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Sandra S. Snyder

Shickley, NE

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Cooperative Learning Groups in the Middle School Mathematics Classroom

**Sandra S. Snyder
Shickley, NE**

A report on an action research project submitted in partial fulfillment of the requirements
for participation in the Math in the Middle Institute.
University of Nebraska-Lincoln

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Cooperative Learning Groups in the Middle School Mathematics Classroom

ABSTRACT

In this action research study of my classroom of 8th grade mathematics, I investigated the inclusion of cooperative learning groups. Data was collected to see how cooperative learning groups affected oral and written communication, math scores, and attitudes toward mathematics. On the one hand, I discovered that many students enjoyed the opportunity to work within a group. On the other hand, there continues to be a handful of students who would rather work alone. The benefits outweigh the demands. Overall, students benefitted from the inclusion of cooperative learning groups. Oral explanations of solutions and methods improved during the study. Written expression also improved over this time period. As a result of this research, I plan to continue with the incorporation of cooperative learning groups in the middle school math classroom.

In this action research study, I investigated how the inclusion of cooperative learning groups affects scores, written and oral communication, and attitudes in the middle school mathematics classroom. The middle school years can be a difficult time period for some students. Learning and communicating can change drastically. The importance of school may take on a new meaning for students. Some students may decide this is the time to take the bull by the horns and make school a top priority, while some decide school is not as important as a social life. Problem solving is an important general theme in the middle grades, and many students struggle with this. Students may drift away from depending on adults during this time. Communication among peers becomes much more important during this time. I wanted to investigate if cooperative learning groups would have an effect on student learning during this time period.

This study took place in my own math 8 classroom at Learner Public Schools, where I have taught for 14 years. The study involved 11 students, 9 male and 2 female. As the researcher, I had each student journal after each cooperative learning experience. I also had another person video each cooperative learning activity so I could view the group interactions and listen to dialogue at a later time. This also allowed to me to act as teacher, when needed, during each group activity. Grades were calculated and recorded on a graph each week so I could see trends in grades for each student. Students were given pre and post surveys pertaining to their attitudes toward mathematics and cooperative learning.

PROBLEM OF PRACTICE

The inclusion of learning communities in a classroom is one more way to aid instruction. When students work together, the ones who clearly understand a concept may be able to explain the concept in another way to the students who lack the understanding. Group work allows for content dialogue to occur between the students and between teacher and students. Working

together also allows for a double-checking mechanism for spotting calculation errors and correcting them immediately.

At the onset of this study, the situations in my classroom were ones that did not utilize learning communities efficiently. Once in awhile, I required groups of students to work together, but this didn't happen often enough. I wanted to have learning groups in my classroom, but also wanted them to run appropriately. I wanted them to aid in the learning of mathematics, not hinder it.

In the limited times I utilized learning groups, one instance occurred when the class worked on story problems. For the record, most students detest story problems. The students paired up (their choice of partners), discussed the problem, decided together on the method to solve, and then actually solved each problem. The classes with older students enjoyed this opportunity. They have told me they understand more when they are done. My concern with this group was that they found the easiest method by which to solve. Sometimes, my goal was to practice a specific method as opposed to just getting a solution. I was happy to see that partners were chosen more on proximity rather than gender, friendship, etc.

As for the younger students, it appeared to me that if they understood how to do something, they weren't willing to share the wealth. And, for many, getting any type of an answer was success. Working in a group had not been very rewarding for the students, and I had not been pleased with the outcomes. I did notice that girls worked with girls, boys with boys, and students perceived as having a higher understanding tended to group together. I still planned to incorporate group work with these classes. I experimented with me choosing groups to get the males and females working together. Also, this allowed groups to include a student with

perceived high understanding and a student who could benefit from additional explanation. I definitely had to monitor the time on task by all students.

How to assess the work completed in these groups was another issue. Should I have the students grade each other based on their perceived contributions? Should I assess based only on yes, they participated, or no, they didn't? Other teachers must be faced with similar dilemmas. How were they addressing the different issues?

I definitely believed that the use of learning communities is a benefit to all students. I thought that I would find that the inclusion of learning communities helped to promote a deeper understanding of mathematics and also led to improved scores. I wanted what was best for all students. Everyone deserves a chance for success.

My ideal setting would include learning groups of all sizes working efficiently. Discussions about math would occur within the groups and maybe between groups. Students could explain concepts orally and in writing to me. Conceptual understanding would increase and time wouldn't need to be spent reviewing concepts from previous courses. Scores would increase.

