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Using Cooperative Learning to Promote a Problem-Solving Classroom

Amy Nebesniak
Grand Island, NE

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ABSTRACT

In this action research study of my eighth grade mathematics classroom, I investigate the benefits of cooperative learning, the support structures needed to promote a cooperative learning environment, and students' ability to transfer the cooperative learning skills into less structured problem solving situations. The data analysis reveals that cooperative learning increases students' confidence level as well as their involvement in the learning process. In order to create successful teams, students require my providing support structures and modifying the support for each group of students. Finally, students are able to more effectively apply their cooperative skills in concrete situations as compared to problems that require more abstract thinking. The transfer of cooperative learning skills depends on the ability level of the students, teacher support, and exposure to problem solving situations.

INTRODUCTION

I have always felt that my classroom was missing something big. I remembered that as a student, with the teacher in front of the class, I did not learn as much as I could have. Yet there I was, doing the same thing to my students and I did not know how to change. Several excuses came to mind when I would even humor the idea. I do not have the time to figure out a different style of teaching. The kids will be harder to manage if they are not facing the front of the room. How do I put them into groups? If I try to change things now, it will just make more work for me. If I change one thing, I have to change everything. Looking back, all were incredibly selfish reasons for not trying to implement cooperative learning.

Cooperative learning was discussed briefly in some of my preservice undergraduate classes. Although my undergraduate experience was positive overall, this is one area I do not feel I was sufficiently prepared. As an education student, I was often lectured on how important it is to let students work in groups and discuss ideas. Yet very few of my education professors implemented the idea in their own practices. As I began my teaching career, I chose to use a teacher-led approach and I became comfortable with this style of teaching; after all, I had been a student in classrooms for 17 years in which the teacher expelled information and the pupils were to simply absorb the knowledge.

The biggest reason for not incorporating teams into my classroom was my lack of knowledge and understanding. My personal education experiences and undergraduate work had not directly exposed me to this teaching approach. I simply did not understand the tremendous impact on learning that working on and discussing mathematics with other people had. I was able to see the incredible benefits of cooperative learning through my graduate classes at the University of Nebraska at Lincoln. Through the Math in the Middle program, I have been

immersed into an atmosphere that expects students to form partnerships with each other. Teacher-led lessons were still taught periodically, yet the foundation of the classes has been based on collaboration. I have taken much more knowledge from these classes due to the nature of the classrooms. I enjoyed the mathematical conversations I had with my peers as well as the deep understanding I was gaining through our discussions. I knew I had to provide my own students with the same type of incredible learning experiences.

Change is difficult. And changing an educator's teaching style is one of the most difficult challenges in educational reform. I have struggled to transform my classroom into a cooperative learning environment. I take small steps each year, making small strides towards the mathematical teams I envisioned. Although I cognitively attempt to change, I often fall back into the teacher-led routine that is familiar. The significant point at which my classroom became a more student-centered atmosphere was during the 2006-2007 school year. I switched math curricula due to a move into a different school district. It has taken drastic measures for me to renovate my teaching and I continue to take measures for this renovation.

My new math classroom centers on curriculum that meshes together traditional concepts in a problem solving fashion. The concepts I introduce in the context of real-life problems and students have the opportunity to explore these mathematical concepts. The Algebra book I have used[1] recommends having the students work in teams throughout the entire year. In fact, the first unit focuses only on the importance of teamwork, how mathematical discussions with your team members benefit you as a learner, and has tips on how student can work as a team. I had become immersed in cooperative learning. All of my previous excuses for teacher-led learning became invalid. I was in a position that allowed me to shed the teacher-led garment I had been wearing.

[1] College Preparatory Mathematics: 2nd edition

The setting was perfect, but the outcome was not what I was expecting. My classroom was physically set up for teaming and I had curriculum specifically designed to incorporate cooperative learning techniques, but the students were not buying into the idea. When I asked students to work in their cooperative learning groups, they cried out for step-by-step procedures from a teacher. They rarely tackled problems. If a student had a question, he/she looked to the teacher before his/her own team members. Many students chose to do nothing rather than to attempt the problems and risk being wrong.

The cooperative learning atmosphere that I had envisioned was different from what was actually occurring. I wanted my students to feel confident enough to try a problem without my help. It seems natural to expect teams to act as a support system and answer members' questions before turning to the teacher. Team members should be able to trust one another and feel free to make mistakes, explore concepts, and enjoy the "search" for understanding. The members of the team ought to help, encourage, and push one another to understand the concepts. I had wanted someone in each group to naturally step up and become the leader. I had wanted to be the guide for students, someone who questions rather than lectures on how to do the mathematics. I had wanted my students not only to be students, but to also be teachers.

How could I make all this happen? Are the benefits of cooperative learning worth the struggle and fight it might take to get there? How do I teach my students how to talk about math, work in teams, and stay on task? I needed to learn more about this educational strategy in order to teach my students properly.

PROBLEM STATEMENT

Many would agree with the axiom, “two heads are better than one.” Cooperative learning is based on this. Johnson and Johnson (1999), leading experts in cooperative learning, have studied and analyzed numerous educational settings. Together, they proclaim, “Working together to achieve a common goal produces higher achievement and greater productivity than does working alone. This is so well confirmed by so much research that it stands as one of the strongest principles of social and organizational psychology” (Johnson & Johnson, 1999, p. 72). For too long the educational arena has ignored the boundless research that proves students learn more when they work together. Educators would do well to embrace “one of the greatest success stories in the history of educational innovation” (Slavin, 1999, p. 74) and begin to successfully implement cooperative learning.

Cooperative learning is a powerful tool for learning. Research shows that students learn and understand more when they discuss and collaborate on mathematics. Yet how do educators make the risky transition from a traditional teacher-led classroom to a seemingly less-controllable team-based environment? I believe that more teachers would be willing to incorporate the idea of cooperative learning groups into their classrooms if they better understood the benefits of teaming and knew what type of structure was needed for the process to be successful.

Educational research reveals that cooperative learning can benefit students’ learning. Now one needs to identify the details and structure of a successful cooperative learning classroom. Education as a whole seems to be on the verge of taking a giant step in the direction of cooperative learning if educators listen to the research and alter their teaching practices. The

more information available, the more prepared we are as educators, and as a result the more our students will learn.

LITERATURE REVIEW

A review of the literature surrounding the topic of cooperative learning uncovers how crucial this educational reform can be to our schools. Cooperative learning has become a sought after method of teaching, thus creating an enormous amount of literature and research. The research provides readers with the following themes of cooperative learning: cooperative learning versus group work, benefits of cooperative learning, implementing cooperative learning models, conditions to promote cooperative learning, and grouping students. This review of literature provides convincing evidence for the need to implement cooperative learning, as well as structures to promote a successful cooperative learning classroom.

Cooperative Learning versus Group Work

To begin our discussion of cooperative learning, we must have a clear working definition**.** Cooperative learning groups promote higher academic performances from all students. Dr. Roger Johnson and Dr. David Johnson have been involved in the cooperative learning field since the 1960s. They are the co-directors of the Cooperative Learning Center, which conducts research and training nationally and internationally on changing the structure of classrooms and schools to a more cooperative environment. Johnson and Johnson (1999) define cooperative learning by saying, “Students work together to accomplish shared goals. Students seek outcomes that are beneficial to all. Students discuss material with each other, help one another understand it, and encourage each other to work hard” (p. 68).

Cooperative learning is often misinterpreted as a group of students working together on a common task. Dr. Slavin, co-director of the Center for Research on the Education of Students Placed at Risk at Johns Hopkins University, is an influential advocate for cooperative learning. He discusses his view of group work based on knowledge gained from his many studies dealing with the topic and his experience as an author or co-author of over 200 articles and 15 books focused on the educational arena. Slavin (1999) warns teachers of the risk they take by approaching cooperative learning in such a way by saying:

> This 'group work' creates the danger that one child can do the work for the whole group, that some children will take the 'thinking roles' in group activities while others take clerical or passive roles, or that some children may be ignored or shut out of the group activity, especially if they are perceived to be low achievers (p. 74).

Each of the situations described above directly oppose what theorists encourage through cooperative learning. Although group work may have a role in education, it is not as powerful and effective as cooperative learning.

How is cooperative learning different from group work? Dr. Kagan, founder of Kagan Cooperative Learning program, and one of the world's foremost providers of professional training of the topic, states a clear definition of cooperative learning. Dr. Kagan began researching cooperative learning in 1968 and has become an international expert on the topic. Kagan (1994) defines cooperative learning through four basic principles: Positive Interdependence, Individual Accountability, Equal Participation, and Simultaneous Interaction. Kagan explains, "established and effective cooperative learning structures incorporate all four of the PIES (Positive Interaction, Individual Accountability, Equal Participation, and Simultaneous Interaction) principles" (1994, pp. 4-5). Group work alone does not include the four principles.

