Research Question

Will direct instruction in cooperative learning and meaningful group work result in an increase in students’ desire to be part of trusting collaborative groups?

Background

In my first year of teaching AP calculus, I observed a group of female students who chose to work together and appeared to do better in the class and on the AP exam than they might have done otherwise. Although I arranged the desks in my classroom in groups, I did not do much to encourage the students to actively work together or to form lasting relationships with their group members. These girls, however, frequently chose to work together both in class and outside. They would come together after school to work on challenging assignments, and I know that they also studied together on the weekends. I observed them discussing math, and noted that they recognized each other’s strengths. As individuals, they seemed to be confident that if one did not understand a particular concept, someone else in the group would be able to explain it. While two of the students had shown aptitude for math through prior classes, the other two were what I would consider “average” math students. They got A’s and B’s most of the time, but I could always tell that they had to work hard to understand the concepts. In addition to being some of my best students throughout the year, all four girls passed the AP exam (i.e. scored “3” or higher). This is particularly notable because only 8 students overall passed the exam (out of 42 in the class). I believe that they would not have done as well if they had been working alone.

Research Problem Statement

I believe that high school calculus students can benefit from cooperative learning. Some students form cooperative groups naturally, but most teenagers don’t know how to learn as part of a group. They may not recognize the benefits or may not have had positive instruction and experience in effective cooperation. They may not trust each other, or may have had negative experiences with “group projects” which have tainted their views of cooperation. My goal is for students in my AP calculus classes to increase achievement in the class and on the AP exam by forming trusting cooperative learning groups. I will provide direct
instruction in team skills as well as the reasoning behind the group activities that we do in class.

The Students

For my action research project, I focused on my fifth period AP calculus class. The class had 29 students (all seniors) and meets every day for 50 minutes. I also taught an AP calculus class that has 32 students and meets every other day for 90 minutes. While I planned to implement many of the same strategies in that class, I found that because of the size, the frequency, and the relative ability of the students, I had more “extra” time in the fifth period class in which to try new things, do team-building activities that are not necessarily directly related to math, and to sit back and observe. I also felt that I knew the fifth period students better because I see them every day.

Data Collection

The main source of data collection was observations of the students as they worked together in class. I collected some information about the students’ attitudes about group work as part of the team building, and I also conducted a survey of the students’ attitudes about group work at the end of the semester. I used students’ achievement (i.e. grades) as a source of information in forming the groups, but there were too many variables to consider students’ grades an accurate reflection of the success of the strategies, such as the increase in the difficulty of the material throughout the year and students’ variable level of effort due to academic and other commitments. I also expected to see a rise in my students’ AP exam scores at the end of the year, but I think that any increase in their scores may also be attributable to other changes in my instruction based on my experience with it last year.

As I observed the students working in groups, I looked for evidence that the students were working effectively together. I expected to see the groups forming a comfortable group dynamic, with all students participating and all voices heard. While I didn’t have the time or resources to conduct a complete course in group behavior and conflict resolution, I hoped to establish an environment where the students recognized conflict if it arose and were willing to work through it with my assistance.

Timeline of activities

I knew that I would be doing a project of this sort when school started back in August, so I arranged the desks in groups and asked the students to choose groups and to remain in those assigned seats until further notice. I explained to them my interest in helping them to become collaborative learners and related my story about the students from the previous year. I initially allowed them to choose whom they wanted to work with – my first thought was that the students would be more likely to seek out the group outside of class if the group members
were already friends. Throughout the first quarter, I did sporadic, isolated activities to establish the cooperative environment. In particular, I put into place two policies that have helped me to implement the group activities later on: (1) Students were expected to meet with their groups outside of class for at least one hour per unit. (2) Whenever the students worked together as a group, they each worked on their own papers, but I randomly chose one to grade for the whole group.