I thought learning communities would be beneficial for all of the teachers on our staff at Learner Public School. Middle school teachers here did not use learning groups. I wanted to find evidence that they were beneficial, and then take that information to my colleagues. If they were shown the benefits of group work, maybe more teachers would include it in their teaching methods. Our students would become more comfortable with the idea and see that it was beneficial in all subject areas. This could possibly be a strategy that could improve scores in all subject areas. I wanted to research this to benefit our entire staff. Other teachers are utilizing learning communities in their classrooms. Maybe, some of my findings will help these other teachers.

LITERATURE REVIEW

The use of cooperative learning in the classroom, as an instructional strategy, had been a topic of study for many years. Cooperative learning involves groups of students working to complete a common task (Siegel, 2005). This is typically done with groups of 2-4 students; the smaller the group, the better. Dyads produced higher performance outcomes than students working alone, but this effect was not due to the cooperation per se, but the cooperation increased the likelihood of engagement in the types of talk that support learning. When working with a partner, forms of elaborated talk are more prevalent than when working alone (and talking aloud to oneself) (Krol, Janssen, Veenman, & van der Linden, 2004).

The National Council of Teachers of Mathematics [NCTM] expresses that learning with understanding is essential to enable students to solve the new kinds of problems they will inevitably face in the future. Because not all students regularly participate in whole-class discussions, teachers need to monitor their participation to ensure that some are not left entirely out of the discussion for long periods (NCTM, 2000). The use of small groups will allow the students an opportunity to share important thoughts and ideas to a small group of peers, thus improving confidence in sharing of ideas and communicating about mathematical ideas.

Cooperative learning also gives students the chance to analyze and evaluate the mathematical thinking and strategies, another key concept NCTM promotes. This can be done in a non-threatening environment. The interactions with other students can help deepen the level of understanding for all students. The communication of mathematical ideas helps to develop reasoning skills and better understanding of arithmetic procedures. The Nebraska State Math Standard 8.4.6 states that by the end of eighth grade, students will use geometric terms and representations to describe the physical world. The communication of mathematics is a must.

Research has shown that cooperative learning has a positive influence on students' involvement in math related material (Ferreira, 2001). Students appear to enjoy working cooperatively and are willing to cooperate with others in the group (Krol, Janssen, Veenman, & van der Linden, 2004).

Teachers also find satisfaction with the incorporation of cooperative learning groups (Linchevski & Kutscher, 1998). The use of small groups requires fundamental changes not only in the organization of the classroom but also in ways of learning (Kramarski & Mevarech, 2003). There are many different research-based models of cooperative learning. One popular model is the Johnson and Johnson model. This model defines five essential elements: (a) face-to-face interaction, (b) individual accountability, (c) positive group interdependence, (d) social skills instruction, and (e) debriefing (Krol, Janssen, Veenman, & van der Linden, 2004). What is nice is that no one model must be followed precisely to have a positive influence in the classroom. In fact, teachers will adapt research-based models for use in their classroom. Through the mechanism of assimilation, teachers should reorganize the information that they receive about cooperative learning to fit their existing schema of teaching (Siegel, 2005). The inclusion of cooperative learning need not be viewed as an added burden, but as a welcomed change of instruction in the classroom.

With even the best of practices, there may be disruptions. Behavior is one such event. Implementing any cooperative small-group setting does not automatically ensure cooperative work and a positive effect on all students (Leikin & Zaslavsky, 1997). Behavior can also vary depending on the purpose of the cooperative learning activity. Mastery groups exhibited more pro-social leadership, focusing on the math task and group cohesion. Performance groups exhibited more dominance, where one student, regardless of race or gender, emerged to

overpower the group process (Yamaguchi, 2003). Mastery groups emphasized learning and improvement, while performance groups emphasized competition and social comparison.

Research has shown much success when cooperative learning is implemented with heterogeneous groups of students. One study (Krol, Janssen, Veenman, & van der Linden, 2004) paired a low-ability student with a medium-ability student, and a medium-ability student with a high-ability student. This pairing was based on the assumption that the ability levels of the students should be different in order to generate help-seeking and helping behaviors, but not too different in order to still make it possible for the students to work in their “zone of proximal development.” Analysis of the data revealed that approximately 75% of the dialogue that occurred within the dyads was cognitive in nature. There was more high-level interaction between the dyads consisting of a medium-ability learner and a high-ability learner than there was in the dyads consisting of a medium-ability learner and a low-ability learner. But, overall, the level of discussion was of a higher level for both groups. Another study (Leikin & Zaslavsky, 1997) had arrangements of small study groups that made it possible for low-achievers to work in pairs with middle level students to ensure that every student got the opportunity both to study and to teach each type of learning material. More research shows that when working with mixed abilities, the average and weaker students’ achievements showed significant gains, whereas the loss in achievements of the stronger students was negligible (Linchevski & Kutscher, 1998).