Kagan suggests that the sole difference between group work and cooperative learning is the presence of the four previously listed principles in cooperative grouping. Positive Interaction, Individual Accountability, Equal Participation, and Simultaneous Interaction are essential components of cooperative learning and elevate classroom activities from group work to cooperative learning status.

Benefits of Cooperative Learning

The research supporting cooperative learning is boundless. Researchers list numerous positive outcomes associated with this innovative style of teaching. The most researched and anticipated benefit of cooperative learning is higher academic achievement and social skills development (Johnson & Johnson, 1999; Kagan, 1994; Leiken & Zaslavsky, 1997; Ma, 1996; Siegel, 2005; Slavin, 1999; Toumasis, 2004). Tied to increased academic achievement is the development and growth of higher level thinking skills, more frequent transfer of learned concepts to new situations, and more time-on-task (Johnson & Johnson). This academic progress is especially noticeable among minority and low-achieving students (Kagan 1994; Leiken & Zaslavsky, 1997; Ma, 1996).

Cooperative learning also aids students in developing social skills. Teaching appropriate social behaviors to students is increasingly important due to the growing needs of children today. Cooperative situations help students learn these skills by working together. In a three-year study, Toumasis (2004) researched the effect cooperative learning had on 8^{th}-10^{th} graders' ability to read and understand mathematical textbooks. Toumasis determined that working cooperatively helped students "…form new friendships and learn to appreciate differences in ability, differences in personal characteristics and differences in opinion" (p. 669). In addition to

learning social skills, cooperative learning has a positive impact on classroom climate, content communication, students' self-esteem, attendance, students' attitudes towards education, and students' psychological health. Cooperative learning has also been shown to decrease special education placements, classroom/content anxiety, and disciplinary referrals (Johnson & Johnson, 1999; Kagan, 1994; Mueller & Fleming, 2001; Siegel, 2005; Slavin, 1999; Toumasis, 2004).

Implementing Cooperative Learning Models

Now that we know what cooperative learning is and how it benefits students, how do we successfully implement it? Due to the vast array of research, there exists numerous cooperative learning models to structure classrooms upon. Models such as Slavin's 'Student Team Learning', David Johnson and Roger Johnson's 'Learning Together', and Kagan's 'Kagan Cooperative Learning' are a few of the leading models in the world of cooperation.

Although the melting pot of learning models can be refreshing to stir up and dip into, leading researcher Siegel (2005) does not recommend teachers do so. Siegel explored an eighth grade mathematics teacher's implementation of a district-imposed cooperative learning strategy. From her observations, she concludes that just the opposite should happen, as she points out "…fidelity of implementation can be increased when teacher attention is focused on one model" (p. 347). In addition to focusing on one cooperative learning model, Siegel also found that teachers must believe in that model and take possession of the cooperative learning strategies in order to see successful outcomes in the classroom. She explains that, "…in order to promote the use of cooperative learning for school reform, teachers need to share in the ownership of the instructional innovation" (p. 347).

Therefore, not only is it important for one to pick a single cooperative learning model to implement in the classroom, but the educator must also take ownership of the strategies described within the model to promote a cooperative learning environment. Increasing teachers' ownership of cooperative learning models is most efficiently done through professional development training specific to the desired framework (Mueller & Fleming, 2001, p. 265).

Conditions Needed to Promote Cooperative Learning

In order to build a sturdy house, one first needs to lay the foundation. What underlying foundations need to be put into place in order to build a cooperative learning environment? Students first need to be taught what it means to learn in a cooperative group. Students who are products of traditional educational settings have internalized the idea that a "good" student quietly sits in his/her chair, faces forward, listens to a teacher dispense knowledge, and patiently waits to be called on. Cooperative learning forces students to break out of their traditional roles and work with other students in the class to learn new concepts.

Students will not "break free" of traditional expectations unless they are taught what the new expectations in a cooperative learning classroom are. Dr. Elizabeth Cohen spent much of her life researching such educational dilemmas at Stanford University. She believed deeply in an approach that focuses on the development of higher order thinking skills and cooperative group problem solving. She explains that, "If teachers want more articulate and abstract discourse, then students will need to be taught specific skills for discussions and for dealing with each other" (Cohen, 1994, p. 40). Cohen suggests that these norms and skills be taught through a training program for students that involves activities and games, referred to as "skill-builders." These skill-builders teach students positive cooperative behaviors, how to respond to needs of the

group, equal participation, and how to function as a group (Cohen). Taking the time to pre-teach and prepare students for cooperation in advance saves time in the long run and provides for more productive cooperative learning.

A second approach to building the foundation of cooperation is different from skill-building in the fact that it is repeated throughout the school year. Teambuilding and classbuilding activities are ways to create a "positive team identity, liking, respect, and trust among team members and classmates" (Kagan, 1996, p. 4), in an environment where cooperative learning is more likely to occur. Kagan highlights the importance of teambuilding and classbuilding by correlating these skills to the work place:

> Teambuilding and classbuilding activities provide unique learning experiences not afforded by traditional exclusive emphasis on academic content. Today in the workplace, Americans are learning the value of teambuilding, as they follow the successful lead of the Japanese. When teambuilding and classbuilding are neglected, especially in classrooms in which where are preexisting tensions, teams experience serious difficulties. (p. 4)

By implementing teambuilders and classbuilders in the classroom, students build stronger positive relationships with one another, thus developing a more inviting environment for cooperative learning to take place.

Finally, David Johnson and Roger Johnson provide us with another approach to promoting cooperative learning. "Cooperative base groups are long-term, heterogeneous cooperative learning groups of three to four students with stable membership" (Johnson & Johnson, 1999, p. 69). The base group provides support, encouragement, and help to its members throughout the school year. The group also meets twice a week to check-up on one another's social and cognitive progress. Johnson and Johnson believe that base groups improve the cooperative learning environment by making students feel accepted and needed (Johnson & Johnson, 1999).

Grouping in a Cooperative Learning Setting

Creating a cooperative learning classroom begins with the formation of groups or teams of students. The majority of research suggests cooperative groups be heterogeneous, including high, middle, and low achievers, boys and girls, and an ethnic and linguistically diverse representation of the class (Johnson & Johnson, 1999; Kagan, 1994; Mueller & Fleming, 2001; Toumasis, 2004). The distribution of ability levels in a group is specified as including a high-ability, medium-high ability, medium-low ability, and low ability student (Kagan, 1994, p. 6:3) with the favored number of students in a group being four (Kagan, 1994; Ma, 1996).

Summary

The main theme from the review of literature is the positive impact cooperative learning can have student learning. Mounds of research support this educational reform. Scholars have created cooperative learning models and significant strides have been taken to implement cooperative learning. “Given the situation (of our students’ futures), we need to emphasize thinking skills as well as content, and we must prepare our students to act adaptively in a very broad range of social situations” (Kagan, 1994, p. 1). Research suggests strongly that cooperative learning can increase academic achievement and develop students’ social skills. The next step is for educators find ways to implement the valuable classroom strategy of cooperative learning.

The research supporting cooperative learning is practically self-evident. However, it does not address two things that concern my mathematics teaching. I am deeply interested in knowing more about the effects of teaming on student confidence in their own math abilities and willingness to become actively involved in mathematics learning tasks. Teachers are keenly

aware of the importance of keeping students involved in the content and they understand the value of cultivating students' self-confidence in their learning abilities.

Additionally, while the researchers discussed various support structures for successful cooperative grouping, they had little to say about which strategies were most effective in teaching kids how to work together. Is simply pre-teaching cooperative learning skills through Cohen's skill-builders enough? How important is teacher support and guidance in a team's cooperative learning success? Are Dr. Kagan's teambuilders and classbuilders merely fun "games", or do they serve an important purpose in a teaming environment? Is there a best combination of support structures for successful cooperative learning in a middle level math classroom?

Finally, as I read the research, I kept asking myself how cooperative learning fits in with learning mathematics. Does teaming encourage problem solving? Does it help students learn math content and enable them to apply it to a real-life situation? What effect does cooperative learning specifically have on the mathematics classroom? This project uses much of my knowledge gained from the literature and pushes me to gain further information and answer questions not directly addressed in the research articles.

PURPOSE STATEMENT

Research clearly indicates that cooperative learning can be a vital educational strategy. In my work, I have a district curriculum and the support of a local initiative to implement cooperative grouping. This past year (2006-07), I have had significant resources, yet cooperative learning was not having the powerful impact I was anticipating. Something was missing.

The purpose of my study is to make sense out of what was missing. It is an opportunity to

enhance my knowledge of cooperative learning and determine what changes I can make for this teaching strategy to have a strong influence on problem solving in the classroom. In this study I investigate the effects cooperative learning can have: on students' confidence in their individual mathematical abilities and their involvement in the math classroom; the most effective support structures in my classroom; and students' abilities to transfer cooperative skills to less structured learning activities.

