7-2007

Improving Student Engagement and Verbal Behavior Through Cooperative Learning

Daniel Schaben
Orchard, NE

Improving Student Engagement and Verbal Behavior Through Cooperative Learning

Daniel Schaben
Orchard, NE

Math in the Middle Institute Partnership
Action Research Project Report

in partial fulfillment of MAT Degree
Department of Mathematics
University of Nebraska-Lincoln
July 2007

Improving Student Engagement and Verbal Behavior Through Cooperative Learning

Abstract

In this action research study of my classroom of 10th grade Algebra II students, I investigated three related areas. First, I looked at how heterogeneous cooperative groups, where students in the group are responsible to present material, increase the number of students on task and the time on task when compared to individual practice. I noticed that their time on task might have been about the same, but they were communicating with each other mathematically. The second area I examined was the effect heterogeneous cooperative groups had on the teacher's and the students' verbal and nonverbal problem solving skills and understanding when compared to individual practice. At the end of the action research, students were questioning each other, and the instructor was answering questions only when the entire group had a question. The third area of data collection focused on what effect heterogeneous cooperative groups had on students' listening skills when compared to individual practice. In the research I implemented individual quizzes and individual presentations. Both of these had a positive effect on listing in the groups. As a result of this research, I plan to continue implementing the round robin style of in- class practice with heterogeneous grouping and randomly selected individual presentations. For individual accountability I will continue the practice of individual quizzes one to two times a week.

The topic of my inquiry is improving student engagement and verbal behavior through cooperative learning. I selected this topic because I could see in my classroom that students relied solely on the instructor for mathematical communication. I am only able to help a few students in the course at a time, and there are more students with questions than I am able to handle in one period. Students in a large group do not have much of a chance to respond to questions posed by the teacher or others. With a class size around 17, the students were probably asking themselves, “Why should I figure out the answer when there is only a small chance that I will be picked to give the answer anyway?” In smaller groups the student should be responding at a much higher rate, and thus mentally engaging in the material more often.

In my classroom I communicate with the entire group often. I have a traditional style of teaching: lecture followed by individual practice. The problem with this technique is that some students can spend the entire period not engaging in the mathematics because there are enough other students in the classroom to answer the questions posed. The other problem is that there is only one of me and up to 20 students, so with a challenging curriculum it is nearly impossible to get to all questions posed during individual practice.

Cooperative learning reduces these problems by creating a support network for students to turn to other than the instructor. It is a support network that is always available in the classroom without having to wait for the instructor to get to the student.

Problem Statement

The purpose of this study was to discover the best practices of cooperative learning to address the communication standard in the National Council of Teachers of Mathematics (NCTM) standards. Students need to be able to collaborate and communicate with each other in

order to become mathematically literate. This study addressed the problems that occurred with implementation of social learning strategies.

I see cooperative learning as a solution, not only in my own classroom, but also in other classrooms where there are students that do not participate in the learning process because they have few chances to participate. Small groups are more aware of the problems that occur with other members of the group. They are also sometimes better able to deal with those problems. An example of a problem is the understanding or misunderstanding of the mathematics. Cooperative learning is a way to use networking to solve an instructional dilemma. Instead of one teacher going around a room to put out ten fires, that teacher may only have to put out three major fires while students within each group are able to put out the minor fires. As instructors we will never have a class with only one student where we just have to look over the shoulder of that student to know when to come in to provide support. Cooperative learning is a way of allowing students to support other students. Often students can explain problem-solving tactics to another student better than a teacher can, while the teacher often cannot see the perspective of the student. Another major reason to use cooperative learning is that students in a large group of, say, more than 8 students, do not have much of a chance to respond to questions posed by the teacher or others due to the large size of the group.

Literature Review

In this study I explored the use of cooperative learning as a tool to improve student time on task, quality of time on task, and social interaction skills in a mathematics classroom. Traditional mathematics classrooms of lecture followed by individual practice will have “80% of class time devoted to teacher talk” (Brahier, 2000, p. 159). This only leaves students with twenty percent of the time to converse and ask questions. If a teacher is using individual seat work for

practice in, say, a ninety minute period with 24 students, then individual students can only ask questions and reason out loud for forty-five seconds. If knowledge is constructed through social interactions, this does not leave much time for students to construct knowledge.

Nardi and Steward (2003) say that there is quiet disaffection among students in the current traditional lecture and individual practice format of mathematics education. “The classroom culture seems to foster images of mathematics as a rather mindless task-completion activity that does not require high levels of concentration” (Nardi & Steward, 2003, p. 356). The evidence of this is in mathematics classrooms all across the nation including my own in which students feel that they can talk about topics that are unrelated to mathematics at the same time they are practicing mathematics.

Not only does the task of mathematics seem irrelevant to students, but also the practice of making mathematics an individual endeavor is creating a feeling of isolation among students. Nardi and Steward’s research has shown that during peer interaction students felt they received understanding of the mathematical ideas most efficiently because they were allowed to explain and discuss the mathematics with others.

From a humanist’s perspective, Gillies (2006) adds more reasons to investigate peer learning by stating that teachers who used traditional, whole class instruction tended to be “authoritarian, rigid, and impersonal” (p. 271) with their verbal behaviors, while instructors who engaged in cooperative learning strategies tended to be more helpful and encouraging. This study goes on to state that not only were there fewer disciplinary remarks from the teacher in the cooperative setting, but the number of individual instructional comments increased. This research sets out to define the following: cooperative learning, the instructional elements that

should be in place for cooperative leaning, and the relationship between cooperative learning and direct instruction.