This action research project is intended to examine three areas. The first is to see if students’ attitudes toward mathematics are changed by the inclusion of cooperative learning groups. Secondly, I will see how written and oral communications in mathematics classes are affected by the inclusion of cooperative learning group work. The third area is to monitor students’ scores

and observe any effect due to the inclusion of cooperative learning group work. Teachers in all subject areas could benefit from this research.

PURPOSE STATEMENT

The purpose of this study was to investigate the effects that cooperative learning groups have on the middle school mathematics classroom. Data collection took place during the spring semester, 2006, in the researcher's classroom. This study attempted to answer these research questions:

- In what ways will students' attitudes toward mathematics change by the inclusion of cooperative learning groups?
- How does the inclusion of cooperative learning group work affect the mathematics scores of students?
- How is written and oral communication in mathematics classes affected by the inclusion of cooperative learning group work?

METHOD

Three types of data collection were used to determine how cooperative learning groups affected the mathematics scores of the students in the target class. Cumulative averages of all daily work, quizzes, tests, and cooperative learning group work were calculated each week during the research time period. This allowed for comparison of grades over the time interval. Scores on each group activity were recorded in the teacher's grade book and also entered into PowerGrade, the district's grading software. Standardized math scores over the last three years were also compared, looking for any marked changes. The Terra Nova, second edition, has been administered for the last 3 years in the district.

Students were asked to journal about their experiences in cooperative learning groups. This took place at the end of each group activity. The same three prompts were used for each journal entry. The first was: Did working in a group affect how you thought about or solved the problem? Explain. The second was: Working in a group (helped, hurt, didn't affect) my understanding of the problem because.... The third was: I liked/didn't like working in a group because.... Students were also asked to give written explanations of their method of solving individual problems from the group activity. This took place four times, and was kept in their individual journals. Most individual homework assignments also included exercises in which the student was to explain the mathematics used in a specific problem. Cooperative learning activities were videotaped to allow the researcher the opportunity to evaluate the oral communication about the mathematics among the groups. The researcher kept a weekly journal on thoughts and feelings about the communication, both written and oral, that occurred within the classroom.

The researcher administered a math attitude survey and a cooperative learning attitude survey at the onset and the conclusion of the research period. This data was used to track changes in students' attitudes in these two areas.

ANALYSIS

Most students had a positive attitude toward mathematics when working cooperatively. Data from two surveys administered before the research period and upon the conclusion of the research period demonstrate this. One survey dealt with cooperative groups and the other with mathematics in general. A Likert scale of one to five was used. Mean, median, mode, and range for each statement are:

COOPERATIVE GROUP SURVEY

	PRE-SURVEY (N = 11)					POST-SURVEY (N = 10)				
	Mean	Median	Mode	Range	Std. Dev.	Mean	Median	Mode	Range	Std. Dev.
1. I like to work in groups in math class.	4	4	5	4	1.26	3.8	4	4	4	1.23
2. I ask questions of others when I work in a group.	3.55	4	4	3	1.04	3.3	3.5	4	4	1.34
3. I understand the math concepts when I work in a group.	4.18	4	4	2	0.75	4.3	4	4	2	0.67
4. Others in the group ask me questions when we work in groups.	3.55	3	3	3	0.93	3.4	3	3	3	1.07
5. Working in a group helps me understand the concepts better.	3.73	4	5	4	1.35	3.8	4.5	5	4	1.55
6. Working in a group helps me get the work completed on time.	3.91	4	4	4	1.30	3.4	3.5	5	4	1.65