I thus constructed the following research questions:

1. How does implementing cooperative learning influence students' confidence in their individual mathematical abilities and their involvement in the math classroom?
2. What type of support structures assist students in their cooperative learning groups?
3. Do students transfer group cooperation from more-structured to less-structured learning settings in problem solving? If so, what does this transfer look like?

These questions have enabled me to explore my cooperative learning struggles and helped me realize the complexities and benefits of teaming on students' self-confidence and participation in the mathematics classroom. The research I report here has allowed me to understand how to better organize support structures and supporting students in transferring cooperative skills to new problem solving situations.

METHOD

The subjects of this study are seventy-three eighth grade students in a middle school mathematics classroom. The student population of the school is approximately 45% minority, with the minority being largely of Hispanic descent. About 65% of the student population

qualifies for free- or reduced-lunch (low-economic status). The study was conducted during the spring of 2007 in three different classrooms, each being approximately half female and half male. The first class was an accelerated Algebra course for eighth graders. The students in the Algebra class were generally motivated and responsible kids. Core 2 was the second classroom, in which general eighth grade mathematics (Math 8) was taught. The students in Core 2 exemplified a typical group of students, with five of the twenty-five students qualifying for Special Education and four of the twenty-five students enrolled in the English Language Learners program. My third class (Core 3) was also general eighth grade mathematics and was made up of twenty-five students. Ten of those students had a Special Education label and eight were considered English Language Learners. A Special Education co-teacher was present with this class. In general, the students in Core 3 struggled with the mathematical content and with being motivated in school.

Using what Siegel (2005) found in her study of the implementation of cooperative learning, I chose to focus my eighth grade mathematics classroom on one single model: Kagan's Cooperative Learning. To begin my research, I formed heterogeneous teams based upon Kagan's suggested structure. I used the students' first semester math grade, as well as my knowledge of individual students' personalities, attitudes, and learning needs to structure teams. Each team was composed of a high, medium-high, medium-low, and low achiever. The students remained on the same team for approximately six weeks, as suggested by Kagan. Therefore, during the researching timeframe, I was able to observe the development of two different sets of teams in each of my three classes.

Throughout the researching period (February 12, 2007 to May 18, 2007), I kept a personal teacher journal (see Appendix A for examples of my journal prompts). I focused my

daily thoughts on my second and third research questions by writing each day about what happened in class related to my research questions. At the end of each week, I would journal in more detail about cooperative learning support structures and the transference of cooperation into a less structured problem solving situation. The journal allowed me, as a researcher, to remember the small events that occurred and continually helped me focus my attention.

I gave surveys to all students in the three classes to further investigate students' attitudes towards math and cooperative learning. The surveys helped me answers research questions one and two, specifically student involvement, student confidence, and helpful support structures. A pre-survey was conducted on February 22, 2007 (Appendix B shows an example of the survey). A post-survey was given to the students on May 18th. The second survey included many of the same questions from the pre-survey, as well as more detailed ones (a copy of the post-survey is included n Appendix C). A total of sixty-eight students from Algebra, Core 2 and Core 3 completed each survey. Putting a name on the survey was optional to get an honest response from the students. Before each survey was given to the kids, I discussed the reasons for the survey and stressed the importance of honest and thoughtful responses.

Individual students were interviewed throughout April and May. Twelve students, evenly dispersed through the three classes, were asked to participate in the interview (see Appendix D). The responses to the interview questions gave me more detailed information on students' views of their involvement in the math class as well as their personal confidence in their own mathematical abilities. I randomly selected teams of students to be interviewed. Team 3 from my Algebra class and Team 3 and 4 from Core 2 were interviewed. I asked questions of all four team members at the beginning of their six weeks together and after their time as a team was finished (samples of the interview questions are found in Appendix E and F respectfully). Throughout the

interviews, I collected data on what support the students believed was helpful in their time together as a team.

In order to determine a student's ability to transfer cooperative learning skills into a less-structured problem-solving situation, I chose to have the teams complete four different Habits of Mind problems during the researching timeframe. Habits of Mind problems are problem solving situations that require students to pull mathematical knowledge from past experiences and incorporate their various problem solving skills into one solution. The problems are not directly related to concepts currently being discussed in class. Students were given Habits of Mind #1 to complete individually. Approximately three to five days later, the students were given the same problem and were asked to complete it with their team members. A Habits of Mind problem was given in this fashion at the beginning and ending of each set of teams. Habits of Mind #1 and #2 are more structured and concrete in nature, where as Habits of Mind #3 and #4 require more abstract thinking (Appendices G, H, I, J, & K). Then I collected and analyzed all of the individual and team solutions.

I had originally planned to video teams of students every other week throughout the six weeks teams were together. My hope was that the videos would allow me to further determine if student involvement increased the longer a team was together (Research Question #1). I also wanted to use the videotapes to observe the transferring of cooperative learning skills into a problem-solving situation (Research Question #3). Unfortunately, I was unable to receive finalized Institutional Review Board (IRB) approval of my research early enough to begin videotaping the first set of teams. As the second set of teams began, we quickly ran into scheduling issues (district assessments, testing, end-of-the-year activities) as most teachers do in the last seven weeks of school. Approximately four videos of student teams were collected. I

chose not to include that data in this study due to the minimal number of videos I was able to collect.

FINDINGS

Students in a successful learning environment radiate certain positive characteristics. Two of those important characteristics are confidence in their abilities and involvement in their learning. In my classroom, I continually strive to increase the confidence and involvement of each of my students. I was interested in the effect of cooperative learning on these two student characteristics. Through my research, I hoped to identify the role cooperative learning plays in students' confidence in their individual mathematical abilities and their involvement in the math classroom.

Student confidence is evident in the way a student carries himself/herself. A confident math student is willing to try problems, learn from mistakes, and help other students. When students choose to work towards understanding rather than seeking immediate answers, I know they are confident in their math abilities. Student involvement in learning can be demonstrated through a student's body language, verbal participation, and social interactions. An involved student has eye contact with the appropriate person(s), attempts the math problems, asks questions when needing clarification, participates in activities, and is an overall active class member. Direct interaction with the teacher is not a necessary requirement. Students can be involved in the learning process by interacting with their peers, teacher, or both.

Student confidence is one of the main challenges I struggle with each year. This challenge is especially evident in mathematics classrooms due to a preconceived fear of math. My research indicates that students feel more confident and like they understand the concepts

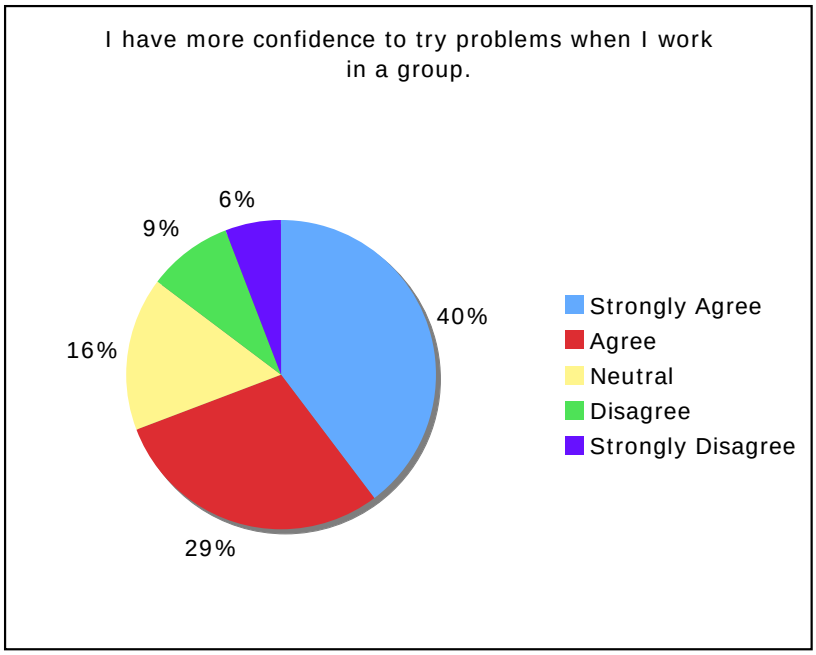
covered in class when they work in cooperative learning groups. Of the twelve students interviewed, all except one said they felt more confident in their math abilities when they worked with their cooperative learning team as opposed to working alone. When I asked students which environment they were more confident in, some of their comments were as follows:

> Working in my group because if I make a mistake, they will be there to tell me if I did it right. That makes me confident to know that I will always have at least one person in my group helping me. (Core 3)
>
> With a team because I can concentrate more. (Core 3)
>
> With my team, because I can get more opinions to see if I do something wrong. Sometimes I don't catch it when I do something wrong. (Algebra)
>
> When I work with my team. Because I know I have a better chance of getting the questions right since I can ask people and check. (Core 2)

Therefore the data suggests that students are more confident in their math abilities when working with their learning teams. Still, not all students have a high level of confidence when it comes to mathematics. My research shows that students have a higher confidence level in teams as compared to working individually.

