? Explain your work!

Appendix I

Small Group Interview Questions

1. Do you think being able to describe your solution to a math problem is important?

2. Is it easier to write about a solution to a math problem or to talk about it?

3. Do you think there is more than one way to solve a math problem?

4. Does working in a group help you understand math/make you feel more confident?

5. What are the benefits/drawbacks of working in a group?

Appendix J

Small Group Rules
1. Listen to one another/ cooperate.
2. Don't leave anyone behind.
3. Don't blame group members for wrong answers.
4. Compare your answers.
5. Respect your group.
6. Don't give up, keep trying!