MATH SURVEY

	PRE-SURVEY (N = 11)					POST-SURVEY (N = 10)				
	Mean	Median	Mode	Range	Std. Dev.	Mean	Median	Mode	Range	Std. Dev.
1. I like math.	3.73	4	4	3	0.92	4.2	4.5	5	3	1.03
2. I am good at math.	3.64	4	3,4	3	0.92	3.5	4	4	3	0.97
3. Math skills are important for other skills.	4.09	4	5	2	0.94	4.1	4	4	2	0.74
4. I am able to show the work required to solve math problems.	4.09	4	4,5	2	0.83	3.7	4	4	2	0.67
5. I like to answer questions asked in math class.	2.91	3	2,3	2	0.83	3.2	3	3	4	1.32
6. I feel comfortable asking questions in math if I don't understand a concept.	3.55	4	4	3	1.13	3.8	3.5	3	2	0.92

There was a slight increase in the average of responses to the statement related to the self-perception of the understanding of math concepts when working in groups. This was also evident in journal responses to the second prompt, 'Working in a group (helped, hurt, didn't affect) my understanding of the problem because'.... Nine of the eleven students responded that

working in a group helped at least one time. Five students reported that it was helpful three or more times. Standard deviations are quite high, due to the small sample size.

Groups worked better together if the students chose the groups rather than the teacher. Journal entries reflected this. When the students picked groups, group work had a positive effect on how they thought about and solved problems. Some student responses were, "I learned it a better way," "I heard different theories to how to solve the problem," "It helped me see stuff in different ways," "My own thoughts became clearer," "My partner could explain it better," "I could find how others do the work." When the teacher chose the groups, responses were somewhat different. Seven of 22 possible responses (two for each student) were that they didn't like working in a group when the teacher chose the groups. Some student responses were, "I already knew how to solve the problems," "I just did it my way," "One partner didn't do anything," "It took longer to get the work done," "My partner asked too many questions." Responses to all journal prompts took on a neutral or positive tone when the students chose the groups. When the teacher chose the groups, the responses tended to be more negative.

This also came through on the videos when the researcher viewed later. Each group was on tape at least six times during each 50 minute taping period. The teacher picked groups twice, students picked groups once, and groups were randomly changed every ten minutes once. When the students picked the groups or floated between groups, the groups were on task almost the whole time. On task was defined as working on the math activity with paper and pencil, or discussing the problem within the group in a positive manner. When the teacher chose the groups, often arguing took place, one student would try to take control of the group, or no interaction would take place at all. During the two times that the teacher chose groups, discourse

was observed 29 out of 48 recorded times, or about 60% of the time. When the students chose the group, on task interactions were observed 32 out of 48 recorded times, or 67% of the time.

Cumulative averages during this project were the same or slightly higher for all students. Overall, averages increased an average of 3.5 percentage points from the implementation of the project until the completion of the school year. Lower level students performed above their typical scores by an average of 4 percentage points, during this time frame. One possible reason for this increase is the result of the group work. Another possible reason may be the result of different presentation techniques that were implemented to do the activities cooperatively.

Scores on individual papers following the cooperative group sessions were much higher than when completed on their own. A test covering material that was practiced in groups during the first two weeks of the research period was administered and all students scored passing grades, with six students receiving As. Typically, there are at least two students who fail tests, and four students score an A consistently. Topics of study were geometry terms, markings, and measurements. Historically, these topics are not harder or easier than others. Another cooperative group activity involved measuring actual 3-dimensional objects and then finding surface areas and volumes. Two assessments of Nebraska State Mathematics standards were later given. Students scored in three proficiency levels: progressing, proficient, and advanced. Seven of the eleven scored in proficient or advanced. This has shown in the past to be a rather difficult section and scores have not been this good.

Standardized test results do not mirror this success. The district has administered the second edition of the Terra Nova battery for three consecutive years. Nine of the students were in the district for the three year span. Of those, five held steady or showed slight improvement. The other four showed no gain or decreases, especially in the area of math computation. One

possible reason for this may be due to the level of difficulty increases each year within the format of the standardized testing program.

Oral communication about mathematics improved during the research period. While working in groups, students paid attention to vocabulary in their discussions. At the beginning of the year, students would refer to parts of fractions as 'the top number' and 'the bottom number.' By the end of this project, these were referred to as numerator and denominator. There was evidence of improvement in presenting solutions to the whole class from the start of the research period until the end. The students used to go to the overhead, write the problem, write the answer, then sit down. By the end of the project period, students were eager to present and explain their work. Work was documented on the overhead and explanations to any work were given without prompts. The quality of explanations also improved. Explanations included how they knew how to approach problems and justifications of why they did the work they did.