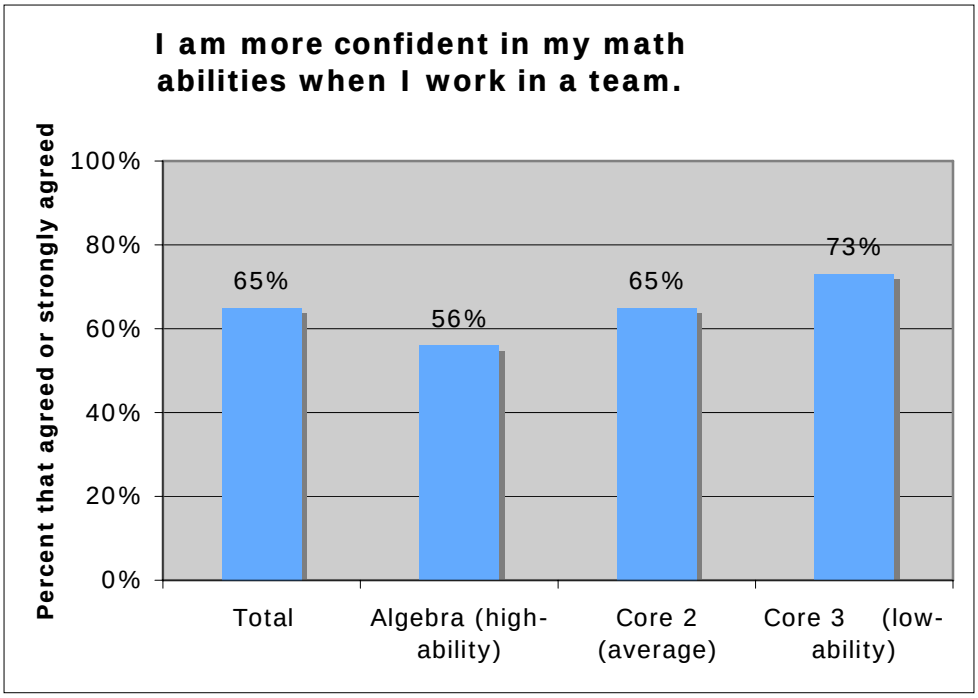
The survey results for confidence levels were very telling. Overall, 69% of my students said they had more confidence to *try problems* when working in a group. Only 15% of the students disagreed and decided they felt more confident to *try problems* when working alone (See Figure 1). Over two-thirds of the population was more willing to try math problems when surrounded by the support of other team members.

Figure 1



When in a team setting, 65% of students answered that they were more confident in their overall *math abilities.* The information I find interesting is the percent that said they were more confident in their math abilities when working in a team for each of my three classes (See Figure 2). My Algebra students, who are at the top of their eighth grade class in mathematics and visibly have the most confidence, reply by only 56% of them claiming to be more confident when in a group. Core 2 has on-grade-level students and responds with 65% of them being more confident in teams. And finally, 73% of the students in my Core 3 have more confidence when working in a team. My Core 3 students struggle due to learning disabilities, reading issues, and being English-Language-Learners. Therefore, the data suggests that 65% of all students have increased confidence in their math abilities when working in teams and students with lower math abilities feel more confident in their abilities when working in cooperative learning teams.

Figure 2

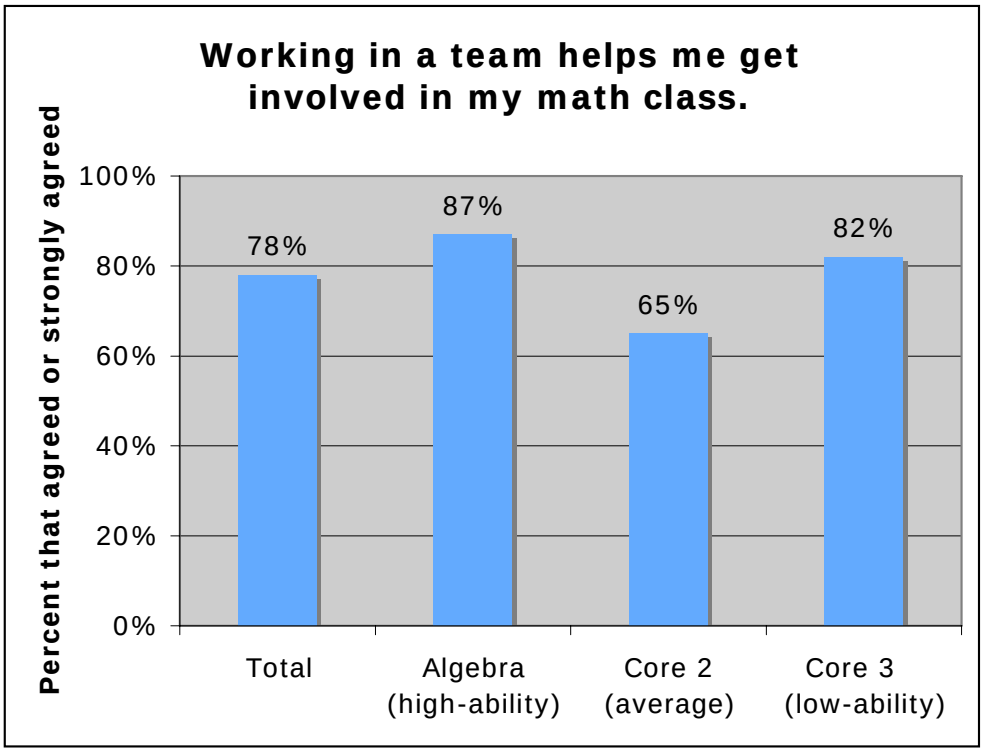


Students' confidence and involvement is related to a student's understanding of the math concepts being taught. Although large gains in confidence and involvement were not found through the research surveys, interesting statistics were uncovered dealing with student understanding. 68% of students in the pre-survey agreed or strongly agreed with the statement, "Working in a group helps me understand the concepts better." In the post-survey, 84% of students felt teaming helped them understand the mathematics. A 16% increase from the pre-research survey suggests that more students realized the significant role teams played in the learning process. Also, I believe changes made during the researching time frame (support structures, teacher support, pre-teaching of cooperative learning expectations, etc.) helped to increase students' awareness of their understanding and learning.

How does cooperative learning affect students' involvement in the mathematics classroom? The results of the post-survey suggest that students become more involved when working in a group. 78% of the students agreed or strongly agreed with the statement: Working

in a team helps get me involved in my math class. Interestingly, the Algebra class and the low-level Core 3 class have 87% and 82% positive remarks respectively, while the "middle-ability" Core 2 class has 65% of the class in agreement that they become more involved when working in teams (See Figure 3). The high-ability students are more tuned-into their own learning since they are (in general) more mature, while students with lower math ability understand the fact that they need help and having a team to help them is beneficial. According to my observations, I believe the on-grade-level Core 2 students are more involved in their learning than they are cognitively aware of. Overall, the data shows that over three-fourths of the sample population feels more involved in their learning as a result of cooperative learning techniques.

Figure 3



Although only 78% of the sixty-eight students surveyed claims that cooperative learning helps them get involved in their learning, the individual student interviews reveal a different statistic. All of the students I interviewed stated that cooperative learning teams did help them

get involved in the math content. When asked to explain why they thought teaming helped them get involved, students explained with comments such as:

> You have someone to talk to and compare your answers with to make sure you are doing it right. (Algebra)
>
> I stay focused and try harder to figure out the problems. (Algebra)
>
> You get to help people and people get to help you. And it is more fun to get involved because you have more confidence when someone is helping you. (Core 2)
>
> We talk about math. We talk about the problem. When I don't understand a problem, they simplify it out for me. (Core 3)
>
> My team is smart. And if I don't get it, they will take time with me and show me how to do it. (Core 3)

One student brought up a valid discussion of other factors that play a role in the ability of cooperative learning teams to involve students in their learning. She explains that teams are not always the best way to involve students. "It depends on who the people [in your team] are. Some people pay attention and some people don't pay attention. Or some people don't talk. Or some people like to mess around. Or they don't have their stuff, which makes it hard to share with them or keep them on task" (Core 3). This student's comments indicate that cooperative learning is only one of many other strategies teachers can incorporate into the classroom. Other important teaching practices such as proximity, classroom management, and high expectations can be fused with cooperative learning to create an educational environment in which all students are involved. Cooperative learning is a powerful tool in the quest to get students involved in the learning process.

The successful implementation of cooperative learning requires teaching approaches not necessarily present in traditional classrooms. Cooperative learning, like all education models, can incorporate support structures to ensure success. What type of support structures assist student in

their cooperative learning groups? I used my research to find a powerful combination of support structures which maximized the potential influence of cooperative learning.