At the end of the first quarter, I observed that although most of the groups seemed to get along well and were trying to work together, I was not seeing the benefits to all of the students in their grades. One of the groups had two students with A’s and two with D’s. That is an extreme case, but I noticed some grade disparity in almost all of the groups. I talked to a few of the lower-performing students informally, and they confided to me that although they liked working with their friends, they felt frustrated that their friends understood the concepts so much more easily. They were reluctant and sometimes even embarrassed to ask questions or ask the group to slow down.

So at the beginning of the second quarter I decided to change the groups around. I sorted the students by quarter grade, and then split the group in half down the middle. I formed groups of four by taking the first two students in each half, then the next two, etc. (with a little bit of editorializing to balance gender and to separate students that I felt needed to be separated for social reasons). I expected some complaints from the students, but after explaining to them how and why I had made the change, they accepted it. As a matter of fact, some students were actually grateful that I had made the change for them so that they did not have to express a desire to be separated from their friends.

Specific Activities and Observations

The following pages contain descriptions of seven activities I used and accompanying observations I made.

I. Positive/Negative Outcomes of Group Work

Shortly after setting up the new groups, I asked the students to reflect on what they thought were the potential positive and negative outcomes of working in groups. I adapted this activity from one I read about on the web at http://teaching.berkeley.edu/bgd/collaborative.htm. The activity proceeded as follows:

First I gave each student three index cards. I asked half of the students to reflect on the potential positive outcomes, while the other half considered the potential negatives. They were to think about these questions individually and write their ideas anonymously on the cards.

Then I collected all the cards from each group and “traded” them with another group who had answered the opposite question. I asked the groups then to look at all of the responses they had received and condense them into two to four common themes. I asked them to do this part of the exercise with the
opposite question because I wanted them to think in depth about both questions, but I also wanted them to consider other students’ ideas without any preconceived ideas they might have developed while thinking independently. I had each group write their themes on a piece of newsprint that we then posted on the wall in the back of the classroom.

After the students had a chance to read all of the other responses, I led them in a whole class discussion of what they had written down as positives and negatives. I emphasized the positive outcomes and had them do some brainstorming on possible ways to avert the negative outcomes or to solve problems if they occur.

The rationale for this activity was twofold. First of all, I wanted to students to have an opportunity to get to know their new group members and to work together on a low-pressure activity. Although I considered this topic extremely important, there was no grade attached to this activity and all students, regardless of their achievement so far in calculus, could participate equally. Secondly, I was looking for a way to help students recognize positive and negative group behaviors without dictating a set of “rules” for working in groups. As seniors, I believe that these students have had enough experiences to recognize what is acceptable and not in group situations, even if they don’t always exhibit the proper behaviors. I think that they are more likely to embrace the positives and avoid the negatives if they feel some ownership.

Observations
On their own, the students listed all of the positive and negative outcomes that I had hoped they would think of. In the class discussion, the students seemed aware of the appropriate behaviors when working in groups. Although I have not yet observed all of the positive outcomes I had hoped for, I think this activity helped to avert some of the negative things that could have happened.

II. Choosing a Name
This activity is suggested on http://teaching.berkeley.edu/bgd/collaborative.htm, but it is also a commonly used icebreaker/get-to-know-you activity in various group situations. The group members are asked to make a list of likes and/or dislikes, such as favorite color, food, music, etc. Then they compare lists to search for some common thread. They use their common like/interest to form a name. The name doesn’t necessarily have to be based on one of their common likes, but making and comparing the lists gives them a starting point for thinking of something. In my other calculus class, I asked them to make up names without doing the “favorites” list first, and many of the groups had a hard time thinking of something.

The groups in the fifth period class named themselves Blue, The Pink Sea, Swiss Cheese, The Blues, The New Tradition, and Spongebob Mathpants,
**Observations**

Although several of the groups had a hard time finding anything common about their lists, the activity gave them a chance to get to know each other a little and enabled them to agree on a name. In my other calculus class, I asked them to make up group names without doing the “favorites” list first, and many of the groups had a hard time thinking of something.
III. Product & Quotient Rules/Everyone Takes a Step

The worksheet for this activity is attached. In this activity, each problem is broken up into 4 parts, and each person does a separate part for each problem. The students are to switch roles with each problem, so that everyone takes a turn at each role.