Distinguishing Between Cooperative Learning and Group Work

Gillies (2006) stated that there were two situations that occur when students are told to work together. These two situations are cooperative learning and group work. In group work there may have been a few rules and structures imposed, but for the most part a free-for-all ensued, and students were allowed to take control of the situation. Key elements of cooperative learning were not implemented. In this situation, Cohen (1994) stated that groups formed a social hierarchy in which a few students in the group were viewed as the experts and controlled much of the situation, conversation, and other aspects of the learning experience. The other members of the group tended to become wallflowers that did not engage fully in the learning task and simply allowed these experts to do the work. What happened was that all students did not engage in the learning. Some students developed undesirable social domination while other students stopped taking part in the activity. On top of and probably because of the social hierarchy that established itself, behavior and motivational problems surfaced that were not present when the instructor was engaged in traditional whole class instruction.

Gillies (2006) said that the other form of collaborative work is cooperative learning. In this the teacher sets the stage for the collaborated work in the form of guidelines for students to model and elements the teacher implements. The elements that were in place during this study were the same in two other studies, and Siegel (2005) quotes them best:

> (1) Face-to-face interaction where students discuss and participate equally;
> (2) Individual accountability where every student is responsible for the learning;
> (3) Positive group interdependence where students sink or swim together;

(4) Social skills instruction where the instructor models and has students model accepted social behavior such as listening, speaking and taking turns; and
(5) Debriefing where instructors reinforce what went well and discourage what went bad (p. 344).

In the Gillies study, when teachers achieved these cooperative learning situations, positive student-to-student interactions were more prevalent. Teachers and students alike displayed an increase in pro-social verbal behavior. In a study by Leonard (2001), students had more of an opportunity to be peer tutors, and this allowed the teacher more time to assist the weaker students. The contrasting differences between group work and cooperative learning underscore the importance of the teacher's role in setting up these collaborative experiences. A teacher may then ponder the fact that cooperative learning sounds like the answer to many academic problems but may ask how to place the students together so that they can have these positive experiences.

Influences of Group Composition and Group Dynamics

Thus far there are five elements a teacher must incorporate in order to achieve cooperative learning. According to Leonard (2001), a sixth critical element should be added. Students should be placed in groups by the teacher based on their abilities. Here a teacher can make or break the dynamics of the cooperative experience simply by the method he or she chooses to group the students. Here are some ways students are typically grouped in classrooms. First, the teacher can allow the students to choose their groups. Second, the teacher could place the students together homogeneously based on their abilities. Third, the teacher could place the students together heterogeneously based on their abilities. Finally, the teacher could modify the grouping so that it has some attributes of both homogeneous and heterogeneous groups.

In the first situation where students are allowed to group themselves, a teacher might think that because students are friends, they will work together more effectively. Cohen (1994) shows in a classroom example how this kind of grouping method can lead to chaos. Friends will tend to play rather than work, and inevitably one or two students will have to be placed in groups by the teacher because no one wants to work with them. These students will probably not contribute to the group experience.

The second situation is to give the teacher the ability to group the students. Traditionally in mathematics teachers have placed students in homogeneous ability groups. Tracking students, for instance, still takes place in many school districts, and one of the reasons is that teachers do not want the low-achieving students to harm the learning of the high-achieving students. It has been shown in research that when students are grouped homogeneously in pairs, high-ability groups "worked more collaboratively, had greater conflict resolution, and produced higher quality work" (Leonard, 2001, p. 178). However, if the primary reason for cooperative groups is peer tutoring, the low ability group is probably going to miss out on much needed help. Leonard (2001) has shown that low achieving students do not increase their learning in homogeneous grouping.

In heterogeneous grouping, students are mixed in a way that low, middle, and high achieving students will be placed together. For instance in the Whicker, Bol, and Nunnery (2001) study, they placed their students in groups of five that included one high-ability student, one low-ability student, and three middle-ability students. This grouping structure will place the low-ability student with the students that can help, but care must be taken in this situation as well. Cohen (1994) states that the high-ability student may, in fact, be considered the expert and be the major contributor while the low ability student may not be allowed to contribute at all. Here a

teacher has to go back to the other five elements of cooperative learning to ensure that all in the group are interdependent on each other. In defense of heterogeneous grouping, Leonard's (2001) study has shown that this grouping has increased learning for low-ability students and has not harmed the learning of high-ability students.

Kroeger and Kouche (2006) have developed a method to group students that combines some of the aspects of both heterogeneous and homogeneous grouping. First of all, students should be ranked according to their ability in the subject area; this ranking could be determined by class grade or assessment performance. Secondly, students should be categorized as high ability or low ability. Next, the teacher should place the highest ability student with the highest low ability student and keep pairing students in this fashion until the lowest high ability student is placed with the lowest low ability student. A teacher that needs to place students in groups of four could take this one step further and rank the students into quartiles. He or she could place the top student from each quartile in a group and place the second student from each quartile into a group. The teacher would keep grouping students in this fashion until all students are grouped. This would ensure that the top student does not end up with the lowest student in the class, but this would still mix the students by their abilities. Once the group has been decided upon, there needs to be a method in place to make each student individually accountable for the learning.

Individual accountability

Students cannot have a choice about the learning. They must be accountable for any and all learning that is presented in a classroom. Siegel (2005) used individual quizzes and tests for accountability. Some students are not motivated by grades on a quiz or test mostly because quizzes and tests do not provide immediate accountability. Some would be happy to sit back, let someone else do the current work, and get just enough information to pass the test later on.

Brahier (2000) suggests that once the group has reached a conclusion on a given task, the teacher could choose one group member at random from each group to present their findings or work. In this way everyone has to be responsible for understanding immediately because no one will be sure who has to present. Another result is that students are forced to clarify their thinking, and students that may still be confused will be able to hear the explanation from someone other than the teacher.