Different students need different types of support structures. Therefore an educator can use various forms of support to make cooperative learning successful. Simply putting people together does not constitute a team. To stay consistent with a single cooperative learning model, I chose to include the support structures from Kagan Cooperative Learning into my classroom during the researching timeframe. Teambuilders are activities aimed at "turning a group of four students with different backgrounds and experiences into a cooperative and caring team" (Kagan, 1997, p. VIII). Kagan classbuilders were also incorporated into each of my classes. Classbuilders are similar to teambuilders, except they focus on "taking a room full of individuals with different backgrounds and experiences and becoming a caring community of active learners" (Kagan, 1995, p. VI).

The study began with two teambuilders and one classbuilder each week throughout the researching timeframe. Since it was a change in our routine, the students and I struggled to remember to incorporate the team and classbuilders into our schedule. I quickly realized that I needed to plan these support structures in advance and write them in my lesson plans daily. Two weeks into the researching period, I made another interesting discovery. "The kids are enjoying the teambuilders and classbuilders. I need to participate also so they know I am serious about them and I am part of the class. When I participate I feel like I am strengthening my relationship with the students" (Personal Journal, February 23, 2007). And a third finding was recognized approximately halfway through the study. "In Core 3, the teams have not bonded yet. Why? I think I need to be specializing the number of teambuilders and classbuilders for each specific group of kids based on their needs. There is no set formula to make teams bond" (Personal

Journal, March 30, 2007). I realized that not all of my classes were benefiting from the number of teambuilders and classbuilders I was doing. If a teacher is planning on incorporating teambuilders and classbuilders into the classroom, the structures can be regulated based on the needs of the individual class.

Students found the teambuilders and classbuilders fun, but did these specific support structures help foster cooperative learning? When surveyed, 76% of students agreed or strongly agreed that teambuilders and classbuilders helped their team work better together. The students had learned so much about each other and expressed their appreciation of getting to know their teammates. One student commented on Teambuilders by saying, "We get to know each other and feel more comfortable around our team." Another student explained that, "I think teambuilders help because we have to work as a team." And a student from Core 3 said, "I don't talk to the people in my group out of school. I don't know much about their personal life. But teambuilders help us get to see what we have in common and it helps us work better together." In addition, some students explained the importance of classbuilders. A student from Core 2 wrote, "Classbuilders make you feel more comfortable since you know everybody better." Another student explained that, "Once you are comfortable with your class, everyone is a better worker." The research clearly shows that students enjoy activities that help familiarize themselves with their peers. When students feel comfortable with the people around them, they are able to work more efficiently with a team.

The benefits of knowing your peers were also evident in the team interviews. When I asked members of Algebra Team 3 what would help them work better as a team, they offered various responses. For instance, Sarah[2] noted the value of Teambuilder activities and "getting to

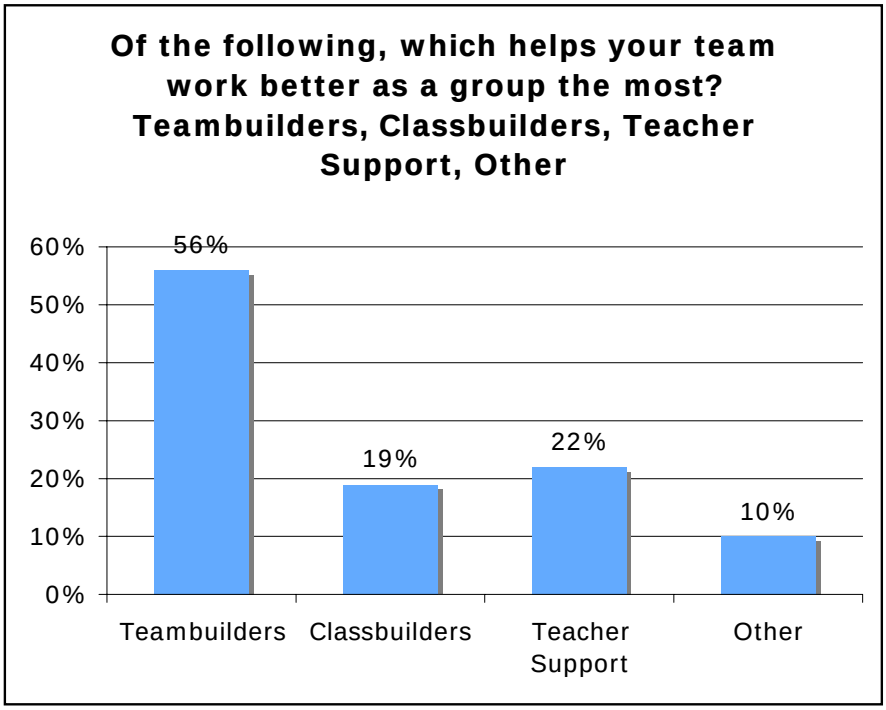
[2] All names are pseudonyms.

know each other as a person, not just mathematically. Jami says similarly that "Those [teambulders] are really fun and all of the class enjoys them. Sometimes when you don't know somebody, you just don't know what to say." Sandra goes on to tell me that "knowing other people's limits," is valuable "so you don't just set them off and then a big fight happens." These utterances show me that Algebra students appreciate time spent getting to know their team members.

Team 4 in Core 2 was also asked what I (the teacher) could have done to help them work better as a team. Jose quickly responded by saying, "More time to know each other…so we can know what they [team members] like and don't like." Ginny suggested "More of those lists of what we like and comparing them to others [on the team]" (teambuilders). I then directly asked the team if the teambuilders help. All four students gave a unanimous "Yes," with Jose adding, "And they are fun." As I interviewed the teams at the end of their six weeks together, I noticed that the interaction between the students was different from their interview when their teams were first formed. They were finishing each other's sentences, laughing, talking about other things before and after the interview. The teams' interactions made it obvious that they were more comfortable with each other and had formed a bond.

An evident theme in the team interviews and the post-research survey was the incredible value of teambuilders. How helpful did the students view teambuilders in comparison to other support structures? In the post-survey, I asked the preceding question: Of the following, which helps your team work better as a group the most: Teambuilders, Classbuilders, Teacher Support, or Other? Why? Of the four choices, the most selected support structure was Teambuilders at 56%. Secondly, 22% named Teacher Support as the biggest help. Classbuilders were chosen as most helpful by 19% of the students and the remaining 10% said Other (See Figure 4).

Figure 4



Teacher support in this context is comparable to fusing together classroom management techniques, clear classroom expectations, and skill-builders as discussed by Dr. Elizabeth Cohen. The importance of my role as the teacher became clear towards the beginning of March. I wrote, "I am probably the support structure that will make the biggest difference. I need to stay involved and discuss cooperative learning with the teams if something is not going right" (Personal Journal, March 2, 2007). I set the tone of the classroom by conveying high expectations of cooperation. The students work harder to cooperate as a team when I am involved and continuously teaching them how a team should work together. The students also discussed in their surveys how the teacher could help a team work better. One student expressed this by saying, "Teacher support also helps us by staying on task and making sure we are doing the work right and we get it too." Another student wrote, "Teacher support is good because it

gives us more confidence and more bravery to do the activity that needs to be done." The individual comments indicate the power of teacher support.

Students in the team interviews did not use the phrase teacher support, but they were definitely describing it. Shane from Core 2 suggested that a teacher should "Tell us to not talk about other stuff." Isabel said the teacher could "Give us consequences so we don't do it next time" as a way to help teams work better together, as Angela recommended she "Help us get back on subject." The final comment for teacher support was made when Shane offered the idea for a teacher to "ask, 'Does everyone understand what we are doing?' If not, help them."

Similar to the team interview in Core 2, the Algebra students emphasized the importance of teacher support. Sandra would like the teacher to "put you in a group of people that you get along with, but still get your work done." Distinguishing the difference between cooperative learning team and group work is another teaching responsibility. Jami suggested an educator "go around and make sure everyone is doing their work and not just watching other people's papers and putting down the answers they are writing." Students need to know that the teacher is expecting learning of the material as well as cooperation among team members. A cooperative learning teacher is responsible for keeping students on task, checking for understanding, and fostering successful cooperation in teams.

Falling under the teacher support umbrella is another important cooperative learning ingredient. All of the teambuilders or classbuilders in the world are unhelpful if group work is being used rather than cooperative learning. "I need to be using cooperative learning itself (Kagan structures) on a daily basis to support cooperative learning. I have to be implementing cooperative learning in order to talk to individual teams about what it means to work as a team" (Personal Journal, March 23, 2007). It may seem ridiculous to mention, yet teachers can use

cooperative learning as a support structure to assist students in their cooperative learning groups. Students are more successful in their cooperative learning groups when assigned a specific learning structure (Kagan Learning Structures for example) and an organized way of cooperating.