Oral communication prepares students for written communication. Writing about mathematics did improve, but is not at a proficient level. The students were given prompts to get them started writing in their journals. The journals were graded for completion, not for being right or wrong. This acted as a safety net and allowed them to practice writing about mathematics in a non-threatening environment. They were also asked to write in their journal about a problem from the group activity, using correct math terminology and vocabulary. Credit was given for doing it, not if it was right or wrong. Homework assignments always had at least one situation to explain. These were graded for correctness and were reflected in cumulative averages. By the end of the research period, writing did improve. Struggle with the writing was evident in the videos. Some of the lower level students depended greatly on their partners to help with the writing. They would ask their partners to read their responses and then try to copy

the response. I also heard more oral communication between students during homework time that pertained to the questions requiring explanations. This was evident when one student would ask another student what they wrote for a specific answer or how they worded their response. I did not squelch this, as communication between students during practice time is promoted.

INTERPRETATION

Students need to learn to work cooperatively, whether it be with someone of their choice or with someone with whom they are assigned to work. A cooperative learning setting is not always an enjoyable situation, but it can be a productive one. The three students who enjoyed working in groups every time did find positive outcomes from the activities. They found it helped them to understand math concepts. Those who didn't like working in a group did not view the situations as positive ones.

Individual grades and cumulative averages did improve for most students after the inclusion of cooperative groups. They were able to ask questions of one another, demonstrate different methods with which to solve, and see how other people think about problems. With continuous group activities geared toward the increasing level of difficulty demonstrated on achievement tests, it may be possible for achievement test scores to reflect the improvement shown in classroom work. Those who didn't show improvement were already in the A range to begin with and scored in the upper 20 percent on achievement test scores.

Oral and written communication improved with the inclusion of cooperative learning groups. Students were able to use correct mathematics vocabulary, such as numerator, exponent, function, and data analysis, to ask questions of others in a small group setting. They were also able to explain concepts to one another within the group. This helped students become more comfortable explaining solutions in front of the whole class. Writing about mathematics

improved, but still has room for improvement. This is an area that we will continue to expand upon next year. Communicating about mathematics is a must in our ever-changing world. Next year, I plan to continue with cooperative group activities with this same group of students in Algebra I. I will also begin the year with cooperative activities with the new eighth grade class. I hope that the utilization of cooperative learning groups from the beginning of the new school year will be more manageable. I will have a new group of students whom I have not worked with before. I don't know what to expect from them. I also plan to implement weekly writing in all of my classes. The activities will vary from class to class. I hope that these changes will make a lasting impact on all of my students.

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COOPERATIVE GROUP SURVEY

Please give your honest response to each statement, 1 being low and 5 being high.

- | | | | | | |
|-----------------------------------------------------------------|---|---|---|---|---|
| 1. I like to work in groups in math class. | 1 | 2 | 3 | 4 | 5 |
| 2. I ask questions of others when I work in a group. | 1 | 2 | 3 | 4 | 5 |
| 3. I understand the math concepts when I work in a group. | 1 | 2 | 3 | 4 | 5 |
| 4. Others in the group ask me questions when we work in groups. | 1 | 2 | 3 | 4 | 5 |
| 5. Working in a group helps me understand the concepts better. | 1 | 2 | 3 | 4 | 5 |
| 6. Working in a group helps me get the work completed on time. | 1 | 2 | 3 | 4 | 5 |

Please answer the following questions.

7. You are asked to work in a group. If you get to choose two people to work with, who would it be and why?
8. Why do/don't you like to work in groups?

MATH SURVEY

Please give your honest response to each statement, 1 being low and 5 being high.

- | | | | | | |
|---------------------------------------------------------------------------------|---|---|---|---|---|
| 1. I like math. | 1 | 2 | 3 | 4 | 5 |
| 2. I am good at math. | 1 | 2 | 3 | 4 | 5 |
| 3. math skills are important for other skills. | 1 | 2 | 3 | 4 | 5 |
| 4. I am able to show the work required to solve math problems. | 1 | 2 | 3 | 4 | 5 |
| 5. I like to answer questions asked in math class. | 1 | 2 | 3 | 4 | 5 |
| 6. I feel comfortable asking questions in math if I don't understand a concept. | 1 | 2 | 3 | 4 | 5 |

COMPLETE THE FOLLOWING STATEMENTS .

7. This is my favorite math concept and why:
8. One good thing that happened in math is:
9. One not so good thing that happened in math is:
10. Two years of high school math are required to graduate from Learner Public School. I plan to take
(circle one) 1 2 3 4 4+ math classes when I get into high school.