Face-to-Face Interactions

Face-to-face interactions are important as long as students have the opportunity to contribute to the group on a level playing field or as level as humanly possible in a social situation. One way to achieve this is to assign tasks or responsibilities that each group member is in charge of and rotate those responsibilities among each group member. For example in a task that requires calculations, writing, and reading, Brahier (2000) suggests assigning each member of the group one of these tasks. For instance, one student may read, one student may run the calculator, and one student may be writing everything down. The teacher must then make sure that responsibilities rotate regularly.

Kroegger and Kouche (2006) achieve this by using a set of worksheets they developed that script the mathematical concept being taught. The job of one member of the group, the coach, is to read this script while another group member solves the problem. The script is read for each and every problem that is done. The coach is also watching the person working the problem making sure that no mistakes are made, and, if they are, pointing them out for the group member to correct. After approximately 15 minutes of practice the roles are reversed.

In Siegel's (2005) study, grouping was implemented only during practice skill time and sometimes during reviews. Students were required to submit one solution set per group, so for

each problem there was a group leader who read the problem and verbalized the solution to a recorder and a person who was in charge of the calculator. Roles were typically rotated with each new problem.

Positive Group Interdependence

Groups need to know that they have to depend on and help each other to get the job done. Siegel (2005) used group worksheets to complete this task. Each group would be given a grade based on one product. This product might be a list of problems, and in each problem the students have to take turns performing a certain task. This could be reading and leading, calculating, or recording. All students in the group have to take turns in order to complete the task.

In another method called STAD (Student Teams – Achievements Divisions) utilized by Whicker, Bol, and Nunnery (1997), positive group interdependence was achieved by giving the group a goal to work toward and a possible reward at the end. In this method points are earned by the group based on its improvement on an assessment. The number of points improved by each group member is added and then divided by the number of group members. The group with the highest improvement points will win some prize. This allows for lower achieving students to contribute the highest amount of points to the group. It also means that everyone has to work together to make sure that all in the group understand the material to be tested.

Social Skill Instruction

When switching from individual seat work to cooperative learning teams, behavioral norms in the classroom are going to take a dramatic shift. Silence will no longer be golden. “Eyes to the front” will be disregarded, and the ever famous “Do your own work” will hopefully be reserved for individual assessments only. At the very least, a new set of norms must be

established in the classroom. In the Gillies (2006) study, teachers who implemented cooperative learning used seven guidelines for students to model. They are as follows:

(1) All information is shared;
(2) The group seeks to reach agreement;
(3) The group takes responsibility for decisions;
(4) Reasons are expected;
(5) Challenges are expected;
(6) Alternatives are discussed before a decision is taken; and
(7) All in the group are encouraged to speak by other group members (p. 278).

Cohen (1994) says that at the very least rules should be established that require equal contributions from everyone in the group and rules on listening skills.

To model some of these new behaviors, Cohen (1994) has come up with a list of methods to try, though these methods will not be fully explained in this report. For being aware of the needs of others in the group, Cohen suggests the "Broken Circle Activity." For improving communication of deductive reasoning, Cohen suggests "Rainbow Logic." "Master Designer" can be used to promote three social skills. It can be used for showing other students how to do things for themselves, for promoting group dependence on an explanation, and for equating cooperation to group success. The reason for these non-curricular activities is to take the focus away from the curriculum so that students can concentrate on the social skills that need the most work. Social skill instruction does not always have to be elaborate. For example, Seigel (2005) simply used verbal directions and reminders.

Debriefing

Debriefing, according to Seigel (2005), is a way to provide general comments on what seems to be working in the group and what needs to be changed to make the group work better. In the Seigel study all debriefing was done at the end of class by having a whole class discussion

or a wrap-up of the activity. A teacher could keep a clipboard during the cooperative activity and write down both positive and negative group experiences for the wrap-up at the end of class.

Cohen (1994) says that students have to be trained on what they should be looking for when it comes to the norms of cooperative problem-solving behavior. Debriefing does no good if students do not know what to expect. Some questions that Cohen uses to make students mindful of these behaviors are the following:

> (1) Is everyone in the group talking?
> (2) Are you listening to each other?
> (3) Are you asking questions? What could you ask to find out what someone some one else is thinking?
> (4) Are you giving reasons for ideas and getting out different ideas? What could you ask if you wanted to find out someone's reasoning? (p. 53)

It might even be helpful to assign one member of the group the role of observer and have him or her write down a behavior that he or she notices is working or a behavior that is hindering the group's progress.

Meshing Direct Instruction with Cooperative Learning

Cooperative group and discovery learning purists might argue that these are the only methods a teacher should use to effectively teach mathematics. However, the mathematics that we know today came from generations of mathematicians. It has taken more than 3,000 years of collaboration to bring us to this point. Johanas Kepler worked on the three laws of planetary motion for approximately 30 years of his life. The proof of Fermat's last theorem took Andrew Wiles more than seven years of his life. Cooperative learning is a great tool to use in the mathematics classroom, but by no means should it be the only tool. The lack of time is the biggest drawback to making it the only tool. Veenman, Denessen, van den Oord, and Naafs (2003) suggest that it should be used in conjunction with direct instruction. In fact they say that students must first learn the new concept or skill, and then the cooperative grouping would be

used instead of individual seat work. If students are allowed to work cooperatively on task after task without direct instruction, gaps would form in the learning of the students. Important concepts would be missed. In Seigel's (2005) study, the cooperating teacher also used direct instruction along with cooperative grouping.