The quality of a team's mathematical task or problem solving challenge seems to be a direct result of how well the team works together. The more bonded a team is, the more cooperative they will be with each other, resulting in a higher quality final product. My research indicates strategies such as teambuilders are the most helpful support structures a teacher can implement in the classroom to encourage a team to work together. The students need to feel comfortable with their peers before they can open up and work as a team. Although teambuilders are important, they cannot provide enough support alone. Classbuilders help create a safe and comfortable learning environment for all students. Also, teacher support is crucial in developing a cooperative learning environment. The successful teacher believes in cooperative learning, works with individuals and teams to develop the skills for working cooperatively, and implements daily cooperative learning structures as opposed to group work. Evaluating what type of support structure is needed for each class and individualize the implementation of these structures is an important characteristic of cooperative learning educators.

As a mathematics educator, I strive to mold my students into mathematical thinkers. Problem solving is one step in that process. A beneficial problem solving situation has little structure, allowing the students to think openly and discuss various approaches to the problem itself. Since traditional cooperative learning is structural, I was interested in how incorporating a less structured problem solving situation would fit into the cooperative model. Would students be able to transfer their cooperative skills? What problem solving situations would foster more

cooperation? What would the transferring of cooperative skills look like? My research helped answer many of these questions.

Students can transfer the idea of cooperative learning into less structured problem solving situations when the problems have concrete mathematical concepts. Throughout the researching timeframe, the teams were beneficial in helping their team members arrive at the correct concrete answers. Numerous students made mathematical errors when completing the problem individually. However, when the teams worked the same problem together, all solutions resulted in correct concrete answers. This trend was especially evident in the first two Habits of Mind problems since they incorporated more knowledge or procedural questions. In Appendix L and M, a representative sample of this process is given. When working individually, the student set up his/her table incorrectly and was not able to finish the problem (See Appendix L). When the same student worked with the cooperative learning team, understanding of the concept was made. The student was able to fix his/her mistakes and complete the task (See Appendix M).

From Habits of Mind #1 and #2, I conclude that students use their cooperative learning skills in a less structured setting. However those cooperative skills are utilized at a very concrete level. Although the students transferred the concept of cooperation into a less structured problem-solving situation, the setting was still structured. Were the types of problems holding students back from cooperating at a higher level?

> The difficulty of the task determines how much cooperation occurs among the team members. I believe that the Burning Candles problem (Habits of Mind #2) was not difficult enough for the Algebra class. Many of them arrived at the correct answers individually, thus not discussing the problem much with the team (Personal Journal, April 2, 2007).

The first two habits of mind problems focused on concrete concepts, thus painting a disguised picture of transferring cooperative skills. In order to further investigate students' ability to

transfer cooperative learning skills into problem solving situations, the problems needed to be more abstract in nature.

In a more abstract setting, differences began to arise between the various classes. Habits of Mind #3 and #4 allowed me to differentiate between student ability levels. All teams in Algebra had outstanding solutions that demonstrated both knowledge of mathematics and significant cooperation among the team members. I gave this class very little prompting or direction, yet the high ability students were able to work as a team to produce quality solutions (See Appendices N & O). The students in my second core class however, needed more prompting. I stopped by each team once to discuss ideas or strategies to solve the problem. Five out of the seven teams worked together after prompting from me and bettered their individual solutions (See Appendices P & Q). The two teams that did not cooperate had one strongly negative and "cool" person each, which I believe contributed to the lack of effort in the team. Finally, my third core of students struggled with the abstract problem-solving situations. After much prompting and discussion of problem solving strategies from my co-teacher and I, four of the seven teams worked cooperatively to work towards the abstract concept solution (See Appendices R &S).

The evident trend in the research suggests that the higher-level students have an easier time working in a less structured setting. The lower level a team, the less successful they are in the transferring process. Why is this? "My Algebra kids have done a great job of this [transferring cooperation into problem solving situation]. When given a problem, they dive in together, talk it out, and solve it together. Why is this? Maturity level? Higher confidence? More disciplined? Higher expectations for themselves and their peers?" (Personal Journal, May 18, 2007). The higher-level students are more successful in transferring their cooperative learning

skills. The exact reason for this is unknown, yet I hypothesize it is due to elevated maturity levels, more confidence, and better self-discipline techniques.

A student's motivation and level of mathematical understanding play a significant role in the transferring of cooperating into a less structured problem-solving situation. The more confident students are in their overall math abilities, the more they will be able to transfer cooperation into an abstract problem. Likewise, the more stimulated students are, the more effort they will put forth when given fewer concrete instructions. Therefore, students with lower confidence or motivation require more prompting and teacher support. The transference of cooperative learning skills can happen with students of all ability levels, yet the amount of structure will vary depending on each teams' needs.

The correlation between ability level and transference of cooperative skills in problem solving situations is evident in three team interviews. I asked the students to describe how their team approaches a story problem. Each of the three teams varied in ability. The differing approaches to problem solving are also evident in the examples of student work, located in Appendices N through S. The transference level of cooperative learning appears to be directly related to students' mathematical ability.

The Algebra team was composed of high-ability learners. Jami began by replying, "Break it down first." Sarah thought the team would "usually read it through then start writing." Interjecting a thought, Jami exclaimed, "Brainstorm." Sarah continues, "Yeah, brainstorm. We write down little notes of what we said." Jami includes another team strategy. "Every once in a while we each try a way and then show each other. Then we decide which one we like the best." The Algebra team took part in true cooperative problem solving. They used some strategies we

had outlined in class, but also took it a step further with brainstorming and having each student try a different approach to the problem.

Team 3 from Core 2 was representative of average abilities. The responses I received from these four students were simply problem solving strategies. Shane explained that he "read[s] it first" and chooses to "write down important information." "Underline the important information", "do the steps that you have learned", and "plan how we are going to figure it out" is the sequence of problem solving Isabel thought the team followed. The average ability team incorporated more problem solving strategies such as reading the problem, writing down important information, and discussion the problem with the team. They applied more "textbook" strategies that we had discussed and practiced as a class.

Finally, the students from Team 4 in Core 2 had overall lower math ability. Ginny explained her team's problem solving strategy.

> We read it aloud. Quietly, so we can all hear it. Before we read it, we read the questions and then read it (the problem), and then answer them (the questions). We ask each person in our group the question and whomever we think is closest, we put that down.

Team 4 was concrete in their approach. There was little discussion or cooperation taking place between the team members. Often, these groups simply chose to go with whichever answer they thought sounded the best.

Another important discovery from the research was not directly related to the transferring of cooperative skills. I found through these Habits of Mind problems that beginning a problem individually is a great way for students to get acquainted with a problem and start an approach that makes sense to them. Then as all four individuals come together as a team, they have four different ideas and a more fruitful discussion. I believe this technique helps promote more equal

participation among team members in problem solving. In addition, allowing students to first approach the problem individually provides more structure to the team when they discuss the problem together.

Unfortunately, not everything improved when comparing individual solutions to team solutions. The amount of explanation and writing decreased with teams. Approximately 80% of the team solutions had written explanations that were less detailed when compared to the individual solutions. This means that only 20% of the students had equal or more thorough written explanations when working with their team. In general the solutions improved and the written explanations worsened when working with a team. While cooperative learning may hinder the quality of written solutions and explanations to mathematic problem, I believe other teaching techniques such as modeling could help strengthen this area of weakness.

Evidence suggests that the more practice students have in transferring their cooperative skills into less structured settings, the better they will become at it. As time went on, team solutions were more thought out, discussions were focused more on the problem, and students were more engaged. Teacher support is always necessary, especially when asking students with lower mathematical abilities to work in a less structured setting. Transference does not happen on it's own. "I think transferring cooperative skills must be a cognitive effort all year long. The teacher needs to plan tasks accordingly to make problem solving happen" (Personal Journal, May 4, 2007).

CONCLUSIONS

In the future of education, cooperative learning plays a significant role. This study has helped to prove the benefits of cooperative learning in our classrooms today. My research suggests students have increased confidence in their mathematical abilities when working in

cooperative learning teams. Students with lower abilities in particular feel more confident to try problems and work toward understanding when in a cooperative environment. Students' involvement in the learning process increases when teaming is incorporated. Also, students reported a heightened level of understanding of mathematical concepts when given the opportunity to work cooperatively.

The information gathered on the benefits of cooperative learning supports the work of many well-known education specialists. As Johnson and Johnson (1999) write, "Extraordinary achievement comes from a cooperative group, not from the individualistic or competitive efforts of an isolated individual" (p. 67). Cooperative learning teams have several positive effects on students' overall learning, including increased student achievement, classroom climate, students' confidence level, and student involvement in the learning process.

The next logical step is deciding which cooperative learning model to implement and how to ensure success. The research suggests that a teacher needs to manage various support structures. My students continuously stress the importance of knowing the other students in their team and feeling comfortable with their peers. Therefore activities such as teambuilders and classbuilders are essential for the cooperative learning process to be productive. Along with structures to increase knowledge of other students, the data indicates a strong need for teacher support. By keeping high expectations, conveying a strong belief in the power of cooperative learning, and continually teaching students how to work in a team, educators can improve their probability of successfully implementing cooperative learning. There is no magic formula. Different kids need different types of support to assist them in their cooperative learning groups.