Observations

In some groups, the students had their heads together and were all actively participating in all steps. These groups were able to complete all of the problems on the worksheet. In other groups, however, the students were acting as if there were walls between them and they were passing the worksheet over the wall between turns. They did not get as far because each person had to start over every time, reading through the previous work and understanding the question before continuing with his/her part.

IV. Calculus Group Practice – Product and Quotient Rules

Procedure:

a. Everyone get a different color writing utensil – yes, it is OK to use pen!

b. Write your names here in your color: ________________

________________

________________


c. Take turns doing steps in the following problems, passing around the paper between steps. Have a different person start each problem. Do all of your work in your own color.

d. The steps for each problem are:

   1. Identify f and g, rewriting where necessary to put it in a good form for using the power rule

   2. Find f’ and g’

   3. Use the product or quotient formula, making minor simplifications if appropriate

   4. Plug in the x value

Problems

(1) \[ y = \left(x^3 - x + 1\right)\left(\frac{1}{x^2} + \frac{2}{x^3}\right), \; x=1 \]

(2) \[ y = \frac{3x - 7}{x^2 + 5x - 4}, \; x=-3 \]

(3) \[ y = \left(\sqrt{x} + 1\right)\left(\sqrt{x} - 2x\right), \; x=16 \]

(4) \[ y = \frac{1}{x^4 + x^2 + 1}, \; x=-1 \]
(5) \( y = \frac{x}{x + \frac{c}{x}} \) (final step is to simplify as much as possible)

V. Card Games

The first activity was a matching game in which the goal was to sort the cards into groups of four – the function, its derivative, and the graphs of both the function and the derivative. The students had a sheet on which to record their matches. I added a small element of competition to keep them motivated – the group with the most correct matches at the end of the class period received some bonus points on the ensuing quiz.

Observations

This activity lends itself well to group work because the students can easily find a way to divide up the work, but eventually they have to get back together to make sure they haven’t missed anything. It also forces them to communicate about the mathematics. Unfortunately, in some groups I found that the stronger and/or more competitive students were dominating the game, leaving the weaker or shyer students to simply observe and record the answers. Despite my efforts to balance the groups, I think there were still some groups where there was a large gap in ability between the highest and the lowest students. It appears that the weaker students are intimidated or embarrassed and they are reluctant to ask for help. I’m not sure how to resolve this issue.

The second game was a little bit different. Each group received an ordered set of cards containing multiple-choice questions. They also got one dry-erase board and marker per group. There were two different sets of cards, but the topic for each question was the same for all groups. All of the groups started working at the same time, and each card was timed. At the end of each question the student would write the answer on the board and they would all display their boards at the same time. There was a twist to the game intended to encourage cooperation while requiring that each student be involved. The group members were required to take turns working on the whiteboard. While a student was working on a question, he or she could ask any yes or no question to the other group members. The students who were not working at the time were asked to quietly observe and supervise the work, but the only words they could say were “yes” and no.”

Observations

This game definitely got more students involved. With a few exceptions, even the students who were not actively working the problems were paying attention, looking for the opportunity to answer a question or (more often) stifling the urge to correct something. Because of the time limit and the restriction on speaking, it also forced the students who were working to think through what they were asking and how they were wording their questions. They discovered that their questioning was more efficient if they used the correct vocabulary and were very specific about what they were asking for.
VI. Concepts Worksheets

These worksheets are provided with the textbook, a college-level book. They are typically more challenging and thought provoking than the homework problems and other exercises that we do. They require students to exhibit a depth of understanding that goes beyond regurgitating a process to solve a problem. This is the type of understanding that is required for success on the AP exam. However, I have found that most of my students have never been asked to think about math conceptually. Especially in SOL courses, teachers spend more time making sure that students can perform a prescribed list of mathematical tasks than ensuring that they really know what they are doing and why. We did one of these worksheets about every two weeks. I do not provide specific guidelines on how the groups should divide up the work as in the product and quotient rule activity, but I do grade them as a group. I also worked constantly this year to establish a classroom environment in which students understand they value of their own individual understanding and how they can increase their understanding by working with others.