Cooperative learning cannot be achieved by simply grouping students together to work on a task and hoping that everything goes right. What is achieved instead is unequal participation. Therefore, cooperative learning has to be incorporated thoughtfully and systematically to achieve the desired benefits. First of all, a teacher should select the type of group that is desired. Most of the time a heterogeneous group of some kind is best so that low-achieving and high-achieving students can receive the maximum benefits of peer tutoring and thought organization. Each group member must be individually accountable for the information, and in this study the use of randomly selected group members to present cooperative tasks will be incorporated. Face-to-face interactions where everyone in the group has equal participation could be achieved by assigning roles for each group member that are switched after every problem. Positive group interdependence can be achieved by making a group performance rubric and group presentation rubric where grades would be tied directly to how the group performs and learns. Social skill instruction and debriefing can be achieved by letting students know what is expected of them, practicing these skills, and reflecting on which skills still need work.

All students do not stay engaged verbally in mathematics for the entire fifty five minute mathematics period when they work individually. If students are allowed to talk in this teaching style, they usually will not be talking about mathematics, and so are not entirely engaged in the mathematics. The cooperative learning environment, if structured correctly, can be the answer to this problem. This research can add to current research on student verbal behaviors in the

cooperative classroom. Also, this project can add to the research that Siegel has started. What happens in a classroom when a research model is actually applied? Often when a research model is applied to classrooms, it is meshed with what is already working in the classroom, and it is applied based on the experiences of the educator who is implementing the new model.

Finally, group work should be performed along with direct instruction. The group work itself will only replace seat work. This leads to three questions for this study. How do heterogeneous cooperative groups, where students in the group are responsible to present material, increase the number of students on task and the time on task when compared to individual practice? What effect will heterogeneous cooperative groups have on the teacher's and the students' verbal reasoning skills when compared to individual practice? What effect will heterogeneous cooperative groups have on students' listening skills when compared to individual practice?

Purpose Statement

The purpose of this study was to find a way to increase the engagement of students in mathematics through a mix of cooperative learning and individual accountability. I did not discontinue the use of direct whole class instruction. This was a critical component of my teaching style, and it is also what is expected of a mathematics teacher in our society.

I was seeking to understand how social learning after direct, whole class instruction could be used to improve mathematical communications skills. I already knew how a classroom full of students acting individually looked. How does the transition from this individual spirit to one more social in nature look? Will the transformation occur at all?

Methods

This research was conducted during the spring semester, 2007, in my classroom. According to the literature review, there were several areas that must be addressed in order to achieve true cooperative learning. Without restating the review, the area which I addressed first was determining the groups. For this I ranked students based on their first semester classroom grade, with 1 being the top grade in the class and 17 being the worst grade in the class. I wanted the number in each group to remain small, so I made five groups of three and one group of two. To determine who was placed in each group, I divided the numbered students into three achievement levels: high achieving, middle achieving, and low achieving. Students one through six were considered high achieving students. Students seven through twelve were considered middle achieving students, and students 13 through 17 were considered low achieving students.

As the research indicated, it is generally bad practice to match the top student with the bottom student, and so to keep the groups close in achievement level, I matched the top student in each category. In other words students ranked 1, 7, and 13 became a group. Students ranked 2, 8, and 14 became a group. Students ranked 3, 9, and 15 became a group. I did this for five groups until only the students ranked 6 and 12 remained. This became my only group of two. Next I made sure that there was at least one girl in each group and at least one boy in each group. Switches that were made kept this heterogeneous mix as close to the original achievement level as possible.

The next area that was addressed was positive group interdependence where members sink or swim together. To achieve this I gave them the combined responsibility of producing a portfolio once a week. This portfolio was graded based on their group performance, and the

rubric for this portfolio is located in Appendix A. Their group responsibilities are listed on this rubric.

For face-to-face interaction, I replaced the students' normal individual practice with an assignment where group members took turns completing a problem. They were instructed to watch each other work the problem and point out errors. All homework was to be completed in these groups, and each student only had to complete every third problem. If a student was gone on the day of an assignment, he or she was responsible for the entire assignment on his or her own.

For individual accountability there were three added tasks that students had to complete. The first was an individual presentation of a randomly selected problem by a randomly selected group member. Each group was in charge of presenting a problem, and each member had to present a problem at least twice during the action research. This individual presentation rubric is located in Appendix B. The second responsibility of the students was an individual open note quiz. These quizzes were given after the completion of at least two classroom objectives. The third individual accountability portion was chapter tests. These tests where given without the use of notes, and only a pencil and calculator were allowed.

Social skills instruction was discussed in the classroom as needed, but was mainly incorporated into my lectures. When I finished presenting the material, and just before they grouped up to work together on their round robin assignment, I would remind them of my expectations. These expectations are listed on the first two rows of the group performance rubric in Appendix A and the first two rows of the individual presentation rubric in Appendix B.

Debriefing students was accomplished as I walked around the room while they were working on their group assignments. I would compliment groups that were working together

well, and I would specifically tell them what I liked. For instance when things were going well, students were checking each other's work and giving constructive criticism. I also mentioned to groups that were not working together well what they were doing that needed improvement. Most of the social problems I witnessed was the use of sarcasm with each other and the working of the problems individually with no checking of each other's work.

Findings

How do heterogeneous cooperative groups, where students in the group are responsible to present material, increase the number of students on task and the time on task when compared to individual practice?

I noticed that students did not feel that their time on task was any different. The first survey question was, "We talk about mathematics during practice time." This number stayed at six out of ten for the duration of the action research. In this case a "1" meant that they did not talk about mathematics during practice time, and a "10" meant that they only talked about mathematics during practice time. Question two was, "I and the people I work with stay on task." The result of this question was also around six for the duration of the research. The third question was, "Circle the approximate number of times your group members or you were off task." Here again the number did not show much variation, staying around a four.