My study supports the researchers who discuss various conditions needed to promote cooperative learning. I gave the necessary support to my students by implementing Dr. Spencer

Kagan's teambuilding and classbuilding structures, along with Dr. Elizabeth Cohen's skill-builders (form of teacher support). I agree with the importance of each researcher's concepts. I am now suggesting that teachers employ a number of these structures to foster successful cooperative learning.

Support structures enabled students to work with their team members cooperatively. Research shows that the process of transferring of these learned cooperative skills into less structured problem solving settings does occur. Students of high ability have an easier time with the transferring process than lower level students. Cooperative learning teams are able to use their cooperative skills effectively when discussing concrete concepts. Abstract concepts are more difficult for students in general, causing the transference of cooperative learning skills to be more challenging. I found little research prior to mine dealing with students' ability to transfer the concept of cooperative learning into a less structured problem-solving situation. My study suggests that with abundant support and practice, students would be able to solve both concrete and abstract problems in teams using their cooperative learning skills.

IMPLICATIONS

As a result of my study, I plan to work hard at conducting a successful cooperative learning mathematics classroom next year. The year will begin with intense skill building of cooperative teams. We will spend a significant amount of time solidifying the purpose of a team, students' roles as team members, and the importance of cooperative learning. I will continue to implement teambuilders and classbuilders at a minimum of three times a week (two teambuilders and one classbuilder), modifying the amount depending on each class's needs. Pre-teaching my role as the teacher in the cooperative learning classroom will provide my students with a

consistent view of me as a support structure. Throughout the school year, the students and I will be relearning cooperative skills and building a strong community of learners.

To promote the transferring of cooperative skills into less structured problem solving situations, my goal is to implement problem-solving tasks in teams a minimum of once every two weeks. By doing so, I believe the students will have an easier time transferring their cooperative learning skills. The more students practice, the better they become. A high expectation of problem solving will be set early in the year and maintained at a consistent level. With practice and support, I believe that all students will be able to successfully complete less-structured problem solving tasks, working cooperatively with their team.

Research shows cooperative learning as an essential component of successful classrooms. Educational reform is on the verge of taking a giant step towards this incredible teaching strategy. Educators can recognize the importance of cooperative learning and begin to take small strides towards a more cooperative atmosphere. Our children yearn for an effective way of learning and understanding concepts. Our children need cooperative learning.

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APPENDIX A: Teacher Journal Prompts

Research Questions to focus on:

2. What type of support structures assist students in their cooperative learning groups?
3. How do students transfer cooperation from structured learning settings to less structured settings in which they are asked to problem solve as a group?

Reflection Questions:

1. How does each of the two incidents I wrote about relate to my research questions?

Support Structures:

Transferring Cooperation into Problem Solving:

2. What went really well this week, related to my problem of practice (cooperative learning)?

3. What did I learn this week about support structure for cooperative learning?

4. What did I learn this week about transferring cooperation into problem solving group work?

APPENDIX B: Pre-Research Survey

Cooperative Groups Survey
Pre-Research

Name (optional) _____

Please give your honest response to each statement.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
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. Others in the group ask me questions when we work in groups.	1	2	3	4	5
4. I have more confidence to try problems when I work in a group.	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. What is the best thing about working in groups?

8. What is the worst thing about working in groups?

9. What helps your team to work better as a group?

APPENDIX C: Post-Research Survey

Cooperative Groups Survey Name (optional) _____
Post-Research

Please give your honest response to each statement.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I like to work in groups in math class.	1	2	3	4	5
2. Working in a group helps me understand the concepts better.	1	2	3	4	5
3. Others in the group ask me questions when we work in groups.	1	2	3	4	5
4. I ask questions of others when I work in a team.	1	2	3	4	5
5. Working in a team helps me get involved my math class.	1	2	3	4	5
6. I have more confidence to try problems when I work in a group.	1	2	3	4	5
7. I am more confident in my math abilities when I work in a team.	1	2	3	4	5
8. Teambuilders and Classbuilders helped me get to know other students in my class.	1	2	3	4	5
9. Teambuilders and Classbuilders helped our team work better together.	1	2	3	4	5

Please answer the following questions.

10. What is the best thing about working in groups?

11. What is the worst thing about working in groups?

12. What helps your team to work better as a group?

13. Of the following, which helps your team work better as a group the most? **Why?**
Teambuilders Classbuilders Teacher Support Other

APPENDIX D: Individual Student Interview Questions

Individual Student Interview Questions

Research Question:

1. How does implementing cooperative learning affect students' confidence in their individual mathematical abilities and their involvement in the math classroom?

Student: **Class:** **Date:**

Interview Questions:

1. What do you like best about Math?
2. What do you like least about Math?
3. What makes math easy or difficult for you?
4. What could teachers do to help students with math?
5. On average, how would you rate your involvement in math class? Why? (1 being 'not involved' and a 4 being 'very involved')
6. What helps to get you involved in math class?
7. Does working in a cooperative learning team help get you involved in your learning? If so, why do you think that is?
8. How do you participate in your cooperative learning groups?
9. What makes you participate more in your team?
10. What do you think about working in cooperative learning groups?
11. What do you like about cooperative learning groups?
12. What do you dislike about cooperative learning groups?
13. Are you confident in your math ability? Why?
14. Are you confident in your math ability when working with your cooperative learning groups? Why do you think that is?
15. Are you more confident when you work alone or when you work with your learning team? Why do you think that is?
16. Is there anything else I should know about you to better understand your problem solving in math or your general math experience?

APPENDIX E: Beginning of a Team Interview Questions

Student Interview Questions (Groups ~ Beginning of a New Team)

Research Question:

2. What type of support structures assist students in their cooperative learning groups?

Students:
Class: **Date:**

Interview Questions:

1. What is your attitude towards cooperative learning in the math classroom?

2. Why is it important to work together on a cooperative learning team?

3. What would help you work better as a team?

4. What could your teacher do to help you work better as a team?

5. What is your role as a cooperative team member?

6. How does the cooperative learning team help you learn math?

7. Is there anything you want to know from me?

8. Is there anything else I should know about you to better understand your cooperative learning experiences or your general math experience?

APPENDIX F: Ending of a Team Interview Questions

Student Interview Questions (Groups ~ Ending of a Team)

Research Question:

2. What type of support structures assist students in their cooperative learning groups?

Students: **Class:**
Date:

Interview Questions:

1. What is your attitude towards cooperative learning in the math classroom?

2. Has your attitude towards cooperative learning changed throughout the last 6 weeks with your team?

3. Why is it important to work together on a cooperative learning team?

4. What helped you work better as a team?

5. What could your teacher have done to help you work better as a team?

6. What is your role as a cooperative team member?

7. How has your role changed throughout the past 6 weeks?

8. How does the cooperative learning team help you learn math

9. How does your team approach a story problem?

10. Is there anything you want to know from me?

11. Is there anything else I should know about you to better understand your cooperative learning experiences or your general math experience?

APPENDIX G: Habits of Mind #1

Trouble with Toothpicks
Habits of Mind #1

Name _____
Team Members: _____
_____

Below is a sequence of toothpicks. The sequence continues on forever, growing the same way each time.

Figure 1 Figure 2 Figure 3 Figure 4

a. Draw in Figure 4.

b. Find the perimeter of each figure shown. Then complete the table below.

Figure Number (x)	Perimeter (y)
1	
2	
3	
4	
5	
6	

c. If you knew the perimeter of the Figure 10, how could you find the perimeter of Figure 11?

d. Write a description (complete sentences) of how the perimeter changes from one figure to the next figure.

e. Using what you know about tables and equations, write a linear equation to find the perimeter of any figure number.

f. How can you explain the rule using the toothpicks? (Show me how you know your rule works with the toothpicks. You will need to use diagrams and words on the back of this paper to explain completely.)

APPENDIX H: Habits of Mind #2

Burning Candles
Habits of Mind #2

Name _____
Team Members: _____
_____

Maria's house lost power because of a severe thunderstorm. She has two candles (we will call them Candle A and Candle B) that are both 18 inches long. Maria lit the candles at the same time. Candle A took 6 hours to burn out, but Candle B took only 3 hours to burn out.

a. On graph paper, draw pictures of both candles for each hour that passes.

b. Using what you see on your pictures, complete the tables below.

Hours that have passed (x)	0	1	2	3	4	5	6	7
Candle A (y)								

Hours that have passed (x)	0	1	2	3	4	5	6	7
Candle B (y)								

c. After one hour of burning, which candle was longer? How much longer? Explain.

d. After how much time was one of the candles exactly twice as long as the other? Explain.

e. Using what you know about tables and equations, write a linear equation to find the height of Candle A after any given number of hours.

f. Using what you know about tables and equations, write a linear equation to find the height of Candle B after any given number of hours.