Observations

There is some variation from group to group and student to student depending on the nature of the topic and how motivated they are to work on any particular day. However, my general observation is that some students really do want to understand while others just want to do the minimum required for a passing grade, and that difference in attitude makes all the difference in what the students get out of any classroom experience, including group work. In groups in which the majority of students are motivated to learn and understand, the group seems to function very efficiently because the students will do whatever necessary to understand and complete the task. On the other hand, in groups in which the majority of students just want to get the activity over with, whether they understand or not, the group is significantly less successful as a whole. I think this is partly because the students think it is more efficient to split up the work and do parts of it individually then copy answers than it would be to collaborate on everything. I think they also suffer when they disagree on what is important – if the dominant personality in the group is someone who just wants it done, then anyone who wants to take the time to understand thoroughly is seen as a hindrance.
VII. Survey

I gave the attached survey to the students after all of the described activities had been completed. I assured them that their responses would not be used against them and that they would remain anonymous to all but me. I encouraged them to be candid and complete in their replies. I believe that they reported honestly, telling me what they really think rather than what they thought I wanted to hear.

The results are summarized on the following pages, along with selected quotations from the students’ responses.

Analysis of the results

Overall, I think what the results suggest is that an individual’s personality and past experiences are the most influential characteristics in determining what kind of group experience they will have. Despite my best efforts to balance groups, to provide a safe learning environment, and to encourage trust and team building, the reality is that some students would rather be with their friends (whether they learn anything from each other or not) and some students would rather work alone.

The first question confirms my suspicion that many teachers are using group assignments in some form in their classes. Students in their senior year have almost universally participated in some form of cooperative learning, though they have had varied experiences. More than half of the students indicated that all of their group learning experiences have been positive, but nearly a third have had at least some negative experiences with group work. They cite such positive aspects as different perspectives and communication skills. However, they are concerned about the equal distribution of work and about issues of working with people that they do not know well and may not trust.

I did not ask detailed questions about the type of group work that students have done in other classes; i.e. whether they have done isolated group projects or whether they have been part of cooperative groups on a regular basis. I did not ask whether they have experienced direct instruction in cooperative learning because (a) I am almost certain that they have not and (b) I’m not sure that they would recognize or remember if they had. The fact that only five of the students expressed any improvement in their opinions about cooperative learning leads me to believe that either my instructional strategies were not successful in developing true group learners, or that there are other factors besides “knowing how to do it” that affect a student’s inclination towards cooperative learning.

The responses to the questions about how students solve problems were both revealing and confusing. I think it is notable that a third of the students admitted that they would rather wait for someone else to solve a problem than work it out alone or in a group. The reason that this result is so important to assessing cooperative learning in high school is that I believe that these same students think that they are participating in effective group learning if they allow
others in the group to do the work “because thy can.” In other words, they think it is OK to sit back and let the (allegedly) more capable members of the group do the work, as long as they listen to the explanation at the end. Theses are the students who end up making the others feel like the work has not been evenly distributed. I don’t think the root of the problem is poor education about how to work in groups. I think it goes a little deeper and is based on the individual students’ work ethics and innate desire to learn.

While I was not disappointed with the decision to switch groups at the end of the first quarter, it was not as successful as I had hoped. I thought that to be fair everyone needed to be switched, but I think in the process I broke up some very effective groups. I also think there are a few students who resented being separated from their friends and because of that they did not put their full effort into making the new groups work. At the same time, a few of the new groups did work out the way I had hoped, to the surprise of many of the students involved.

Cooperative Learning Questionnaire

Please answer the following questions honestly and openly.