On the other hand looking through my journal prompts, I noticed that their time on task might have been about the same, but they were communicating better with each other mathematically. At the beginning of this social learning project, students were mainly trying to work individually without communication, as if they were still individuals working on the assignment. This can be shown with group performance rubric scores that began as a 23 out of

40 whole class average. In the end groups started to work together and keep on task enough to finish four group performance portfolios and end at a 36 out of 40 whole class average.

Grouping students had no outright effect on their time on task from the students' point of view. From the instructor's point of view, time on task improved. At the beginning of the research project, students worked individually even though they were in groups. They did not yet have the skills to communicate mathematics to each other effectively, and so if they had a question or were stuck they would ask the instructor for help. There might be six students stuck on the same question, yet the instructor can only answer one at a time. While the instructor would be answering this one question, the other five would be busy talking to each other about non-math related work and generally disrupting the class.

To combat this, at first the instructor would call their attention to the board and do the problem that all six were having trouble with in an attempt to control the situation, but at the same time the rest of the class was busy working ahead and would create a distraction of their own. In my first journal entry I wrote, "At this point most of the questions were directed to the instructor. There were a couple of times that I called their attention to the board to answer a question on problem 12 of 10-2. All groups seemed to get stuck on this problem, and instead of asking each other what to do they just asked me" (Personal Journal. February 28, 2007).

In another journal entry, "I have had to call them down several times. One time was to "keep hands off." Another was to pay attention to the third member of their group" (Personal Journal. March 1, 2007). In the beginning the individualism expressed in the classroom was part of the reason why many students were disruptive and off-task. I was having students do every third problem in a round robin style. They would do the problem when it was their turn without talking and pass the paper around. While they were not working, they would be disruptive. If

they had a question they would not ask their group members, but they would ask the instructor for help.

In order to combat this complacency when it was not their turn to work, I started giving open note quizzes more often. The effect of these quizzes can be seen in my journal. I wrote,

> Today was the first time I saw a couple of the groups working the problem as a team. Three students were talking and asking each other many questions. In fact I noticed that they were all jotting little notes on the worksheet as they went along. They had one paper that was for the turn in, but they were putting notes beside their own page. I think the reason for this is the open note quizzes I have been giving. They want the solution to some of these problems for future reference (Personal Journal. March 22, 2007).

At the end of the research project I wrote, "One thing that I notice with this situation is that I am able to manage the classroom better. I spend a ton of time wandering through the classroom with nothing to do but observe. Before I was the mother bird trying to get everyone a worm. Now they feed each other somewhat, and I only have to help when they are all stumped. So they are questioning each other" (Personal Journal. April 15, 2007). In this situation students were less disruptive because they could rely on each other to get the work done and understand the concepts. The students themselves were managing the classroom. As an instructor I have never had a class where all I had to do was observe. The students from their point of view saw talking as being off-task, but the talking that I was watching and listening to dealt with the problems on which they were working.

In fact there is one student who always seems to be off-task, but in his journal the instructor writes, "In one group a top-ability student and a low-ability student had an argument about a problem. The low-ability student was correct, and the top-ability student was wrong, but it is probably the first time this low-ability student buckled down and really tried to learn what we were doing. Usually he is the class clown and just makes noise the entire period. In this case he was concentrating on math" (Personal Journal. March 22, 2007). All of these events are

examples of the students' improvement when they have to rely on each other for understanding. The comment that I had made about having nothing to do but observe and the group performance rubric grade increase showed to some extent that the class was making an improved attempt at staying on task.

What effect will heterogeneous cooperative groups have on the teacher's and the students' verbal and non verbal problem solving skills and understanding when compared to individual practice?

Even though the students were in groups, at first they acted as individuals. In my first journal entry my comments are, "There are tons of students working, but they are not asking each other questions. At this point most of the questions are directed to the instructor" (Personal Journal. February 28, 2007). In fact they were not sure how to ask each other questions. From my second journal entry, "The question that I hear most often is, 'How do I do that problem?' They are not specific enough with their questions to each other or in the responses students are giving to each other. This is not helping group cohesiveness. The typical response to, 'How do you do that problem?' is the smart member of the group taking the paper away and doing the problem [for the group member with the question]" (Personal Journal. March 1, 2007). Thankfully this did not continue.

I could see on March 13 that students were still struggling with communication, so I asked them what they needed to work better as a group. The answer was surprising to me, but it was also a breakthrough. In my seventh journal entry I wrote, "They were not given enough time to get things, and could not get the full benefit of other members of the group. So I told them that if they stay on task, I would start giving more time for them to work together. It was amazing the improvement. All groups went to work and started talking about the assignment. It almost felt

like something clicked." Also I wrote that same day, "Although there were a couple of questions directed at me, these came because three groups could not agree on the answer of a particular problem; most of the questions were directed toward group members. They are starting to accept their situation, and some are starting to take advantage of the stronger math people in their group and asking questions. Leaders are popping out, some expected and some unexpected" (Personal Journal, March 13, 2007).

The deal I made with them seemed to change their attitude and their desire to communicate with each other. Another occurrence that happened that same day as I made my rounds was, "One of the boys was absent yesterday, so I overheard him ask his group how to work through the problems I assigned. One of the girls, who is normally very quiet, went to work explaining the problems to him" (Personal Journal, March 13, 2007). Both of these students have probably not said ten words to me all year, and yet they were able to communicate mathematically to help each other through the assignment. From here the groups just seemed to gel. In my tenth journal entry I wrote, "Today for the first time class was buzzing with mathematical discussion. I couldn't even pick out one particular discussion" (Personal Journal. March 22, 2007).