APPENDIX I: Habits of Mind #3

Kisses Problem
Habits of Mind #3

Name _____
Team Members: _____
_____

Kisses Problem

(Taken from Thought Provokers by Doug Rohrer)

If there are 100 people from Hollywood at a party and each kisses every other, how many kisses take place? What if there were 200 people?

APPENDIX J: Habits of Mind #4 (Algebra)

Shaky Story
Habits of Mind #4 (Algebra)

Name _____
Team Members: _____
_____

A Shaky Story Problem

Stacy and Sam Smyth were known for throwing good parties. At one of their gatherings, five couples were present (including the Smyths). The attendees were cordial, and some even shook hands with the other guests. Although we have no idea who shook hands with whom, we do know that no one shook hands with themselves and no one shook hands with his or her own spouse. Given these facts, a guest might shake hands with as many as eight other people or the guest might not shake anyone's hands.

At midnight, Sam Smyth gathered the crowd together and asked the other nine people how many hands each of them had shaken. Much to Sam's amazement, each person gave a different answer. That is, someone didn't shake any hands, someone else shook one hand, someone shook two hands, someone shook three hands, and so forth, down to the last person who shook eight hands.

Given this information, determine the exact number of hands that Stacey Smyth shook. (Explain your answer in detail.)

APPENDIX K: Habits of Mind #4 (Core 2 and 3)

Crossing the River
Habits of Mind #4 (Math 8)

Name _____
Team Members: _____
_____

Crossing the River Problem

A group of adults (teachers and parents) go on a camping trip with a group of 4th grade students. On the first day, the campers (adults and students) come to a river. It was not a very wide river, but it is too deep to wade across. Fortunately, the campers find a boat. Unfortunately, the boat is not very big. Even more unfortunately, the adults are rather big and only one adult can fit in the boat at one time. Fortunately, the 4th grade students are quite small, small enough that the boat will hold any two of the students. Also fortunately, the students have experience boating and each can safely row across the river by them selves.

a. Suppose that there are four adults and two students on the camping trip. Is it possible to get the entire camping group across the river? If yes, how many one-way trips across the river will it take to get all six people across the river?

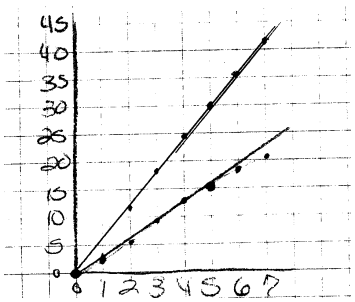
b. What if there were five adults and only one child on the trip? Is it possible to get the entire group across the river? If yes, how many one-way trips will it take?

c. What if there were 5 adults and 2 children?

d. How can this problem be generalized?

APPENDIX L: Student sample of individual solution

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.



APPENDIX M: Student sample of team solution (Same student as Appendix L)

Maria's house lost power because of a severe thunderstorm. She has two candles (we will call them Candle A and Candle B) that are both 18 inches long. Maria lit the candles at the same time. Candle A took 6 hours to burn out, but Candle B took only 3 hours to burn out.

a. On graph paper, draw pictures of both candles for each hour that passes.

b. Using what you see on your pictures, complete the tables below.

Hours that have passed (x)	Candle A (y)
0	18
1	15
2	12
3	9
4	6
5	3
6	0
7	0

Hours that have passed (x)	Candle B (y)
0	18
1	12
2	6
3	0
4	0
5	0
6	0
7	0

c. After one hour of burning, which candle was longer? How much longer? Explain.

Candle A Because it goes down 3 inches every hour. And that makes it 3 inches difference

d. After how much time was one of the candles exactly twice as long as the other? Explain.

2 Because Candle A is at 12 inc. and B is a 6 inc.

e. Using what you know about tables and equations, write a linear equation to find the height of Candle A after any given number of hours.

$Y = -3x + 18$

f. Using what you know about tables and equations, write a linear equation to find the height of Candle B after any given number of hours.

$Y = -6x + 18$

APPENDIX N: Representative Algebra Sample (high-ability)

Individual Solution for Habits of Mind #3

Kisses Problem

(Taken from Thought Provokers by Doug Rohrer)

If there are 100 people from Hollywood at a party and each kisses every other, how many kisses take place? What if there were 200 people?

1 kisses 99 people

99 · 100 = 9,900 kisses take place

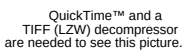
1 kisses 199 people

199 · 100 = 19,900 kisses take place

If one person was to kiss 99 people, and every single other person (100) were to kiss 99 people, then 99 · 100 = 9,900 kisses.

APPENDIX O: Representative Algebra (high-ability)

Team Solution for Habits of Mind #3




QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

APPENDIX P: Representative Core 2 Sample (average-ability)

Individual Solution Habits of Mind #4

Crossing the River Problem

A group of adults (teachers and parents) go on a camping trip with a group of 4th grade students. On the first day, the campers (adults and students) come to a river. It was not a very wide river, but it is too deep to wade across. Fortunately, the campers find a boat. Unfortunately, the boat is not very big. Even more unfortunately, the adults are rather big and only one adult can fit in the boat at one time. Fortunately, the 4th grade students are quite small, small enough that the boat will hold any two of the students. Also fortunately, the students have experience boating and each can safely row across the river by them selves.

a. Suppose that there are 4 adults and 2 students on the camping trip. Is it possible to get the entire camping group across the river? If yes, how many one-way trips across the river will it take to get all six people across the river?

13 trips will be needed to get across the river.

b. What if there were 5 adults and only 1 child on the trip? Is it possible to get the entire group across the river? If yes, how many one-way trips will it take?

No it is not possible

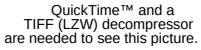
c. What if there were 5 adults and 2 children?

21 trips

d. How can this problem be generalized?

APPENDIX Q: Representative Core 2 Sample (average-ability)

Team Solution Habits of Mind #4



c. What if there were 5 adults and 2 children?

It would take 21 trips for 7 people to go across the river.

d. How can this problem be generalized?

X	Y	
1	4	+4
2	8	+4
3	12	+4
4	16	
5	20	+4
6	24	+4
7	28	+4
8	32	+4
9	34	+4
10	40	

$y=4x+0$

$4(x)$

Students

X	Y	
2	1	+2
3	3	+2
4	5	

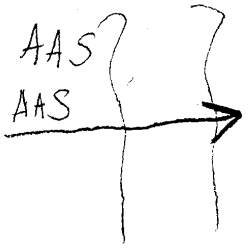
APPENDIX R: Representative Core 3 Sample (low-ability)

Individual Solution Habits of Mind #4

Crossing the River Problem

A group of adults (teachers and parents) go on a camping trip with a group of 4th grade students. On the first day, the campers (adults and students) come to a river. It was not a very wide river, but it is too deep to wade across. Fortunately, the campers find a boat. Unfortunately, the boat is not very big. Even more unfortunately, the adults are rather big and only one adult can fit in the boat at one time. Fortunately, the 4th grade students are quite small, small enough that the boat will hold any two of the students. Also fortunately, the students have experience boating and each can safely row across the river by them selves.

a. Suppose that there are 4 adults and 2 students on the camping trip. Is it possible to get the entire camping group across the river? If yes, how many one-way trips across the river will it take to get all six people across the river?



b. What if there were 5 adults and only 1 child on the trip? Is it possible to get the entire group across the river? If yes, how many one-way trips will it take?

NO because how will the boat get back

c. What if there were 5 adults and 2 children?

YES 20

d. How can this problem be generalized?

yes 2 adults go with one child
Jatlc + 2c

APPENDIX S: Representative Core 3 Sample (low-ability)

Team Solution Habits of Mind #4

Crossing the River Problem

A group of adults (teachers and parents) go on a camping trip with a group of 4th grade students. On the first day, the campers (adults and students) come to a river. It was not a very wide river, but it is too deep to wade across. Fortunately, the campers find a boat. Unfortunately, the boat is not very big. Even more unfortunately, the adults are rather big and only one adult can fit in the boat at one time. Fortunately, the 4th grade students are quite small, small enough that the boat will hold any two of the students. Also fortunately, the students have experience boating and each can safely row across the river by them selves.

a. Suppose that there are 4 adults and 2 students on the camping trip. Is it possible to get the entire camping group across the river? If yes, how many one-way trips across the river will it take to get all six people across the river?

11 1111 1111 11

The two kid cross the river One kid takes boat back then a adult adult goes across the the kid that still on the other side brings the boat back this pattern repeats it self. 4 times

b. What if there were 5 adults and only 1 child on the trip? Is it possible to get the entire group across the river? If yes, how many one-way trips will it take?

NO It won't work because if one person takes the boat No one can bring it back across

c. What if there were 5 adults and 2 children?

follwing the step we use in Part A it took 21 1-way trips to get everybody acrossed the river

d. How can this problem be generalized?

2 Students, 1 student ← adult adult goes → and it repeats.