1. Name of group: __________________

2. Before you took this class, had you worked in groups in other classes?

3. If yes, did you find these experiences to be positive or negative? Why?

4. Have the group experiences in this class changed your opinion of group work at all? Why or why not?

5. When you encounter a difficult problem, do you prefer to:
   - work it out alone
   - work it out in a group
   - wait for someone else to figure it out so they can explain it to you

6. Do you think your group experience has been:
   - more helpful
   - about the same
   - less helpful
   since we switched groups at the end of first quarter? Why?

7. When we do group work, has the work been fairly distributed in your group?
8. Do you think the time spent outside of class with your group has been helpful?

9. Do you prefer to work with:

- friends, regardless of ability
- people of equal or lower ability
- people of higher ability than yourself
- I really prefer to work alone

10. If you could choose any 3 people from this class to be in your group, who would they be? (note: This is not a promise to set up this group. Remember, you are supposed to be anonymous!)

**Survey results**

Total number surveyed: 25 (out of 29 students in the class)

2. Have you worked in groups in other classes? Yes: 24 (96%)  
No: 1 (4%)

3. Were group experiences in other classes positive or negative?  
Positive: 17 (68%)  
Negative: 2 (8%)  
Both: 5 (20%)  
No answer: 1 (4%)

Selected quotes: “Any experience is positive because you learn how to act in similar situations.”
“IT helped me improve my skills by discussing issues with others.”
“You get different perspectives on things.”
“I like using many brains to find one solution, but some people end up doing more work than others.”
“I only like working with people I already know.”

4. Have group experiences in this class changed your opinions? Yes – improved 5 (20%)  
Yes – declined 3 (12%)  
No change 17 (68%)

5. How do you prefer to solve problems? Alone 5 (20%)  
(Note: Some students circled more than one choice)  
in group 15 (60%)  
Wait for someone to explain it 8 (32%)
6. Has group experience changed since more helpful groups were switched?  
- More helpful: 8 (32%)
- About the same: 12 (48%)
- Less helpful: 5 (20%)

Selected quotes:  
- "I got to meet new people with new ideas."
- "Some people in my last group were grabby and tried to take my work before I was done."
- "I still work with really smart people… except this time they're able to explain things more clearly."
- "My grade hasn't improved much."
- "I have to stop what I'm doing and explain why."
- If you ask people you don't even know [for help] they wouldn't care and will not help you like your friend would."

7. Has group work been fairly distributed?  
- Usually: 21 (84%)
- Sometimes: 4 (16%)

8. Has time spent outside of class been helpful?  
- Yes: 14 (56%)
- Sometimes: 8 (32%)
- No: 3 (12%)

Selected quotes:  
- "It is less stressful for us and the teacher is more free to help."
- "It motivates me to do my work more, and it is more fun than doing it on my own."
- "I think it is more of a struggle to get together than the help we get out of it."

9. Whom do you prefer to work with?  
- Friends: 5 (20%)
- People of equal or lower ability: 8 (32%)
- People of higher ability: 13 (52%)

Selected quotes:  
- "Even if you all don't understand, you can learn it together and be comfortable."
Where do I go from here?

My big question at this point is whether it is within an individual’s personality to want to be part of a group, and whether I can counteract that instinct and make the students want to work this way. I know that the ideal group that observed before formed naturally, not because anyone told them to do it. I wonder whether simply teaching students how to work together will make them want to do it. I still think the experiences that I provided are valuable to them for the future because both colleges and corporations expect individuals to have cooperation skills. However, I doubt that some of my students will ever actively seek out learning groups by choice.

Next steps

I will continue to seek out meaningful group activities for students, to require them to study together outside of class, and I will incorporate non-math team building activities as time permits. I am not sure how I will organize the groups at the start of the next school year. I will most likely change the requirement for work outside of class to reflect the fact that groups often form in my classroom after school based on whoever happens to be there on a given day to work on a particular topic. Although this type of group does not have the lasting bond and trust that I had hoped to create, this type of collaboration is equally valuable and should be recognized.