On a later date I made another observation in my journal. "In most groups there was low chatter the entire period, and some of the group members were coming to the front to check to see if they were correct. There was only one spot in the day in which a student was not talking about math. She was talking about the upcoming prom, and I had to focus her attention on the task at hand" (Personal Journal. April 12, 2007).

Also I wrote, "They are still asking questions of me. When the group gets stuck they make sure to ask me what is happening. One thing that I notice with this situation is that I am

able to manage the classroom better. I spend a ton of time wandering through the classroom with nothing to do but observe. So they are questioning each other. In fact, Marcus normally will not ask me a question, but I noticed that he and Charlie work very hard together. Marcus is always asking Charlie what to do. Today Charlie told me that he thinks Marcus understands this stuff better than anything we have done. We will see on the quiz." [Marcus's quiz score was a 37%.] The jury is still out on whether it leads to a better understanding of the material, but students felt that other students were helping them understand the mathematics. Note that for confidentiality, all names used in this report are pseudonyms.

Question 5 of the survey located in Appendix C states, "Other students have helped me understand the mathematics this week." The students began the action research with an average response of 3.7 out of 10 on February 12, and ended with a mean score of approximately 6.0 in the middle of April. In this survey a "10" means that they completely agree with this statement and a "1" means that they do not agree with the statement.

What effect will heterogeneous cooperative groups have on students' listening skills when compared to individual practice?

As stated before, even though students were grouped they did their problems individually at first. They were trying to stay in their old routine of doing the assignment alone with no one bothering them. From my second journal entry, "With students working on their assignments individually there is very little listening going on" (Personal Journal. March 1, 2007). The group members that were not working on a problem oftentimes were not engaged in what was happening, so even if there was a question the other students would have to read the problem themselves first. I also noticed that some students were using group members as their crutch. In my personal journal I recorded, "I noticed that several students, two in particular, were not

listening to the presentation. They were not writing down the examples I was putting on the board. They were not engaged in any part of the class. I asked them why they were not doing anything, and they said that one of their group members had it handled" (Personal Journal. March 6, 2007). Shortly after this, the instructor started giving open note quizzes.

By my seventh journal entry things were starting to turn around. "Today I heard several conversations about the mathematics. Others were talking back and forth. I would say in that 10 minutes there might have only been one or two off-topic conversations" (Personal Journal. March 13, 2007). By my thirteenth journal entry, listening and communicating were really taking off. The entry for that class period was, "Three students are all working together fairly well. One was a student that would not sit and listen to anyone, including me. Lately I have noticed that when I show up to their group to answer a question, he is engaged and asking clarifying questions. That alone shows that they are listening to each other. The problem I helped him on was not even his problem. Two of the students have been working really well together. One has pretty much become the other's tutor" (Personal Journal. March 28, 2007).

At the end of that quote I had written a profound statement. The problem I helped that student on that day was not even his own problem. He was the hardest student to get engaged to work. With individual work I had to practically threaten after school suspension every day in order to get him to complete the assignments. He is now engaged in all problems, including problems from the other group members. This also happened with several other groups. The main reason was those individual quizzes on which they wanted to be able to do well. The other reason based on the negative responses to the survey question, "I would rather work alone," was that they were starting to click and work well together. Some even enjoyed it. Student responses started with a mean of 5.75 out of 10 on that statement. A "10" meant that the student loved

working alone, and a "1" meant that the student loved working in groups. At the end of the project their mean response was 4.1 out of 10.

Also on the rubric, groups' listening skills for seated practice improved from a 5.3 on that section to a 7.3. In the presentation rubric, I included a section to rate the cooperation of the audience. They started with a 0, but ended the year with mainly 3's and 4's out of a 4 point rubric section. In my opinion, listening and communication saw the biggest improvement.

Conclusion

My journal entry on the 12th of April says it best. "Before I was the mother bird trying to get everyone a worm, now they feed each other somewhat, and I only have to help when they are all stumped." During individual practice where the instructor is seen as the only resource in the classroom, the instructor is stretched too thin and may not get to all students who have questions, or worse yet have to answer the exact same question ten times. When students are grouped and truly working cooperatively, the teacher is no longer the only resource in the room. They will help each other, and the instructor is able to help students when all are struggling. It really streamlined our practice time. I had fewer students disrupting the class while they were waiting on me for help.

At this point my research supports the findings of my literature review. If the instructor follows all of the criteria in forming cooperative groups and also gives at least four to six weeks for groups to develop, the students will start communicating mathematically. Giving the time to allow groups to get accustomed to the new situation was the hardest part. If I did not have a long term plan in place, it would have been easy to slip back into individual practice. The students certainly would have wanted that at first because they were working individually anyway.

I started the cooperative groups on the 28th of February and was finally starting to record positive results in my journal around the 22nd of March. My failure in the past with cooperative grouping was that I did not keep the groups together long enough for them to get used to each other or the situation.

The most important finding that I came across was making sure that groups have plenty of time to work together. At first I was only allowing about 15 minutes for the groups to interact. This was not enough time to work, and in my journal entry on the 13th of March I noted that students were asking for more time to work together. My entry reads, “They mentioned to me that they need more class time to work together. They were not given enough time to get things, and could not get the full benefit of other members of the group. So I told them that if they stay on task I would start giving more time for them to work together.” Over the rest of the project I started watching my lecture time and cutting that back. In turn I tried to give 30 minutes of group time, and if the groups were busy and communicating on task I let this time carry into the following day.

All of these finding come down to one thing. In order to make cooperative grouping work, a teacher has to have a plan in place that supports all the criteria. This means planning ahead and sticking with it longer than just a couple of weeks. My social skill instruction was weak, and in turn I did not have the success I was expecting. I wanted to see more improvement in test and quiz grades from students in the low-ability levels in the class. That did not happen. In fact some scores were lower. There was no effect on my high-ability students. The other reason for the lower scores could have been the fact that this material was new. It was the first time that students had worked with logarithms and logarithmic properties.

Implications

As a result of this research, an area that needs to be improved in my practice is social skills instruction. Research says that in order to make the groups work cooperatively, social skill instruction should be done separately from the curriculum so that students can concentrate on working together. The problem with this is time. I did not have the time to take away from my curriculum to do these activities. There were a few students that never did work with the group. In my journal entry dated March 27th I state, "Steve and Aaron - neither one pays attention. Steve probably less than Aaron, and it shows. They are not disturbances in the classroom, but they do not engage themselves mentally in the lecture. During group work this group worked together okay; however, Steve always distances himself from the group. Lana has finally gotten Aaron to pay attention while they are working but not Steve." On March 27th my research was almost complete, and most groups were well on their way to working cooperatively together. This group never did reach that point.

In the future I will probably mix individual practice and group practice more often. The simpler tasks seem to work better individually, while the more complex problem solving tasks lend themselves well to group work. As an example in my journal entry on the 10th of March I wrote, "They were listening to each other, but the task was simple, and I had a lot of off-topic conversations going on." We were solving simple one or two step exponential equations like $2^x = 25$. This task would have worked better as an individual assignment.

On the other hand on the 29th of March I wrote, "As far as reasoning goes, I am trying to get them to know where to plug numbers into the equation. Sometimes they loose what is what when the problem is in a story form. I have been watching their paper work, and listening to how they work through problems together. Carry knows very well how to solve logs, but cannot seem

to set up the problem. Others know how to set it up, but have no clue how to solve, and so that group seems to reason well together. The problem will be that individually they will not be able to perform on the exam." On this day students were applying what they knew about logarithms with actual exponential decay and growth problems. Here was a case where group cooperation was essential, and if I had more time to allow groups to operate in this fashion they would eventually be able to put all the pieces together individually.

For students to be productive mathematicians later in life, they have to learn to communicate mathematically and solve problems in groups. The current practice of lecture followed by individual practice does almost nothing to address this need for social learning. My classrooms in the future will incorporate the criteria of cooperative learning, and cooperative groups will be an integral part of my teaching strategy in the future.

For the rest of the teaching community in general that feels that they have students that are not participating in the classroom because students do not seem to have ample opportunity, I would say that cooperative learning would be a viable solution. Like many interventions this is one that will use up some precious time, so a teacher who is planning to implement cooperative learning needs to have a good plan in place. In this way wasted time will be minimized. To get the full benefit of social learning, students must be taught, in addition to the current curriculum, how to operate socially in their new situation. Along with this a teacher who is new to implementing social learning strategies cannot expect immediate results. In my project I started at the end of February, and did not start seeing positive results until the end of March. Even in April I had one group that still did not work cooperatively.

References

Brahier, D. J. (2000). *Teaching secondary and middle school mathematics*. Needham Heights, Massachusetts: Allyn & Bacon.

Cohen, E. G. (1994). *Designing group work: strategies for the heterogeneous classroom, 2nd Ed.* New York: Teachers College Press.

Gillies, R. M. (2006). Teachers' and sudents' verbal behaviours during cooperative and small-group learning. *British Journal of Educational Psychology*, 76, 271-287.

Kroeger, S. D., & Kouche, B. (2006). Using peer-assisted learning strategies to increase response to intervention in inclusive middle math settings. *Teaching Exceptional Children*, 38, 6-13.

Leonard, J. (2001). How group composition influenced the achievement of sixth-grade mathematics students. *Mathematics thinking and learning*, 3, 175-200.

Nardi, E., & Steward, S. (2003). Is mathematics T.I.R.E.D.? A profile of quiet disaffection in the secondary mathematics classroom. *British Educational Reasearch Journal*, 29, 345-367.

Siegel, C. (2005*). Implementing a research-based model of cooperative learning. The Journal of Educational Research*, 98, 339-349.

Veeman, S., Denessen, E., van den Oord, I., & Naafs, F. (2003). Direct and activating instruction of a preservice course. *The Journal of Experimental Education*, 71, 197-225.

Whicker, K. M., Bol, L. & Nunnery, J. A. (1997). Cooperative learning in the secondary mathematics classroom. *The Journal of Educational Research*, 91, 42-48.

Appendix A

Group Performance Rubric

CRITERIA	8	6	4	2	0	SCORE
Group Verbal Communication. **Explaining, questioning, reasoning.**	Members talking mathematically, contributing equally.	Sarcasm or negative comment used. Gossip or generally non class related conversations herd	one members not communicating. Negative comments heard twice	Two members not communicating. Negative comments heard three times	Group not communicating or is using sarcastic, negative comments put downs heard more than three times.	
Group listening **during seated practice time. Listen to other members of your group.**	Members listening to each other. And responding in a positive math manner.	Group member not listening at any point in the week.	One group members not listing, or two days of non listening in the group	Two group members not listening or three days of not listening to the geoup.	Group members are talking about unrelated information every day.	
<u>Stumblers</u>	Stumbler sheet completely filled out showing complete understanding of a challenging word.	Stumbler sheet filled out but students didn't show understanding on all sections.	Section of Stumbler is not filled out .	Stumbler is improperly filled out.	Stumbler is missing.	
Habits of Mind Problems (double points 0 to 8 points awarded objectively)	All group members show thorough understanding of any concepts. Computations are correct. Written or computational explanations are exemplary. Answers the question **why and how.** Any graphs are accurate and appropriate.	One group member Shows understanding of most concepts. Computations are mostly correct. Written or computational explanations are effective. Any graphs are mostly accurate and appropriate. Satisfies all requirements of problems.	Shows understanding of some concepts. Computations are partially correct. Written or computational explanations are present. Any graphs are partially accurate and appropriate. Satisfies most requirements of problems.	Shows little understanding of concept. Computations are partially correct. Written or computational explanations are not satisfactory. Graphs are not accurate or appropriate. An attempt was made at the problems.	Shows no understanding of concept. Computations are incorrect. Written explanations are not present. Graphs are not present when needed. Very little attempt was made with the problems.	

Assignments (double points 0 to 8 points awarded objectively)	All assignments completed with work shown on every problem.	Did not do one or two problems, but work was still shown on the rest of the assignments	Missed three or four problems, but work was still shown on the rest of the assignments.	Missed five or six problems, Work is shown but not on all problems.	Missed six or more problems with little or no work shown.	
Organization	Neatly written in pencil and ordered like rubric. Names on all problems.	Assignments not ordered from oldest to youngest	ICP and Habit of mind out of order.	Everything is there, but had to look for it.	Nothing organized. Took too much time for instructor to grade.	

Appendix B

Individual Presentation Rubric

CRITERIA	4	3	2	1	0	SCORE
Class Cooperation	Everyone listening and No one interrupting during presentation.	One interruption. Student talking during presentation.	Two interruptions	Three interruptions.	Four or more interruptions.	
Class engagement	4 Clarifying question asked by classroom.	3 clarifying questions asked.	2 clarifying questions asked.	One clarifying question asked,	No clarifying questions asked.	
Presenter 1 **Name**	Ready to present Mistake free presentation. Portrays understanding of problem. Speaks clearly and explains problem.	Ready to present Mistake made in presentation. Portrays understanding of problem. Speaks clearly and explains problem.	Ready to present Mistake made in presentation. Portrays some understanding of problem. Explains problem.	Not ready to present. Mistakes made in presentation. Portrays little understanding of problem. Explanation missed important pieces	Does not present	
Presenter 2 **Name**	Ready to present Mistake free presentation. Portrays understanding of problem. Speaks clearly and explains problem.	Ready to present Mistake made in presentation. Portrays understanding of problem. Speaks clearly and explains problem.	Ready to present Mistake made in presentation. Portrays some understanding of problem. Explains problem.	Not ready to present. Mistakes made in presentation. Portrays little understanding of problem. Explanation missed important pieces	Does not present	
Presenter 3 **Name**	Ready to present Mistake free presentation. Portrays understanding of problem. Speaks clearly and explains problem.	Ready to present Mistake made in presentation. Portrays understanding of problem. Speaks clearly and explains problem.	Ready to present Mistake made in presentation. Portrays some understanding of problem. Explains problem.	Not ready to present. Mistakes made in presentation. Portrays little understanding of problem. Explanation missed important pieces	Does not present	
Presenter 4 **Name**	Ready to present Mistake free presentation. Portrays understanding of problem. Speaks clearly and explains problem.	Ready to present Mistake made in presentation. Portrays understanding of problem. Speaks clearly and explains problem.	Ready to present Mistake made in presentation. Portrays some understanding of problem. Explains problem.	Not ready to present. Mistakes made in presentation. Portrays little understanding of problem. Explanation missed important pieces	Does not present	
Presenter 5 **Name**	Ready to present Mistake free presentation. Portrays understanding of problem. Speaks clearly and explains problem.	Ready to present Mistake made in presentation. Portrays understanding of problem. Speaks clearly and explains problem.	Ready to present Mistake made in presentation. Portrays some understanding of problem. Explains problem.	Not ready to present. Mistakes made in presentation. Portrays little understanding of problem. Explanation missed important pieces	Does not present	
Presenter 6 **Name**	Ready to present Mistake free presentation. Portrays understanding of problem. Speaks clearly and explains problem.	Ready to present Mistake made in presentation. Portrays understanding of problem. Speaks clearly and explains problem.	Ready to present Mistake made in presentation. Portrays some understanding of problem. Explains problem.	Not ready to present. Mistakes made in presentation. Portrays little understanding of problem. Explanation missed important pieces	Does not present	

Appendix C

Weekly student survey

On a scale of 1 to 10 with 10 being that I agree with this statement and zero that I do not agree with this statement please rate the following questions.

1. I understand the mathematics covered this week.
   0 1 2 3 4 5 6 7 8 9 10

2. Group work has helped me understand the mathematics this week.
   0 1 2 3 4 5 6 7 8 9 10

3. Our group allows everyone to participate.
   0 1 2 3 4 5 6 7 8 9 10

4. We talk about mathematics in our groups.
   0 1 2 3 4 5 6 7 8 9 10

5. I have learned math from my peers in group work.
   0 1 2 3 4 5 6 7 8 9 10

6. When I have trouble understanding math my group members help.
   0 1 2 3 4 5 6 7 8 9 10

7. My group stays on task.
   0 1 2 3 4 5 6 7 8 9 10

8. I understand the mathematics when my group members explain it to me.
   0 1 2 3 4 5 6 7 8 9 10

9. I would rather work alone.
   0 1 2 3 4 5 6 7 8 9 10

10. What problems are we experiencing in our groups?

11. What has been working our groups?